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CHAPTERS ON AN

BY

MARY TREAT



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CHAPTERS ON ANTS

BY

MARY TREAT



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PREFACE.

THE "Chapter in the History of Ants" was originally contributed to *Harper's New Monthly Magazine*. It grew out of my observations of the habits of the slave-making ants (*Formica sanguinea*) of New Jersey.

The paper on "The Harvesting-Ants of Florida" was published in *Lippincott's Magazine*, and its appearance in this form is due to the kind permission of the proprietors of that publication.

M. T.

Vineland, N. J.

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TWO CHAPTERS ON ANTS.

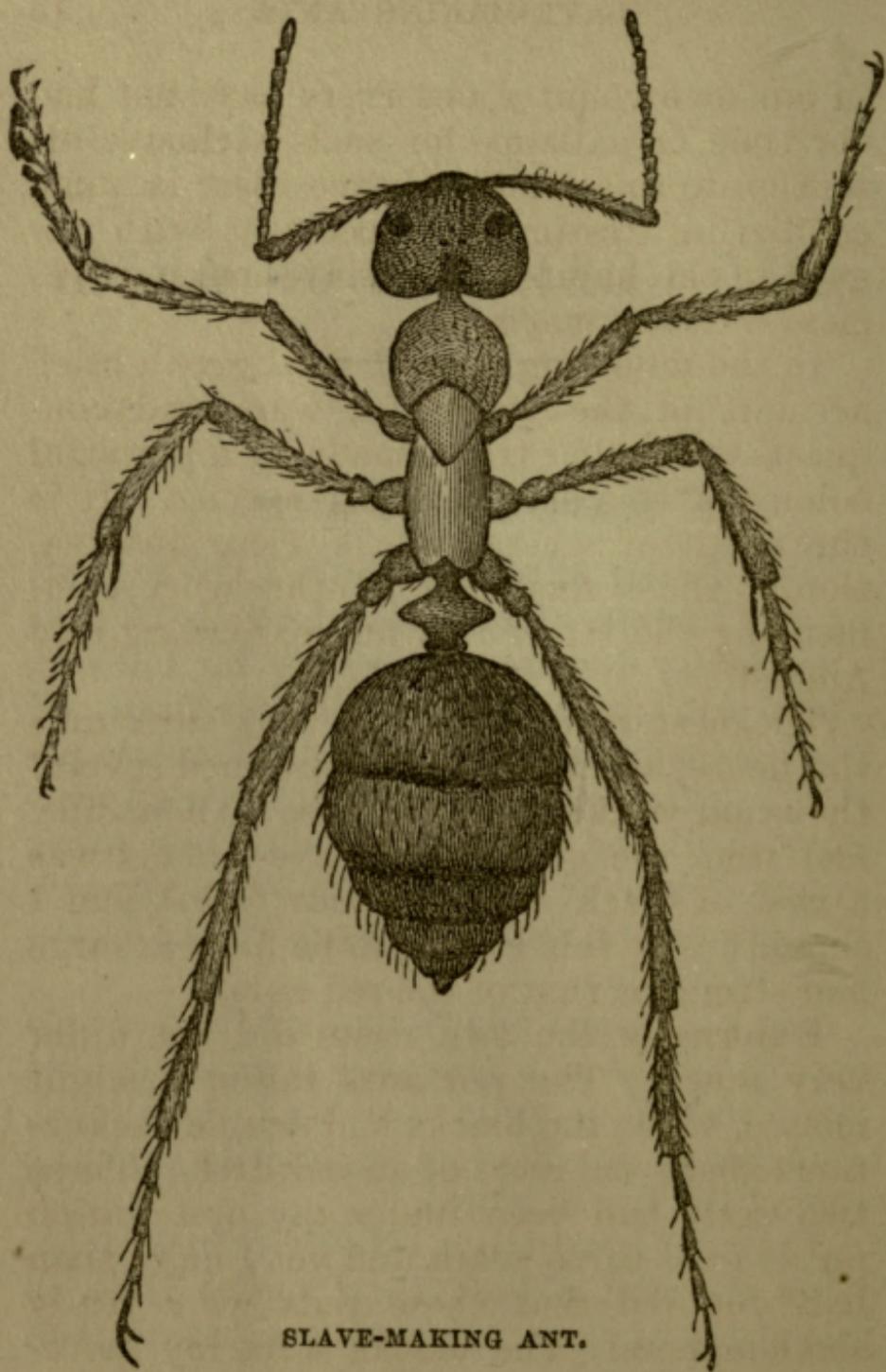
I.

SLAVE-MAKING ANTS.

THE family of ants is ranked the highest among insects. The geologist tells us that this family does not date very far back in the world's history. The lowest forms of the hymenoptera appear in the Jurassic period, but the ants do not make their appearance until the tertiary period, while other orders of insects have been found in the carboniferous era, and some even in the Devonian formation.

The anatomist shows us that the nervous system of the ant is highly organized, that the cerebral ganglia are well developed, evincing an intellectual superiority over the rest of the insect world.

Eminent naturalists, especially in Europe, have devoted almost their entire lives to the study of these interesting creatures, but



SLAVE-MAKING ANT.

in our own country observers have not had the time or patience for such exclusive attention to this family; hence there is much conflicting testimony, especially with regard to the habits of the slave-making species—*Formica sanguinea*.

In the following pages I shall give a brief account of the wonderful wars and conquests over other tribes made by a powerful colony of this slave-making species. It is the result of several weeks' close observation, to the exclusion of all other work, commencing the 1st of July and extending into August.

The nest was in a grove that surrounds the house, and must have contained several thousand working inhabitants. About fifty feet from the nest of red slave-makers was a nest of black ants (*Formica fusca*), and I should judge this colony to be fully as large and strong as that of the red ants.

Externally the two nests did not differ very much. The red ants raised a slight mound, while the blacks had simple excavations about the roots of an oak-tree. These two nests had been under my observation for at least three years, and yet I more than half doubted that these reds were really slave-makers. The blacks were my favor-

ites, being so much more quiet and steady in their habits. A black scarcely ever attempted to bite my hand, even if I used him quite roughly, but the reds would resent a slight provocation. I have had my gloved hand almost covered with the angry fellows, biting and holding on to my glove, simply because I uncovered one of the closed entrances to their dwelling. I have sometimes allowed one to bite my hand, and found it could hurt considerably, and that it left a small purple spot where its mandibles had pierced.

It is stated in scientific works that colonies of the red ant often move, and carry their larvæ and pupæ to other nests. Up to this summer I should have concurred in the above statement, as I had several times encountered a trail of red ants carrying larvæ and pupæ, and had traced the trail from its starting-point, and found only red ants emerging from excavations among rubbish, and so concluded that these ants were simply moving; but a closer and more careful study of their habits has convinced me that this opinion was founded on superficial observation.

On a sultry afternoon, the first day of July, I was lazily sauntering in the grove,

when, on looking down, I found, to my surprise, that I was in the midst of a battlefield. A powerful army of red ants had invaded the dominions of the black colony which for three years past I had had a kind of supervision over. I had often brought plants covered with aphides—the immortal Linnæus called these aphides the ants' cows—and stuck the plants into the earth around their dwelling, and had given them sugar, and had driven and carried toads from their nest which were devouring them. In short, I had become very much interested in and quite attached to this colony, but I was powerless to aid them now. I could only look on in wonder and astonishment.

A yard or more around the foot of the tree the battle was raging, and no place for the sole of my foot without crushing the combatants. I found in every instance a red ant pitted against a black; sometimes two red ones against one black, in which case the black was soon despatched. For three hours I watched the conflict; all around me the combatants locked in a close embrace, rolling and tumbling about, never separating until one was killed, and often the dead victim had fastened with so firm a hold on his adversary that it was with the

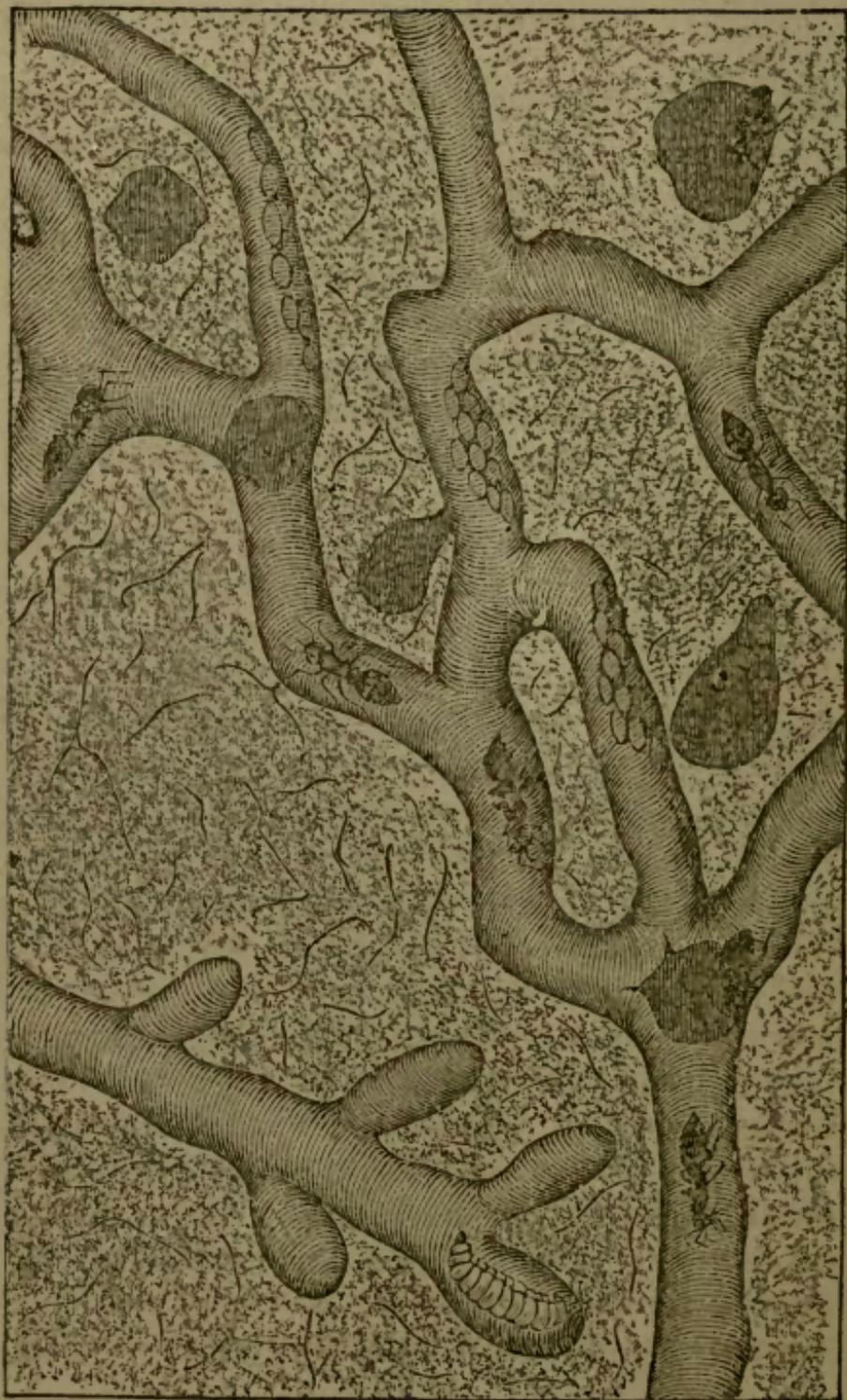
utmost difficulty that he could free himself from his death-grip.

The sun went down, and the gathering darkness compelled me to leave my post of observation; but as long as I could see, the conflict was as fierce as when I first beheld it. I now picked up several of the warriors, but so intent were they in their terrible struggle that my handling did not divert them in the least. I carried several pairs into the house, placed them under a large oval glass (the cover of a fernery) on a marble-topped table, and watched the conflict.

I found I had ten black and ten red warriors, not engaged in a general *mêlée*, but each intent upon killing his own adversary. It was fully an hour before the first warrior was killed—a red has at last dispatched his black antagonist, and not satisfied with killing him, he tears his legs from his body and severs his antennæ. After convincing himself that he is really dead, he looks around at the other warriors which are still closely locked in their dreadful embrace, and now he hurries from one couple to another, as if to see where his services are most needed. He finds a couple whose struggles are nearly over—a black is fastened with a death-

grip to his adversary's foreleg. The red hero soon severs the head from the black soldier, and leaves it hanging to the leg of his dying comrade. He now goes to another couple who are still fiercely contending; he seizes the black, and now all three roll and tumble about together; but the black is soon killed, and, as in the other case, his mandibles are locked on his adversary's leg. But this time our hero does not sever the head from the black soldier, but leaves his comrade to free himself as best he can, while he goes to the assistance of a third less fortunate brother, where the black seems to have the better of his antagonist. Here a long struggle ensues, and now another red soldier has despatched his opponent, and he comes to the struggling three, moves about them in an excited manner, with his mandibles stretched wide apart, waiting his opportunity to fasten them on the black; he finds his chance, seizes him between the thorax and abdomen, and severs the body in two; but the dying black does not relax his hold of the first antagonist, and they die together.

I now leave the fierce combatants for the night. In the morning I find that every black is killed, and four red soldiers are

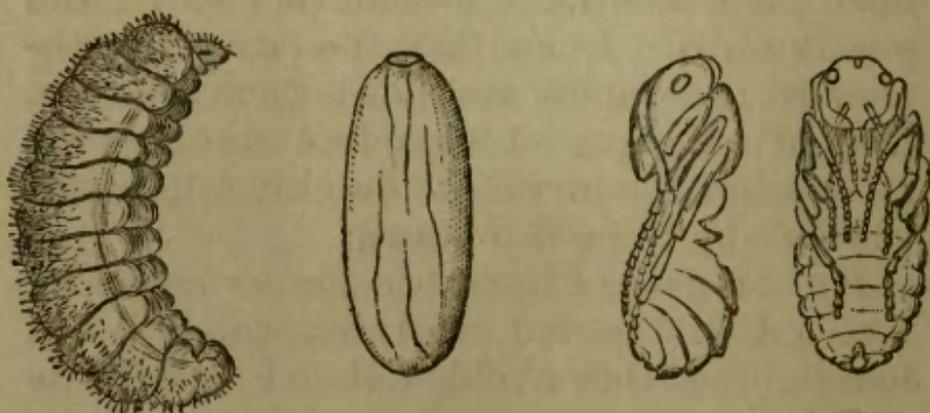


ANT-NEST, WITH UNDERGROUND PASSAGES.

dead, and two others cannot long survive. The legs and antennæ and mutilated bodies of the dead warriors are strewn about, every fragment showing conspicuously on the white marble. Out of the twenty, fourteen are dead and two nearly lifeless—only four have survived. I put some drops of water and moistened sugar under the glass for the surviving heroes: two find the water and drink. I now repair to the battle-field. The struggle is over: not a black to be seen, but a column of the red invaders is emerging from a large cavity that leads to the numerous galleries and underground chambers of these industrious blacks, and each invader is carrying a larva or pupa. I follow the column, which is from four to five inches in width, to the nest of red ants before mentioned. There is a wide opening in the side of this nest, down which they all disappear and leave their burdens, and again start for more plunder. All day long these powerful marauders are engaged in this work. They carry a larva or pupa carefully, and drop it on being disturbed. But what does this mean? Every little while a red warrior comes out with a black bundle, which he carries as carefully as he does the pupa or larva. I stop him to inquire into the mat-

ter; he drops his bundle, which immediately unrolls, and lo! it is a lively black ant, apparently unhurt, and, to my eye, no way different from the warrior with whom he was so fiercely fighting.

The books which I have read on the subject inform me that "the red ants carry the pupæ and larvæ of the blacks to their nest, where they rear them for slaves, but they never capture the adult ant, for it would



LARVA, COCOON, AND PUPÆ OF RED ANT.

not stay in the new home if they did." But these ants certainly carried a great number of adult blacks to their nest, and I am quite sure they did not run away, but stayed and helped to nurse and feed the larvæ. I capture several of the red marauders with their victims, and place them under the glass. The reds now pay no attention to the blacks,

but simply try to make their escape. I take larvæ and lay them on a leaf, and put them under the glass also, and place moistened sugar in their reach. Very soon the blacks are feeding the helpless larvæ. I remove the glass cover; the reds immediately run away, but the blacks stay, and continue to sip the moistened sugar and feed the young. I hold a magnifying-glass over them, and find the little larvæ raise up their heads and open their mouths to be fed, very much like young birds. I now take the larvæ, together with the nurses, and place them near the nest of red ants. I soon lose sight of the nurses, but the larvæ are quickly taken into the nest by the red soldiers.

By this time I have become so much interested in the red warriors, which I had heretofore rather avoided, that I resolved to devote my time to them, so I keep a daily record of their behavior. This record would be much too long for a magazine article, so I will make extracts from it.

On the 3d and 4th of July the soldiers were very quiet, scarcely one to be seen, as if they were resting after their great raid of the 1st and 2d.

On the evening of the 4th the blacks close the large main entrance through

which the larvæ and the pupæ had been carried, and compel all the inhabitants to go in and out through another smaller door. While this entrance is being closed, two or three of the red soldiers stand just within the door-way and help to arrange the sticks which the blacks bring. Occasionally a red soldier which has been meandering about the premises comes to the nearly closed entrance as if he would like to pass in; immediately the antenna of one of the guard within is thrust through a small opening, and the one outside touches the antenna with his own, and then walks away and passes through the side door.

After the entrance is closed I remove the covering; this makes a great commotion among the soldiers; a large number rush out and run about in an excited manner. Finding nothing on which to vent their rage, they soon become quiet; some return within, but a good number stay out and assist the blacks in reclosing the entrance. First they bring sticks from an inch to three inches in length and lay them across the opening, not in any regular order; often the end of one of the sticks is pulled in by those within, and the other end left sticking out. All sorts of material is brought and piled

on to the sticks—pieces of dried leaves, and a butterfly's wing nearly two inches across, small pebbles and clumps of earth, and one brings a cherry-stone; now a red soldier has found a piece of anthracite coal an inch in length and half an inch in thickness; it lies nearly two feet away from the entrance; he walks over and around it, and tries it with his mandibles as if taking its dimensions; he leaves it, and I lose sight of him among the busy toilers; but very soon a large force of workers, both black and red, have surrounded this piece of coal; it is jagged and irregular in outline, thus affording places for the workers to fasten their mandibles. They move it a few inches, and now a tuft of stiff grass is in the way; they drop the coal, and some pass over and others around the tuft; back they come and again seize it, but evidently the workers are of two minds; a part of them are determined to lift it over, and the others are equally determined to take it round the grass on a comparatively smooth road. After several ineffectual attempts to lift it over, they finally give up and join the others in taking it round. At last the feat is accomplished; this great weight is placed over the entrance, as if to hold the other material in

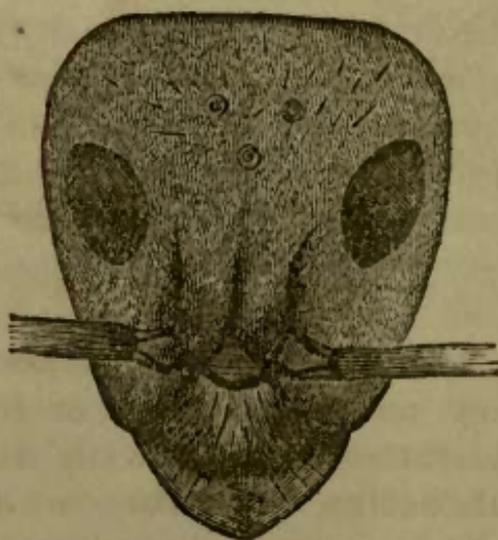
place, and to prevent another such catastrophe—the sudden sweeping away of their work. And I respect their industry and courage sufficiently to leave them for this evening in their imaginary safety.

Toward noon of the next day the blacks open the large entrance, dragging the material with which it is closed to one side; and now the soldiers come out in full force, and march in a straight line to a spot about thirty feet distant; here they diverge, and seem to be hunting over the ground; soon they find a small colony of blacks. The greatest excitement now prevails among the invaders; some are passing down the main entrance, while others are rushing about with extended mandibles prepared for conflict; but the blacks are escaping from another opening a few inches distant, not trying to defend their young in the least. Very soon the marauders emerge, each with a larva or pupa. Those outside, seeming satisfied that there will be no battle, quiet down and join the ranks in ravaging the nest. In less than an hour the spoils are all taken; and the marauders, not satisfied in sacking so small a settlement, again form in line and march directly to another colony a few feet beyond the one they have so recently plun-

dered.* They go so directly to this spot that it looks as if it must have been a preconcerted plan. This colony also proves to be a small one, and the inhabitants all flee, leaving the young to be captured. In less than two hours the spoilers have transferred the young to their own nest; and now, apparently satisfied with their day's work, they make preparation to close the entrance—the blacks are clearing the passages which their masters have littered while carrying in their booty. As soon as the passages are cleared, a large force is engaged in closing the entrance, and this proves to be a permanent closing. About the same hour, for several days in succession, the blacks continue to pile material on and around this closed door; but only a few inches distant from this a small opening is being greatly enlarged, which leads to several different galleries.

I supply the ants with coarse granulated sugar; they immediately commence to carry grain by grain to their storehouse. Occasionally I notice that an ant carries a grain opposite to the nest and drops it, and then returns to the sugar and takes the next to the nest. I moisten the end of my pencil and pick up the discarded grain, and find it

is sand. I now mix sand and sugar together; the sand is left or thrown away, the sugar only is taken to the nest. Some observers are inclined to think that ants do not store up food, and everything that is taken



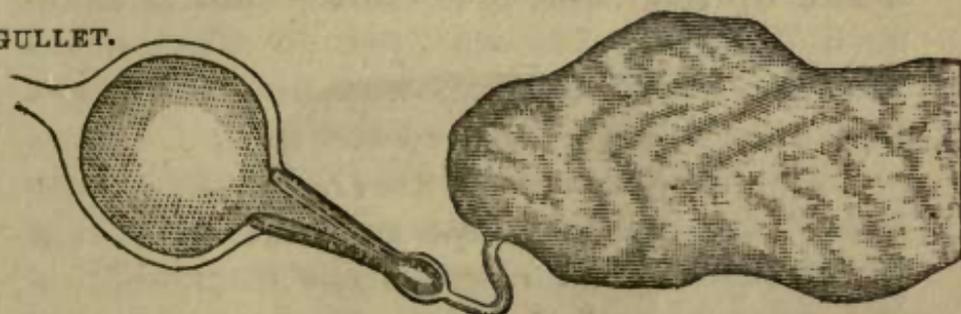
FRONT VIEW OF RED ANT'S HEAD, SHOWING
ANTENNAE AND MANDIBLES.

to the nest is for building purposes. If this were true, the sand would not be discarded.

I dissolve sugar with a few drops of water, and place it on an oak leaf; a large number of black ants, and a yellow species about the same size as the blacks, surround the edge of the sirup, jostling and crowding one another, and some that cannot find a place on the leaf mount the backs of the others

and reach down to obtain a share. These are the nurses that feed the larvæ. Their honey-sacs soon round out almost to bursting, and now they go thus heavily laden to

GULLET.



HONEY-SAC AND STOMACH OF RED ANT.

the nest. I notice at the entrance through which they pass a number of red soldiers stationed like a guard, with their heads thrust out, acting as if they would like to stop this line of honey-bearers; they touch them with their antennæ, and sometimes one puts his forefeet against the shoulders of a nurse, but uses no real violence to detain her. Most of the nurses pass in regardless of these demonstrations, but occasionally one stops and puts her mouth to the soldier's, and feeds him in the same way she does a larva. These may be young soldiers which the nurses are about weaning, but they are so old that I can see no difference in their looks or general behavior from the rest.

Huber and other observers state that the nurse assists the young ant to escape from its pupa case, and feeds it for several days thereafter. But it is quite remarkable that a red soldier seldom partakes of the sirup or honey from the leaf, yet he often takes grains of sugar to store away, and will assist in taking a large lump to the nest.

The sluggish oak moth (*Dryocampa senatoria*) afforded the ants a rare harvest. This moth deposits her eggs on the underside of the oak leaf, and she is so sleepy during the day that she will not stir when the leaf is picked from the tree, and she will even submit to being drowned without a struggle, rather than make the effort to rouse up and fly. So, on throwing one of these moths near the nest, it is soon surrounded with ants, and before it fairly awakens several pairs of mandibles are fastened so firmly on its body and head that its feeble struggles are of no avail. These moths are always taken into the nest head-first; several times I have turned a moth round just as the ants reached the entrance with it, but they would immediately turn it head-first, seeming to know as well as I did that this was the only way that it could be carried through the narrow passage.

But they do not seem to manifest so much reason in taking an earth-worm to the nest. Several red ants are coming on a gravel-walk with a worm about three inches in length; they move along the walk very well indeed, all working in concert; but soon they reach the border of dwarf iris, and are brought to a stand-still by making a loop of the worm round a stem of iris, about the same number of ants pulling at each end, neither party knowing enough to let one end drop. They try to raise it over the plant, which is about six inches high; when they get nearly to the top, something always happens to bring it down to the ground. This is repeated full twenty times; at last the strongest party are at one end, and now they soon pull it round the iris, and quickly disappear with it in the nest.

But the most remarkable feat of this kind was performed by another colony of ants—*F. schanfussii*—a trifle longer but more slender than *F. sanguinea*. It has a black head and abdomen and a russet-brown thorax, and seems to be the most intelligent species which I have observed. This species also has its nest in a border of dwarf iris, about fifty yards from the slave-owners. Some five feet from the nest I notice a number of

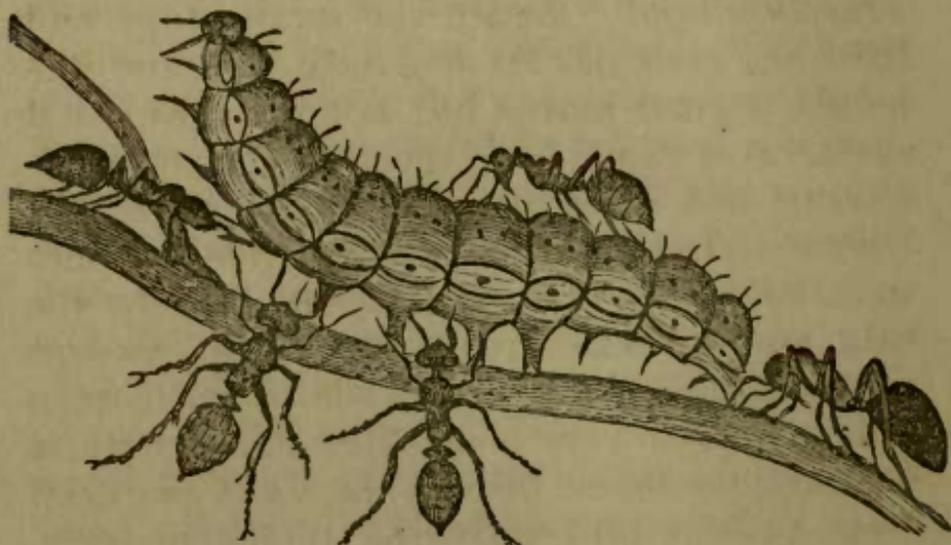
these ants congregated in the grass pulling away at an earth-worm. About two inches is unearthed, the remaining part is in the ground. Several ants are removing the earth from around the worm, while many others are holding on to it to prevent its crawling back. It is nine o'clock in the morning when I first observe them. At three in the afternoon a little more than four inches is unearthed, and two inches or more of this is dead. There is considerable excitement around the nest; they are evidently making preparations for storing this huge monster. A company are carrying a stick into the nest as thick as my little finger, and over an inch in length; they soon return and take several smaller sticks, as if they were building a new apartment.

It is now four o'clock, and their progress is so slow with the worm that I fear I shall not see the termination of the unearthing, so I take a small pair of forceps and assist the workers in pulling the worm out. There were about two inches remaining in the earth, and I found I had to exert a little strength in extracting it. This end is still alive and squirming. The worm is very large, full six inches in length. Much excitement now prevails among the workers;

they act very much like the slave-makers when they are capturing another tribe. In less than two minutes from the time I extract the worm a large force of workers has come from the nest: not half the number can assist in carrying the worm at the same time, but they act as relays. About an equal number are at each end, fewer toward the middle. They all pull in the same direction; this makes a loop of the worm, and they must carry it through grass all the way. A large number are just in front trying to clear the road; grass is pulled down, small sticks taken out of the way. I lay a small stick three inches in length in their path; it is immediately removed by the force in front. But now they have become hopelessly entangled in the grass; they can neither raise the worm nor pull it through; at last they cut it in two; about two inches of the dead part is taken off and speedily carried to the nest by a part of the workers. The remaining portion of the worm contracts, so that it is not much more than three inches in length; and now they move along rapidly, and soon have it housed. In less than five minutes after it is taken into the nest not an ant is to be seen; the door is closed from the inside. This is the only

species which I have observed that closes the entrance in this way.

One other exploit of this colony, and I



ANTS ATTACKING LARVA.

will return to the slave-makers. I find a full-grown larva of *Thyreus abbotii*; it is nearly three inches in length, strong and robust, and, like nearly all of the sphinges, has a thick, tough skin, and when it is disturbed is the worst-acting member of the family. I place it on the nest of this colony of ants, and they attack it in large numbers; they mount on its back and hang to its sides. The larva thrashes about and throws the ants right and left, but the plucky fellows are back again in an instant. The

larva now tries flight on the smooth carriage drive. This gives the ants the advantage; they fasten their mandibles in every available spot. Again the larva stops and thrashes violently from side to side, and dislodges a good many, but not all. Again it starts at a rapid rate, most of the ants following, but some turn back and go to the nest as if discouraged. The larva now comes to a little heap of débris washed here by the rain, and takes refuge under it. This sweeps all the ants off, and they seem puzzled for a moment; but very soon they find where it is, and commence taking the light material from over it and throwing it to one side. Soon they reach it, and the larva, again feeling their mandibles, rushes out, and goes a few inches to another pile, where it again seeks refuge. By this time many of the ants have returned home, only about a dozen remaining; but these soon unearth it; and now it goes very fast a little way, and brings up against a wall of brick set edgewise in the earth to prevent the grass from encroaching on the drive. Instead of going over this wall—only an inch or so above the ground—it is trying to get its head under something. Only seven ants now remain; but they are getting the advantage of the

larva, and slowly worrying its life out. Every little while an ant comes across the drive from the nest, as if to see how his comrades are getting on, and usually stays and assists in trying to kill the game. By the time that it is nearly dead a large force are on hand, and they drag it to the nest—some fifteen feet distant—more quickly than they did the earth-worm.

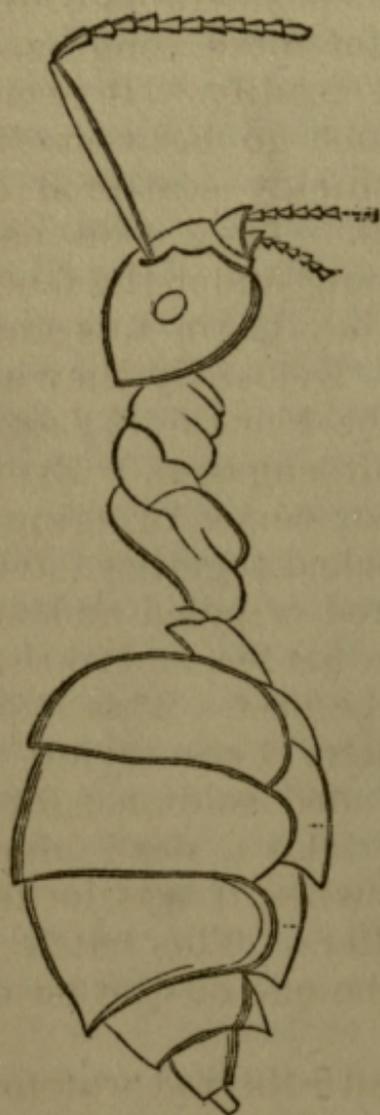
On the morning of the 9th the red soldiers start in full force, and keep in line until they have gone about twenty yards. Here they disperse, and seem to be hunting over the ground; but this proves a fruitless adventure, and they return home in line empty-handed. In an hour or so they again form a line and start in another direction, this time halting about thirty feet from the nest among some dry oak leaves. Here they attack a colony of yellow ants apparently as large and strong as themselves; but they prove to be great cowards, and skulk among the leaves, and flee in all directions. Probably not more than a dozen are killed. The nest does not prove to be very rich in larvæ and pupæ, for in about an hour it is plundered. Here, too, as in the case of the black ants, several adults are carried to the nest unhurt. The next day after the raid the

yellow ants return to their ravaged home, and occasionally one comes near the nest of the red warriors, attracted by the sugar and honey with which I keep them supplied. It approaches very timidly even when its own species and the blacks are feeding alone, and runs away each time that an ant turns from the honey to go to the nest, as if afraid of pursuit. And I find that even the yellow ants will drive it away if they come in contact with it. But on two occasions I saw this yellow ant capture one of its own species that was feeding and domesticated with the reds, and carry it to its own nest. I think these two ants were nurses that had been so recently captured by the reds, and they were recognized by this yellow worker.

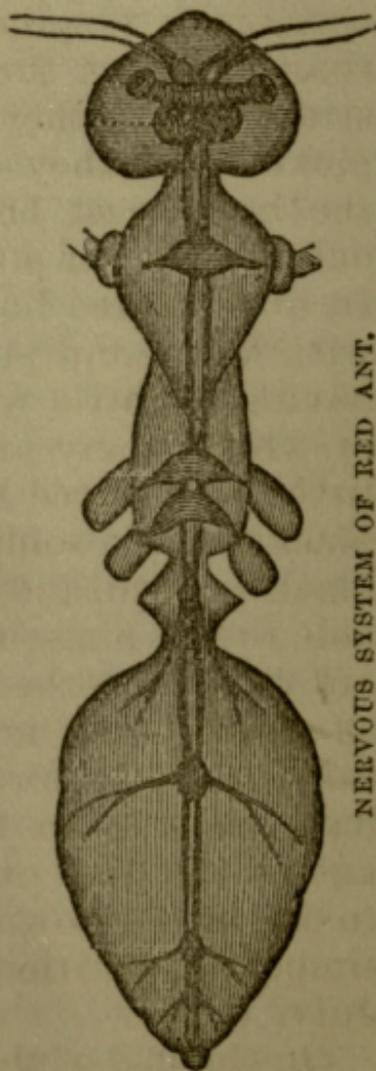
The black and yellow ants never accompany their masters in their raids on other tribes, but stay at home and clear the passages, open and close the entrances, and nurse the young. I tried many experiments to test the intelligence of the ants, which I must omit, as I wish to dwell more especially on the feature of their invasions.

On the morning of the 18th the soldiers make a long march; they go directly to a line fence, some thirty yards distant, which separates the grounds from a neighbor's

garden. A board about six inches wide runs along the ground, to which pickets are



EXTERNAL ANATOMY OF RED ANT.



NERVOUS SYSTEM OF RED ANT.

attached. When the ants reach the fence, they all go through a small opening on the

ground, about three inches in width. The line has to converge here in order to go through, and sometimes considerable confusion seems to prevail, for more congregate than can pass through readily. It seems strange that they do not go between the pickets, for they are thickly scattered on the board just beneath. They soon pass out of my sight after going under the fence. In about three hours they begin to return with larvæ and pupæ. Evidently they are having a battle with the blacks (*F. fusca*), in which many are still engaged. Every little while a red warrior comes bringing a black and red soldier locked together. The black is dead, and the red crippled and unable to free himself from his foe, and so they are taken together to the nest. This looks as if these red marauders were trying to take care of their wounded soldiers; for I have never seen them take a dead black ant to the nest except when it was locked to one of their own soldiers. This battle is simply a repetition of the one on the 1st of July.

On the 23d of the month the red warriors attack a different species of black ant, larger and more robust than *F. fusca*. This proves to be a very large colony. The nest is among

the grass in the grove, about sixty feet from the nest of the invaders. I was not aware of its existence, although I must have passed over it frequently.

It is toward evening when the marauders come down upon this large, peaceful colony, and the inhabitants flee in every direction, not making the least exertion to defend themselves; the grass is fairly black with the fugitives. There are some ten or a dozen openings in the space of a yard, through which they are pouring out. The red ants simply dance around the openings with extended mandibles, scarcely even attacking the fugitives, yet seeming excited and impatient to get to the nest, which is impossible for them to do while so many are coming out. Finally they get possession of the nest, and commence transporting the pupæ to their own dominions. I see no larvæ, and most of the pupæ are naked; seldom is one enclosed in a cocoon.

It is growing quite dusk, and still they work on, but the line is evidently thinning. At nine o'clock I take a light and find a very few engaged in work. At six in the morning I still find a few carrying pupæ, but by eight o'clock the force is all out; the line is from four to five inches in width, and

extends from one nest to the other, about an equal number moving in each direction—the empty-handed coming toward the invaded nest, and those laden with plunder going to their own dominions. As soon as they deposit their spoils they resume the line of march. All day long this line is unbroken, at dusk it is considerably thinner, and by ten o'clock in the evening all have disappeared.

During the entire day I saw no black ants around the nest, but every little while a marauder would emerge with an adult black, which it carried to the nest; and they captured a large number of young ants that were still soft, and of a grayish color—not yet turned black. When I disturbed a captor with one of these, it dropped it, and the young ant would try to hide under something, and remain quiet until picked up by another warrior, when it would crouch and roll itself up in a ball, so that it could be carried just as easily as a larva or pupa. It reminded me of a cat carrying a kitten; the young ant behaved very much like a kitten when carried.

On the morning of the 25th a few of the marauders are around the invaded nest, going in and out of the various openings, as if

to make sure that nothing is left; but they soon return to their own dominions empty-handed, and visit the ravaged nest no more.

During the day I keep watch of the plundered nest, and occasionally a black ant comes timidly up and cautiously moves around; finally it ventures into one of the openings and disappears, but it soon comes out and walks away. Toward night of the same day a large number of the black fugitives return to their home, not in any regular order, but from various points, and each is carrying a comrade which he takes into the nest. I can offer no solution of this; there was no battle, and these are not wounded soldiers.

In most nests which I have observed there seem to be two sets of workers, one larger than the other; the smaller seem to be the true nurses: it was these that were carried back to the nest. But why they did not return in the same way they left is one of the mysteries of ant life.

The returning fugitives all disappeared through the same opening, and in the morning this was closed, mostly with sticks and clumps of earth. I remove the covering, but not an ant appears; it is fully an hour before they venture out, and now a dozen

or more come out, and quickly reclose the entrance. A small place is left open, so that one at a time can squeeze in and out. I place sugar and various things about the nest, but they store nothing away, and eat sparingly.

On the 3d of August I notice a very curious proceeding on the part of these red warriors. Their nest extends into the edge of a tulip bed, which is bordered with the iris before mentioned. The bed is about three feet wide, and in the border just opposite is a nest of tiny yellow ants, with which I am unfamiliar, so small that they are scarcely distinguishable to the naked eye. They are scarcely longer than the little red ant which is often such a pest to house-keepers, but they are broader and more robust than this species, and of a light yellow color. From fifty to a hundred red marauders assail the nest of this tiny species; but the openings are so small that they cannot get to the nest, except as they go to work and enlarge them, and this proceeding is fiercely resented by the little ants; sometimes three or four will attack one of the invaders, fastening themselves to him in such positions that he cannot reach them with his mandibles, and they hold on with such pertinacity that he finally

becomes fairly frantic; he doubles himself up and rolls about over the ground, trying to reach his tiny tormentors; and now one of his comrades, attracted by his strange behavior, stops and looks on, and walks around him, as if to learn what all this tumbling means. Seeming satisfied, he picks him up and carries him toward home. While he is being carried he is quiet. I take him away from his comrade and put him on the ground, when he again resumes his tumbling, until picked up by another and carried into the nest, as if the public highway was no place for such contortions.

I put several of the red warriors, with this tiny species hanging to them, in alcohol; the little things do not relax their hold, but die holding on to the big marauders.

Sometimes an ant will continue work with one of the little things hanging to his antennæ, but more often they stop work and start for home when one is fastened where it cannot be reached: they are not carried home except when they roll about.

The invaders work for several hours, greatly enlarging the openings, and at night return home with no spoils. On the following day a few resume work, and keep steadily at it all day, and enlarge several

openings, through which they can pass in and out readily.

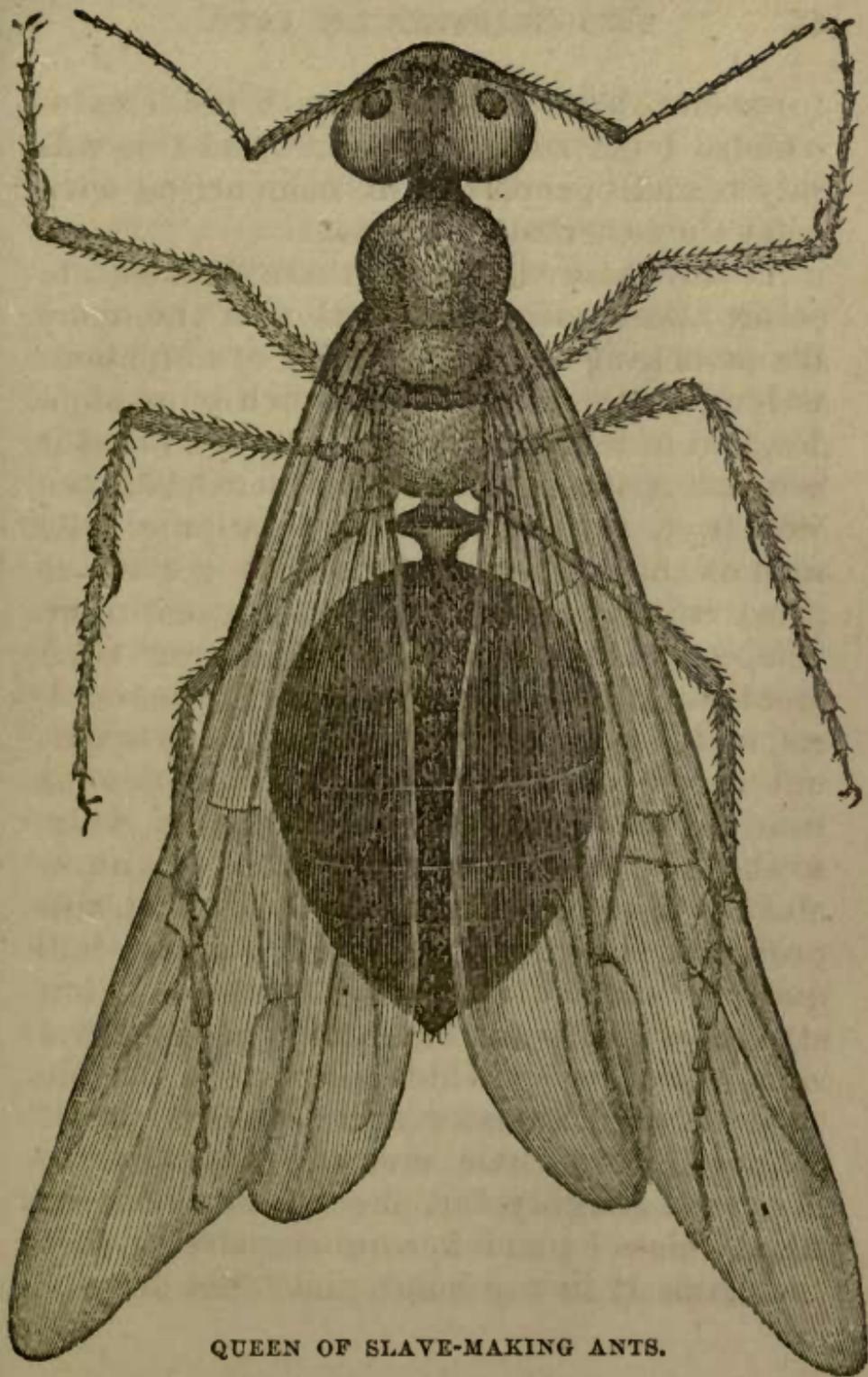
A rain-storm now comes on, lasting three days. During the storm the ants remain closely housed. On the morning of the 8th a dozen or more resume the work of excavation. By this time they have killed so many of the little ants that they can work without much interruption.

What they are after is to me shrouded in mystery; they certainly cannot want the larvæ and pupæ of such a tiny species as this! On the 9th they still continue work, and on the morning of the 10th the treasure is unearthed, and proves to be a great number of large winged females, longer than the red marauders, and with large full abdomens, so heavy that it takes two of the captors to drag them to the nest. Many of the tiny workers have congregated about them, trying to defend them with their lives. But the great, helpless females allow themselves to be taken captive and dragged away without offering the least resistance.

There must have been several hundred of these large females, and of course they had never seen the light. Probably the little workers would have released them before this if their home had not been assailed.

I soon filled a small vial with the females which I took from the captors, and this was only a small proportion in comparison with what they carried to the nest.

At the same time that these females are being taken captive a portion of the army are attacking another species of ant, about as long as themselves, but much more slender, and of a dark brown color. The nest is beneath a gravel-walk not more than ten feet from the nest of the assailants. As soon as they are aware of the danger which threatens them they come out in great numbers, and the nurses have pupæ in their mouths. This seems to puzzle the marauders, and they allow most of them to escape; but occasionally one tries to take a pupa from its nurse, but she will not give it up, so the cruel invader tries to take both nurse and pupa to his own dominions. But this proves a difficult proceeding, for she will not roll up and be carried peaceably, but struggles and holds on with her legs to various things with which they come in contact. I turn monster and pick up one of these devoted little creatures, and handle her quite roughly, but she will not drop the pupa unless I pinch her quite smartly; then she drops it in my hand, and bites fiercely,



QUEEN OF SLAVE-MAKING ANTS.

to which I patiently submit. When she has chastised me sufficiently, she picks up the pupa quietly, and tries to make her escape.

These ants move very gently, do not seem at all excited or hurried, and as soon as they reach the grass and clover they mount a blade of grass or stem of clover, and there they remain perfectly still, holding the pupa. The assailants pass beneath them, hunting over the ground, but not one, so far as I saw, was captured from a stem of clover or from a blade of grass, and sometimes a blade of grass would bend quite low with its burden.

The assailants, satisfied that the game is gone, return to their own dominions. In about an hour from the time these ants were driven from home they begin to return, coming slowly down from the grass, where they have so patiently waited until the invaders were gone, and carry the pupæ directly back to the same opening from which they came out.

The slave-maker (*Formica sanguinea*) is often confounded with the mound-builder (*Formica rufa*), good observers seeing no difference in the appearance of the two species. But the habits of *F. rufa* are very unlike our slave-maker; the former are the greatest workers among our ants, and they keep no

slaves. In the pine-barrens of New Jersey, which have never been disturbed by man, this species build large cities, often extending over several acres. Scattered around a few feet apart, are mounds from two to three feet high and often from eight to ten feet in diameter, some of which may be centuries old; the base is nearly as hard as stone, and covered with moss and lichens; radiating underground galleries lead from one to another, thus connecting all of the numerous mounds.

An excellent observer, Mr. Henry Turner, of Cornell University, during his summer vacation made observations of *F. rufa*, bringing me his reports—as I did not like to leave the slave-makers long enough to make careful observations on these mound-builders; but I made short visits to their city, some two miles distant, to see them repairing damages done to their mounds, and no other species of ant ever assisted them in their repairs.

These ants are fierce and aggressive, if simply disturbed during the working season, behaving very much like the slave-maker; they always succeeded in driving me from the field in a few moments. But I had the satisfaction of witnessing the Rev.

Dr. M'Cook, with his assistants, make a raid on a portion of their city, which was done so promptly and energetically that the ants were completely nonplussed, not acting on the defensive at all. The centre of the mound was quickly cut through with a saw, and then with spades one-half was thrown aside, leaving the other standing, which showed the admirable arrangement of the various chambers and galleries leading to them.

The mounds seem to be the nurseries where the helpless larvæ are fed and nourished: immense numbers were exposed to view, which the ants seized and carried to chambers below, concealing them from our sight; so solicitous were they for the young that not one of our party was attacked, although we stood directly in their midst.

On the 23d of July the last great raid was made by the slave-makers, but up to the 20th of August they went out in detachments two or three hundred strong, despoiling the homes of the little yellow workers mentioned above. Sometimes two or three such detachments would start out in different directions, each company keeping by itself and moving in line, precisely as the large army did earlier in the season. The

tiny workers always fought bravely, trying to defend their homes. They would cling to the legs and antennæ of the red warrior in such numbers as to entirely impede his progress.

During the summer I occasionally saw a large ant, three-quarters of an inch in length, of a yellowish-brown color, with the exception of a black head and tip of abdomen black. At last, on the 14th of August, I had the satisfaction of tracing one to its nest, which, to my surprise, was only about nine feet distant from the slave-makers'. The hole into which it disappeared was nearly an inch in diameter, and about two feet from the trunk of an oak-tree. There was nothing externally to indicate an ants' nest. I now place a leaf containing moistened sugar close to the opening. Soon an ant comes out and sips the fluid and returns; immediately four more come out and find the sugar. These must have been just within the entrance, and learned from their comrade of this rare treat outside. Soon eleven of these large ants are on the leaf. And now a red warrior, apparently wandering carelessly about, comes up and looks on, and at once starts toward home. He meets three comrades, touches each with

his antennæ, and they come directly to the leaf, look on a moment, and turn back as the first did. Quite a large detachment of soldiers have just formed in line, and are marching past this nest at a point some five feet distant. As soon as the informers reach the line it causes a great disturbance, the column is broken, the soldiers seem confused, and rush about as if they did not know what to do. However, a large number soon find the leaf on which the ants are feeding, but they do not venture upon it—simply dance around with extended mandibles, as if daring them to come off. And now the large ants take alarm, and all save one make a simultaneous rush, starting in different directions. Six are soon seized, each by three or four red warriors. Five of the struggling captives I release, and drop into alcohol. The sixth is disabled, and finally killed and left on the field. The remaining ant on the leaf behaves in a singular manner, as if not aware of the danger which surrounds her; she has ceased feeding, and stands nearly perpendicular, passing her forelegs over her antennæ and down the sides of her body. As soon as this work is completed she hurries away in an opposite direction from the nest, but is soon overtaken by the soldiers.

I release her and place her at the entrance of the nest, and she disappears within. Why the ants did not make an effort to regain their home seems strange; for the leaf was within three inches of the entrance, and most of the ants were not overpowered until they reached a point much farther away than the entrance of their home.

Not one of the red warriors will venture within the nest, although no ants are visible; yet they move around it excitedly, just as they did around the leaf. I take a garden trowel and cut away two or three inches of the soil; this does not damage the large cavity, and for a moment almost a solid mass of black heads rush to the front. This, then, is the secret of the timidity of the red soldiers. I push three into the little cavity I have just formed; again the black heads make their appearance, and seize two of the soldiers and literally chew them up, and again retreat out of sight. The soldiers by this time seem disheartened, and the number is greatly decreasing; soon they have all disappeared.

As this large ant seems to be an undescribed species, I was very anxious to reach the nest in order to be able to give reliable information to the entomologist, who will

point out its affinities and relationship to other groups, and give it a name and place in our fauna. So I cut the earth away with a trowel until I came to a hollow root, nearly circular, about an inch in diameter. There was nothing left but the outside shell or bark; the earth surrounding it was clay, and quite hard, so I abandoned the task. In a few days afterward Mr. Turner took up the work of excavation, and followed the hollow root in a diagonal direction beneath the surface of the ground toward the trunk of the tree. He cut off sections of it, throwing out ants as he progressed—which were continually coming to the front to see what new danger was threatening their home—until he was brought to a stand by coming in contact with the oak, under or among the roots of which the nest must be situated, for the hollow root was simply a passage leading to it; but he could not proceed farther without injury to the tree; so the earth was thrown back and pressed down, and the passage to the nest ruined. I now kept watch to see where the ants would next make their exit. I soon found they had a secret passage on the opposite side of the tree in a bed of moss which perfectly concealed the opening.

As with most ants, there are two sets of workers among this species, one considerably larger than the other, and the smaller is larger than the slave-maker. It is the most quiet, unobtrusive species which I have ever observed. I have often met solitary individuals in the pine-barrens of New Jersey. They wander a long distance from the nest, always singly, and return in a direct line. I have followed one from the orchard, a distance of several hundred yards, direct to the nest, and it never seemed bewildered nor made any useless deviations in its course.

After the 20th of August there is a marked change in the behavior of the slave-makers; they no longer make predatory excursions, yet they are very active about the nest—not themselves doing any work, nor even feeding, but they seem to be bringing the different species which they have captured under more perfect subjection.

The cowardly black ants mentioned in the preceding pages—the very large colony captured and put to flight on the 23d of July—are now doing the principal work of excavation, while the brown and yellow ants are mostly the caterers and nurses of the community.

Around the nest are four large oak leaves,

one holding moistened granulated sugar, another honey, and one with hard lumps, and the last with crumbling sugar. A large number of nurses crowd around the honey and moistened sugar, while others are engaged in carrying the lumps within the nest.

That the ants comprehend difference in size is very apparent, and they are ambitious to secure the largest. I have often put a large piece in the path of an ant that was carrying a small one, and found that different individuals of the same species will often act unlike. One immediately drops the small piece she was carrying and tries to take the larger; another will pause and go all round the big one, but still hold on to the small piece, and then hurry off to the nest and deposit it, and bring two or three companions to assist in securing the prize. And with the crumbling sugar one ant will attempt to carry a large lump; and as she seizes it, she finds she has only a small particle in her mandibles. She throws it down, and tries again, with the same result; sometimes she makes half a dozen or more such attempts before she succeeds in carrying off the large piece. Another ant will carefully carry each particle that comes off and deposit it within the storehouse; and

when it no longer crumbles, she carries the large piece.

By the last of August there is a regular division of labor among this mixed colony, all brought about by the determined, persevering will of the slave-maker. There are now eleven openings to the nest, where the miners are at work; and this mining, as far as I can see, is wholly carried on by the blacks. They seem to be preparing for winter, making excavations below the frost-line, and are now bringing to the surface a brick-red earth. This stratum of red earth varies in depth in different localities—from eighteen inches to three feet below the surface. Where this nest is situated it is just three feet below the surface.

The slave-owners are constantly moving about, seeming to superintend everything—looking after the yellow nurses, and after the browns and yellows that are bringing in animal food.

Quite a large number of various species of ants are attracted from other nests to the food which surrounds the home of the slave-maker, and very cautiously they steal up to the coveted honey and sugar; finding a vacant place on the leaf, they quietly slip in to the feast. One of the masters is now

making a round of inspection; he walks around the outside of the circle of feeding ants, touching each with his antennæ as he proceeds, until he comes to a stranger, when he immediately seizes her, shakes her roughly, and lets her go. In no instance have I seen him kill one of these ants; he simply drives her away. The nurses do the same thing if they happen to come in contact with a stranger—even if she is one of their own species—but they do not make it their business to go round the circle and touch each ant as their masters do.

If a black ant wanders away from the work of excavation, it is almost certain to be found and brought back by one of the numerous alert masters, who simply touches the slave with his antennæ, when she crouches before him and rolls up. The master carries her to one of the entrances and disappears within, as if to discipline her. At all events, the slave soon comes out with a bit of earth in her mandibles, and now continues to work. This was repeated a great many times. I often marked the ants, so there could be no mistake about the one carried in soon coming out and keeping at work. Occasionally one of the masters would come out of an opening with a slave

and carry it to another place where the mining was going on, as if more force was needed at that point, and the slave would continue to labor where she was put.

The slaves act very differently from a colony of free ants of the same species. A little more than fifty feet distant from the slave-makers is a large colony of blacks that were not disturbed through the summer. Here all kinds of work is being carried on at the same time. Some are hunting animal food, others are sipping the juice from pears and grapes which lie near the nest, while a large number are partaking of the honey with which I keep them supplied, and others are clearing the passages and galleries of their home. The same is true of the brown ant in her own dominions, but as a slave she is simply a caterer and nurse. Early in the season, before the slave-maker had so many blacks in the colony, the browns and yellows both helped to clear the passages and open and close the entrances, and the masters would occasionally take hold and help close an entrance.

It is thought by some excellent observers that ants do not hear ordinary sounds, but any careful observer must conclude that they are cognizant of sound made upon the

ground. How it is communicated I do not know ; I can only see effects. A large number of ants feeding together will rush off in the wildest confusion when a little unusual noise is made upon the ground. Two colonies—one brown, the other black—are located near the carriage drive. Often, especially in the morning, the simple sound of the gravel under my feet as I walk past the feeding ants is sufficient to make them leave their food and run quickly within the nest.

I suspend a leaf by means of fine thread six inches from the ground ; it swings clear from everything ; I put honey upon it, and now take a thin piece of shingle and rest one end lightly against the edge of the leaf, while the other end rests upon the ground. Soon the ants find the honey, and crowd upon the leaf. I remove the shingle, leaving them no direct communication with the ground. I pick up the ottoman upon which I was sitting, and let it drop a little heavily some two feet distant from the ants ; they rush from the leaf headlong in every direction. But I can raise quite a din above them, even striking tin and various other things, and they seem to pay no attention if the noise is a foot or so above them ; and sometimes when it is not more than six

inches from them they do not heed it; at other times they take alarm, which seems to be communicated by one or two apprising the rest of the unusual proceeding, which I think is seen rather than heard.

But our warlike slave-makers will not run for anything; they are always ready for a fight; any unusual noise only seems to excite them.

I kill eight slave-makers, and place them near one of the entrances. Their comrades soon throng around them, acting excitedly, hurriedly touching each other's antennæ, now moving in circles around the nest as if to find the author of the mischief. Finding nothing unusual, they become quiet, and again direct their attention to their dead comrades. Three are found to be not quite dead; their legs move. These are carried within the nest, the others are taken a long distance off and left.

Very soon a black slave brings one of the dying masters out of the nest, and drops him within a foot of the entrance. He happens to rest against a little pebble in such a position that he is nearly upright, and is so nearly dead that he stays just as he was left. One of the nurses, going to the nest laden with honey, sees him and stops; she raises

herself up until her mouth reaches her dying master's, and tries to feed him; finding no response, she leaves him and continues on her way. Two other nurses make the same attempt, the position in which the ant was placed doubtless attracting their attention. As far as I have observed, when one ant feeds another they both stand nearly perpendicular.

When all is quiet about the nest I again repeat the experiment, killing a number of soldiers. I pick them up here and there, and kill them quickly, until I have twenty dead in my hand. I now pour them all down near one of the leading entrances. Soon the wildest confusion prevails. The soldiers come out in such numbers that I retreat a few steps. The slaves, aware that something unusual is going on, have stopped work and disappeared—all save one, which is busily engaged in carrying sticks and other things to close an entrance about a foot distant from where I dropped the dead soldiers. The circle widens, and many of the angry soldiers rush up excitedly to the black slave. Seeming satisfied that she is not the author of this terrible havoc, they leave her, and she continues her work with the utmost indifference to the excitement

around her. At last one of the warriors, not as keen-sighted as his comrades, seizes the poor slave with a death-grip; two or three others, attracted by the struggle, also seize her, and soon tear her in pieces. This is the only time I ever saw the soldiers kill one of their own slaves. After the excitement dies away, the soldiers treat their dead companions as in the first instance, carrying some away, and others which move are taken within the nest.

I now take a handful of small sticks, from half an inch to an inch in length, and pour them down, which nearly closes the main entrance. This makes quite a commotion for a few moments among the soldiers, but nothing like the agitation caused by their dead comrades. The slaves soon remove the sticks, while their masters assume the defensive, and bluster around, doing nothing.

But the most remarkable and amusing feature in the behavior of these slave-makers is the solicitude with which they guard the food that is placed around the nest—the more remarkable that they seldom touch the food themselves. Wasps, honey-bees, humblebees, two-winged flies, are all attracted to the honey and sugar, but they

are not allowed to remain at the feast. The ants are not obliged to touch these insects to enable them to ascertain whether they are members of the colony, but they see from afar, and usually three or four will simultaneously attack a bee, grasping it by the legs; the bee struggles, trying to free herself from her persecutors, but not until she rises to fly will they let go their grasp. Among these insects is one cunning humblebee that has in a measure learned to evade the attacks of the warriors. She is very quick to see in every direction around her, and if only two or three attack her, she stands on three legs, holding the others up beyond their reach. In a week both masters and slaves have become so accustomed to this persistent humblebee that they seldom attack her, yet still drive off all other insects the moment they alight upon the leaf. But the humblebee is still cautious and wary, and elevates her feet on the side that an ant approaches. After awhile she adopts another stratagem. When one is coming toward her she faces about and strikes quick and repeated blows with one of her forelegs; if the ant persists in coming, it receives the blows, and usually retreats. She never disturbs the ants except

when they attack her; all she asks is to be let alone.

It will be remembered that in the preceding pages a slender brown ant was mentioned, which, when assailed by the slave-maker, behaved very differently from all other species; coming out of the nest with pupæ in their mandibles, they mounted blades of grass and stems of clover, where they remained holding the young until the danger was over. Some of these ants with the pupæ were captured. In a week or so after, I noticed a few were domiciled with the slave-makers, and seemed to be contented with their surroundings; but their habits were so unlike the other species in the colony that they were of no use whatever, and proved to be a great trouble and annoyance to their masters.

One of their habits is to cover all the food they cannot carry into the nest; so, when they found the honey, two or three of these ants set to work to conceal the treasure. They first brought small pebbles and large grains of sand and placed them around the outer edge, making a little wall; then they brought bits of sticks and leaves, and pieces of green moss, and threw them over the wall on to the honey. The masters, in mak-

ing their investigations, notice this unusual accumulation of material over the food, and often pick up the largest pieces and throw them off the leaf. While one is thus engaged in clearing the leaf, a little irrepressible brown captive is making her way to the honey with a piece of green moss, about an inch in length, which she has cut off with her strong mandibles. The outer edge of the leaf which holds the honey is an inch or more above the ground, making it quite difficult for her to reach it with her burden. But at last it is accomplished, and just as she is about to put it in place the inspector who is undoing her work tries to take it from her; she holds on, will not give it up; he now lets go, and takes hold in another place, but cannot wrest it from her; again he drops it, and now picks her up and carries her to the edge of the leaf and drops her on the ground among the rejected material, but she still clings to the moss. She seems bewildered for a moment, but soon finds her old track, and again ascends the leaf. This time she does not encounter the inspector, and deposits the moss.

This proceeding on the part of the slender brown ant and the slave-maker was continued for nearly a week, and then the

browns disappeared. Whether they were driven away, or finally left of their own accord, I am unable to tell.

I found the ants were quite fastidious with regard to the kinds of larvæ and insects which composed a large share of their diet, wholly rejecting some, and very eager to secure others. The oak worm (*Dryocampa senatoria*) was refused in all stages of its growth, but the chrysalids and moths of this species were both taken within the nest. Another larva (*Eudamus titryus*), which feeds on the locust, I supposed would be a rare treat to the ants, as it has a soft, smooth, fat body, and is very quiet during the day, hid away between locust leaves which it has sewn together with silken threads of its own manufacturing; but in this I was mistaken; all species of ants turned away from it, apparently in great disgust. But the larva of the common yellow butterfly (*Colias philodice*), which feeds on clover, was greedily sought for, and large numbers taken to the nest. Also the larvæ of some geometer which I did not recognize were taken from the trees, the ants often ascending twenty feet or more along the trunk of a tree, and then running out on the branches to the leaves where they secured the prey, and de-

scended with it safely, although frequently it was much larger than the ant which carried it.

But there was nothing for which the ants seemed more eager than for the corn worm (*Heliothis armigera*), which feeds upon the tender kernels of green corn. I sometimes took several of these worms to a nest of ants, and very seldom would one escape, although it fought valiantly, and seemed too intelligent to deserve such a fate. With its strong jaws it would pick off the ants that were clinging to its body, and throw them right and left, sending them two or three inches away. But lack of strength was made up by perseverance and numbers, so the ants were usually victorious; even when the worm succeeded in getting twenty feet away from the nest, it was overpowered and brought back.

All the insects which I have observed, however alert and strong, are afraid of the ants, seeming at once to recognize their power and dominion. A large carnivorous beetle (*Calasoma scrutator*) happens to come near a company of ants which are engaged in killing a corn worm; it stops and looks on. I fully expected to see it pounce upon the worm, and attempt to take it away; but

no; several ants start toward the beetle, which sees them, and evidently thinking discretion the better part of valor, it runs away.

I carried several slave-makers to a colony of brown ants, many of which were crowded around the honey, and dropped them among the feeding ants. A battle ensued. Superiority of strength, however, was finally overcome by multitudes; as fast as a brown ant was disabled it was replaced by a fresh one, so that not a single red escaped; but more browns were killed in the conflict than reds. After the slave-makers were all killed, it was amusing to see the difference of mind manifested with regard to the disposal of the enemy. Some of the ants were determined to take the mutilated remains within the nest, while others were equally bent on carrying them a long distance away. Two ants of opposite mind seize the body of the enemy and struggle over it, now one gaining a few inches of ground, then the other, until a third comes up and settles the difficulty by deciding in favor of its being carried away; so the one ant is obliged to yield to the two, and gives up the contest and remains at home. The two ants work together a short time, and

then one returns to the nest, while the other proceeds with the remains until she reaches the distance of some thirty yards, and leaves it on the carriage drive. Their own wounded were all taken within the nest, and a part of the dead were taken in; but the next day I saw three dead brown ants brought out and carried away.

Through the summer this colony of brown ants were all nearly of one size, and I supposed there were no minor workers among them; but on the last day of August I saw a large brood around the entrance of the nest not more than half the size of the rest of the colony, and they were teasing the nurses to stop and feed them, precisely as I had seen the slave-makers doing a month earlier. Some of the nurses would heed their entreaties, another would turn back and go toward the honey, followed by two or three of these inexperienced young. On reaching the food the nurse would put her mouth down to it, as if showing these young ants how to help themselves (she certainly could want no more herself; her honey-sac was rounded out almost to bursting), which they usually did, at first making awkward work, very much like a young kitten in its first attempts to take milk from a dish.

But in a day or two all of these ants helped themselves as neatly as their elder sisters, and now did their share of work; in fact, they seemed more active than the worker major.

All through September and up to the middle of October the mining-work was carried on at the home of the slave-maker, as far as I could see, entirely by the blacks. On chilly days no reds were to be seen, but the nurses and miners still continued to work; and free colonies of blacks and browns were also actively engaged.

By the last of October the war spirit of the slave-maker has greatly decreased, and insects of all kinds are allowed to come about the nest to regale themselves on the fruit and sugar. Only on the warmest days do the masters attempt to drive them away; but the slaves still continue to attack these various insects when they come in contact with them.

I do not pretend to know what the primary object is of the raids made by this red ant on other tribes, but whatever the object, the result is a large number of slaves in subjection to their masters.

The red ant is not as large as some species it enslaves; but on comparing the shape

of the head and the mandibles of the various species, we find our slave-maker has a broader head and more powerful mandibles than the enslaved ants, also a stronger coat of mail than the other species.

The ants were held under the microscope by means of stage forceps, which closed on them with a steel spring. This instrument almost invariably killed the slaves, while the masters stood the ordeal apparently unhurt. On releasing one and taking him back to the nest, I have often seen him attack and whip a stranger as quickly as before he was subjected to the experiment.

Even while at peace he always walks about with extended mandibles, which gives him a fierce look, while the other species keep theirs closed except when actively engaged.

No doubt all of the wingless ants are undeveloped females, and, strictly speaking, the feminine pronoun should be used; but as power and strength and the war spirit are essentially masculine elements, I have preferred to speak of our slave-maker in the gender in which these qualities are supposed to reside.

I submitted the various species of ants mentioned in the articles to Mr. Cresson,

who handed them over to the Rev. Dr. M'Cook, who is interested in this family. Dr. M'Cook gave me much valuable help, but modestly disclaims ability to classify and name. He says:

"My own studies have been greatly in *your* line, viz., the life habits. I have been driven to give some attention to classification by the same embarrassment which you now feel. I found it impossible (in America) to get *names*."

So the ants were named by Dr. Auguste Forel, of Munich, Germany, as follows:

"The slave-maker—*Formica sanguinea*, Latr. var.—*F. sanguinea americana*.

"The black slave—*Formica fusca*, Lim.

"The brown slave—nurses of the community—*Formica schanfussii*, Mayr.

"The yellow slave—also nurses—*F. schanfussii*, var. *foucee*.

"The small yellow ant, clinging to the legs of the slave-maker—*Lasius flavus*, De Geer, American var.

"The large ant, with black head—*Camponotus melcus*, Say.

"The slender brown ant, which could not be made a tractable slave, is a new species, and named by Dr. Forel *Aphaenogaster Treati*."

I am also indebted to Mr. S. H. Scudder

for assistance. And I specially wish to acknowledge the kindness of my friends Rev. Mr. Pittenger and Rev. Mr. Harrison, the former for help in anatomical investigations, and the latter for ascertaining the depth of the red strata of earth in which the ants were mining.



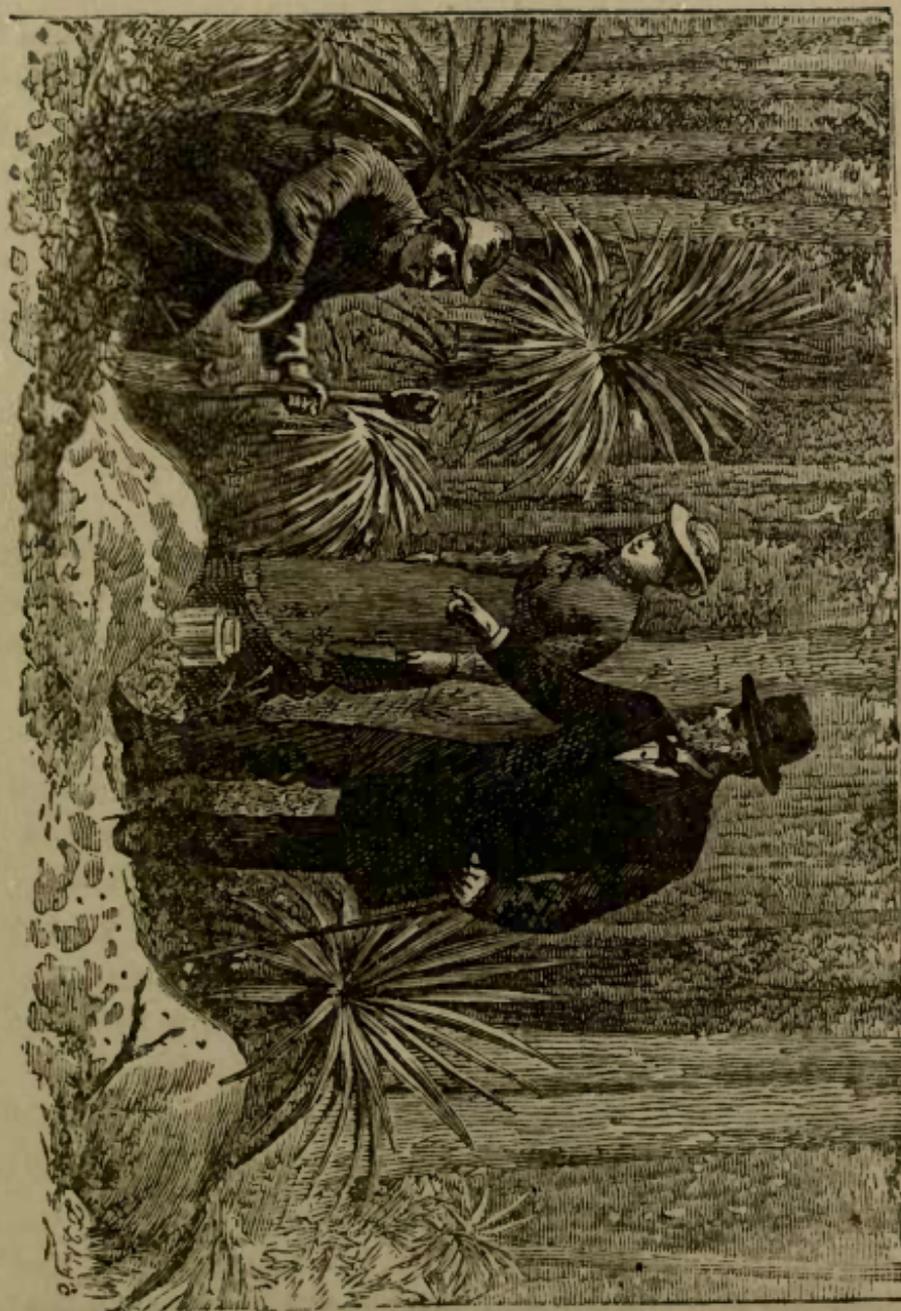
II.

THE HARVESTING-ANTS OF FLORIDA.

IN the low pine-barrens of Florida are large districts thickly dotted over with small mounds made by a species of ant whose habits are unknown to the scientific world. Each mound is surrounded by a circle of small chips and pieces of charcoal, which the busy inhabitants often bring from a long distance. The hills are regular in outline, with a crater-like depression on the summit, in the centre of which is the gateway or entrance.

These ants do not live in vast communities like the mound-builders of the North, but each hill seems to be a republic by itself, though separate colonies in the same neighborhood have friendly relations with

EXCAVATING AN ANT-HILL.



each other. Their color is rufous or reddish-brown, and they are furnished with stings like bees and wasps, and, like the honey-bee, always die after inflicting a wound, for their stings are torn from their bodies and left in the victim. The pain inflicted is about the same as that caused by the sting of the honey-bee. But they are not as vicious as most stinging insects: they will submit to considerable rough treatment before resorting to this last resource.

There are three sets of neuters in each colony—major and minor workers and soldiers; also one wingless queen is found in each nest. The head is very large, especially that of the soldier.* The workers minor—which are the true workers—have regular, well-defined teeth on the mandibles, while most of the soldiers have merely the rudiments or teeth entirely obsolete. All the queens which I have found—eighteen in number—have perfectly smooth mandibles, without the least vestige of a tooth.

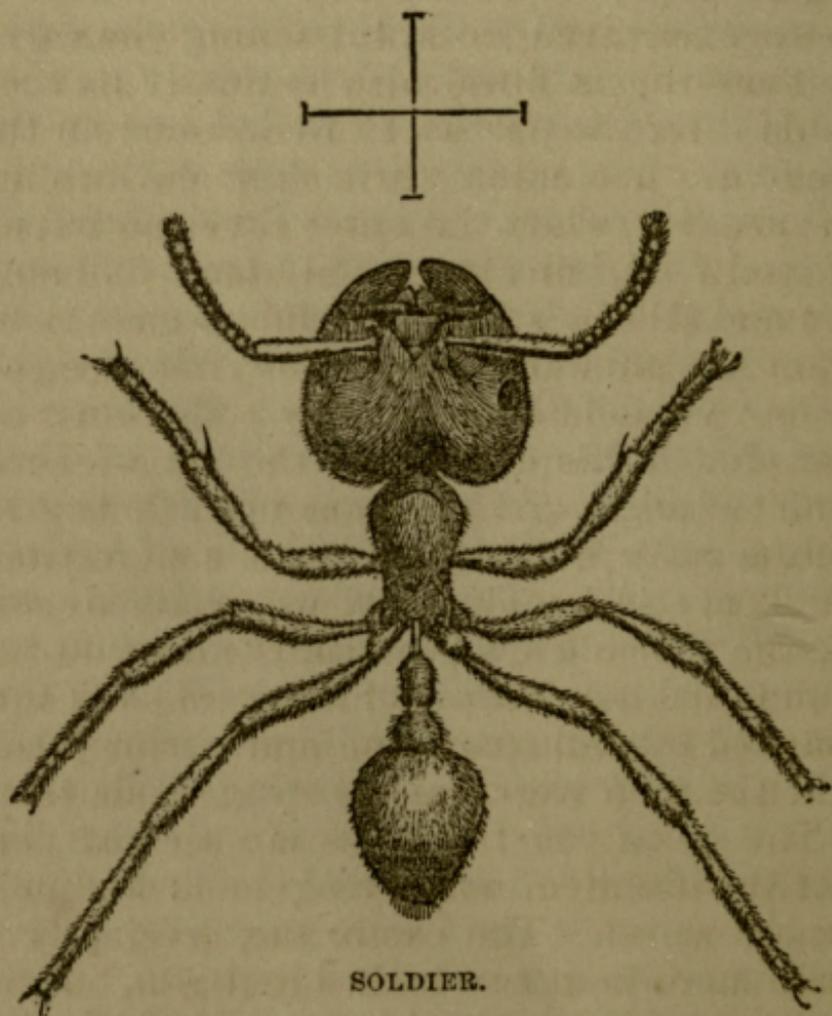
Early in December, 1877, I brought a large colony of these ants from one of the hills,

* I use the term "soldier" for the sake of definiteness. The soldier approaches the queen in size, and in many of the specimens the head is larger than that of the queen.

including the workers major and minor and soldiers, and established them in a glass jar which I placed in my study. They very soon commenced work, tunnelling the earth and erecting a formicary, as nearly as they could after the pattern of their home on the barrens. The mining was done entirely by the small workers. At first they refused all animal food, but ate greedily fruit and sugar; and all kinds of seeds which I gave them were immediately taken below, out of sight. I now visited the mounds on the barrens, and found abundant indications of their food-supplies. At the base of each mound was a heap of chaff and shells of various kinds of seeds. The chaff was *Aristida speciformis*, which grew plentifully all about. I also found many seeds of *Euphorbia* and *Croton*, and several species of leguminous seeds. But the ants were not bringing seeds in at this time of year: they were only carrying out the discarded seeds and chaff; and only on the warmest days were they very active. But they do not wholly hibernate. Even after a frosty night, by ten o'clock in the morning many of the hills would be quite active.

I sent specimens to the Rev. Dr. M'Cook, of Philadelphia, to be named, and he iden-

tified them as *Pogono myrmex crudelis*, described by Smith as *Atta crudelis*.* Dr.



M'Cook predicted, from their close structu-

* "Hymenoptera of the British Museum:" Formicidæa, p. 170.

ral resemblance to the Texan "agricultural ant," that they would prove to be harvesting-ants.

On excavating a nest, I found chambers, or store-rooms, filled with various kinds of seeds. But, so far as I have observed, the seeds are not eaten until they are swollen or sprouted, when the outer covering bursts of itself. At this stage the starch is being converted into sugar, and this seems to be what the ants are after. They also seemed to be very fond of the yellow pollen-dust of the pine. The catkins of the long-leaved pine (*Pinus australis*) commenced falling in February, and I noticed ants congregated on them; so I took those just ready to discharge the pollen, and shook the dust on the mound in little heaps, which were soon surrounded by ants, crowding and jostling each other in their eagerness to obtain a share.

The colony in the glass jar seemed perfectly contented, not trying to make their escape at all. The earth was originally a little more than two inches in depth, but by the first of February these wonderful architects had reared their domicile to the height of six inches. They raised tier upon tier of chambers in so substantial a manner that they never fell in. One of the store-rooms

in which they deposited the seeds I gave them was at the bottom of the jar, and the seeds were stored against the glass with no intervening earth between: it contained about a teaspoonful of millet. I gave this chamber the right degree of heat and moisture to sprout the seed by pouring a little water down the side of the jar until it penetrated the chamber, and then setting it near the fire. The ants soon appreciated the condition of this store-room, and many congregated there and seemed to be enjoying a feast. The next day the seeds were all brought to the surface and deposited in a little heap on one side of the jar, where many of them grew, making a pretty little green forest, which the ants soon cut down and destroyed. This chamber remained empty for three or four days, and was then again refilled with fresh millet and apple and croton seeds.

I kept a small shell, which held about a table-spoonful of water, standing in the jar for the ants to drink from. For more than a month the water was allowed to remain clear, the ants often coming to the edge to drink; but one day one was walking on the edge of the shell, and carrying an apple-seed, when she lost her footing and rolled

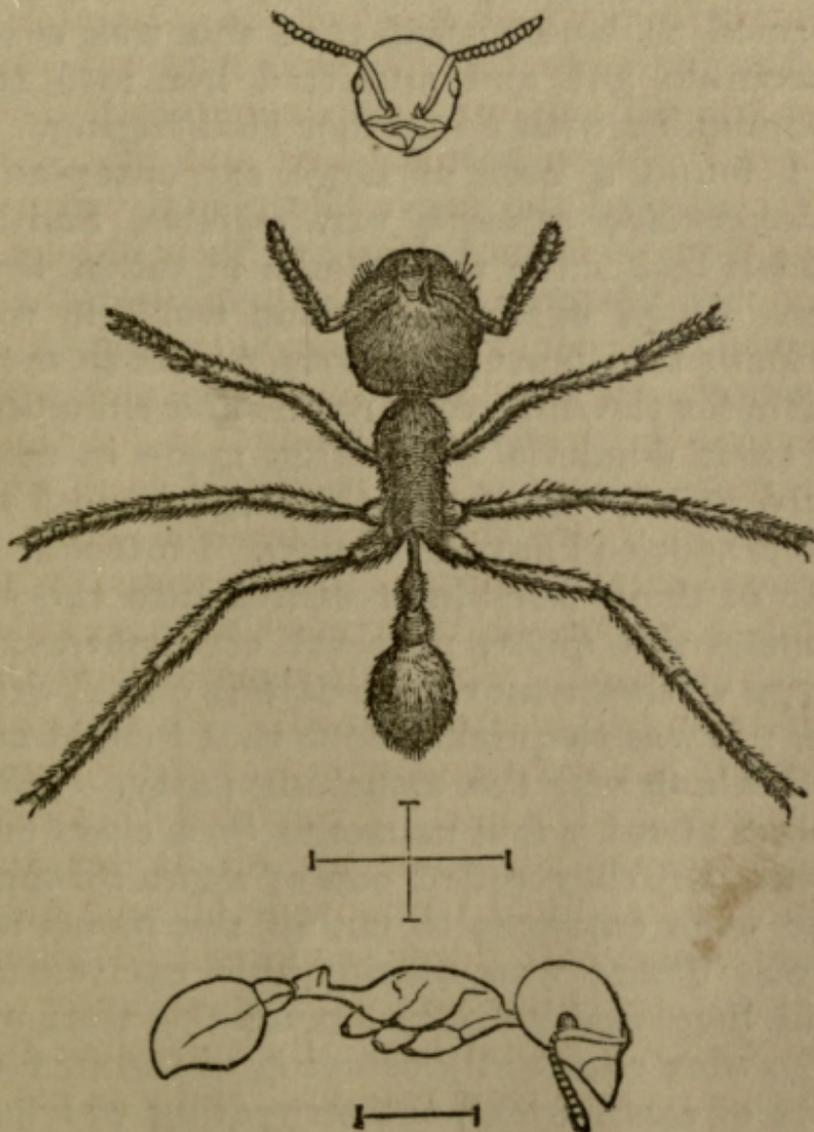
into the water. She floundered about for a few moments, still holding on to the seed: at last she let it drop and crawled out. As soon as she had divested herself of the surplus water, she consulted several of her companions, and they immediately went to work and filled up the shell, first throwing in four or five apple-seeds, and then filling in with earth; and ever after, as often as I cleared out the shell and put in fresh water, it would be filled with earth, sticks, and seeds; and they now served all sweet liquids which I gave them, in the same way, sipping the sirup from the moistened earth.

Like other ants, they are very fastidious about removing their dead companions. I buried one about half an inch beneath the soil. Very soon several congregated about the spot and commenced digging with their forefeet, after the manner of digger-wasps, throwing the earth backward. They soon unearthed and pulled the body out, when one seized and tried to remove it, climbing up the side of the jar, and falling back until I relieved her of the burden.

From time to time I add new recruits of soldiers and workers to the jar. This always causes a little confusion for a few moments: there is a quick challenging with

antennæ, but no fighting, and soon all are working harmoniously together. I found three half-drowned, chilled ants near the mound from which most of the inhabitants of the jar were taken. One was not only wet and chilled, but also covered with sand. These I put on a small leaf and placed in the centre of the jar. The genial warmth soon revived them. Many of their old companions clustered around them, and there seemed to be considerable consultation. The two wet ants were soon made welcome, and, leaving the leaf, were conducted by their comrades—from whom they had been separated for more than two months—to the rooms below. But the one covered with sand—a major—did not meet with so kindly a reception. She still remained on the leaf trying to cleanse herself. All the ants had left her save one, who was determined to quarrel with her. I removed this one, and now another came up, bit at her and annoyed her until I removed this one also. Then some half dozen congregated about the leaf, touching her with their antennæ and walking round her. By this time she was nearly free from the sand, and was looking quite bright, strutting about the leaf in a threatening attitude, with her mandibles

wide apart. She was not attacked by these last inspectors, though still looked upon a

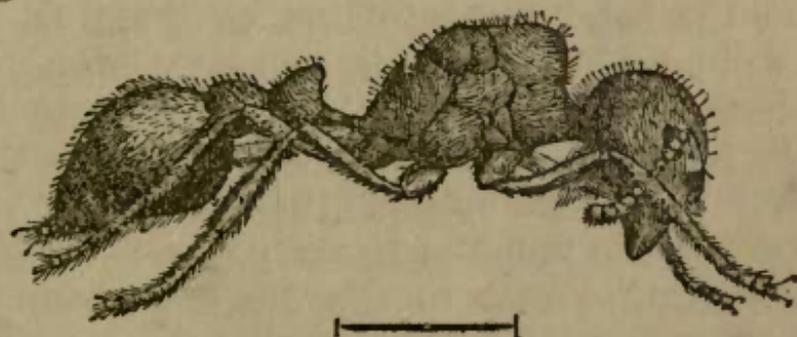


1. WORKER MAJOR; 2. OUTLINE OF HEAD OF WORKER MAJOR; 3. OUTLINE OF BODY OF WORKER MINOR.

little suspiciously. I then returned the two quarrelsome ants: they immediately walked up to their unfortunate comrade, and now seemed to be satisfied that she was a respectable ant, and admitted her into the community with no further challenging.

I found a nest of large carpenter-ants (*Camponotus atriceps*, var. *esuriens*, Smith) which had made their home in fallen timber. Upon examining their work, it was evident they must have strong tools to work with, for the numerous rooms and chambers of their domicile were often made in firm, hard wood. They are the largest, most vicious species I have ever seen. I introduced one of these terrible creatures into the jar among the quiet, peaceful occupants. A large worker major immediately closed with her: it was so quickly done that I could not tell which was the attacking party. They rolled about a few moments in a close embrace, till they rolled out of sight through the wide entrance to one of the rooms below. There was considerable excitement and increased activity among the workers, who were constantly bringing to the surface bits of earth which the struggling warriors had loosened. In about an hour the head of the carpenter was brought out, divested

of every member: both the antennæ and palpi were gone, cut close to the head. A little later the abdomen was brought out, and still later the thorax, with not an entire leg left.



QUEEN: SIDE VIEW, SHOWING PECULIAR CONFORMATION OF THE THORAX.

Several times during the months of January and February I introduced into the jar a number of half-grown larvæ of the harvester. Without any hesitation they were quickly carried to the rooms below by the workers minor. On the 4th of February I found a large number of the larvæ of the carpenter-ant (*Camponotus meleus*, Say). They were very small, and closely packed together in a chamber cut out of hard wood, two inches in length and an inch and a quarter in diameter, nearly circular. It was packed full of larvæ and eggs, the larvæ apparently just hatched. I detached a small

mass, all stuck together, and placed them in the jar with the harvesters. The workers minor immediately surrounded the mass, touching it with their antennæ, and then retreated backward, passing their forelegs over the head and antennæ, as if the larvæ were obnoxious to them. Great commotion ensued, followed by an apparent consultation lasting a few moments; but soon the usual quietness reigned, and most of the ants left the helpless larvæ and returned to their mining and to the storing away of seeds or feeding their own young. But two or three had not entirely deserted the young carpenters. Again and again they touched them, and then retreated, cleansing the antennæ as they moved backward. At last one seized the mass and held it in her mandibles, standing nearly in an upright position. Several workers now surrounded her, picked the larvæ off, one by one, and carried them below, until all were separated and disposed of.

But by far the most satisfactory way of studying the ants is in their native haunts on the barrens, where I had ten nests under observation. One of these was so situated that it received the direct rays of the sun all day, and was protected from north and

east winds by dense, low shrubbery. On sunny days, even with a cool wind from the north, when taking my seat in this sheltered spot, I would soon become uncomfortably warm. This hill was always active whenever I visited it, while in other localities the ants would often be all housed. Around this active nest I stuck stems of millet eighteen inches high, surmounted by the close-packed heads. The ants climbed the stems, loosened and secured the seeds, and stored them within the nest. They worked vigorously, sometimes twenty or more on one head pulling away at the seeds. In my artificial formicary they did not mount the stems, even when the heads were not more than three or four inches from the ground, but seeds that I scattered in the jar were always taken below.

I threw down a handful of apple-seeds near the entrance of the active hill on the barrens. This immediately attracted a large number of excited ants. They rushed to the seeds in a warlike attitude, and began carrying them off, depositing them two or three feet away. But as soon as the excitement caused by the sudden pouring down of the seeds had subsided, they seemed to comprehend that they had been throwing

away good seeds; and now, changing their tactics, not only carried the remainder into the nest, but finally brought back and stored all those that had been thrown away.

On excavating the nests we found granaries of seed scattered irregularly throughout to the depth of twenty-two inches below the surface of the ground: some were near the surface, and a few sprouted seeds were scattered about in the mound. The mound is usually not more than four to six inches above the level of the ground.

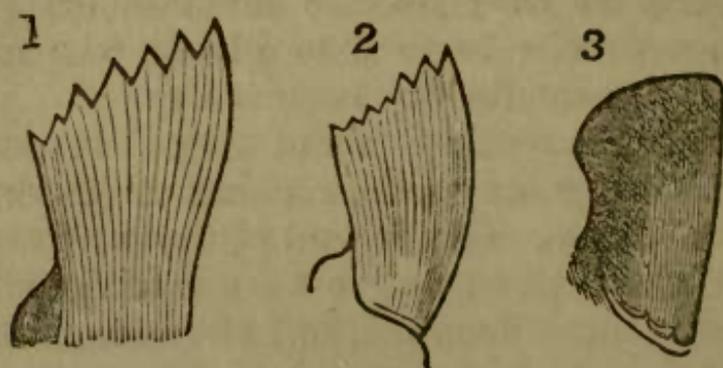
The great majority of nests that I have found are in the low pine barrens—so low that on reaching the depth of two feet the water runs into the cavity like a spring, and stands above some of the granaries. Notwithstanding this wet locality, I found no sprouted seeds in the deeper store-rooms, but only in the warmer mound. On sunny days the larvæ are brought up into the mound and deposited in chambers near the surface, where they receive the benefit of the sun's rays. On cool, cloudy days and in the early morning I found no larvæ near the surface. If the ants are intelligent enough to treat the larvæ in this way, why should they not store seeds where they will not sprout? And when they need to sprout

them in order to obtain the sugar they contain, it would take no more wisdom to treat the seed as they do the larvæ—bringing them near the surface to obtain the right degree of heat for the required result.

The little workers seem very determined not to allow any green thing to grow on their mounds. Cassia and croton and many other plants start to grow from seeds which the ants have dropped, but they are always cut down and destroyed if too near the mound, though allowed to grow at a little distance; so that a botanist would be astonished at the great variety of plants within a small area if not aware of the source from which they came. I sometimes found small shrubs of *Kalmia hirsuta* and *Hypericum*s entirely dead on the mounds, the roots completely girdled in many places. It is very amusing to watch them in their efforts to destroy grass and other plants. Their determined persistence is remarkable: they cut off the tender blades and throw them away. But they do not stop here: the roots must be exterminated; so several dig around the plant, throwing the earth backward, and after making it bare they cut and girdle the roots until the plant is killed.

Early in March the ants in the jar seemed

to have completed their domicile. At first, several chambers were visible through the



1. With well-formed teeth. 2. Partially developed. 3. Entirely obsolete.

MANDIBLES OF THE HARVESTING-ANT.

glass, and the galleries leading to them, but gradually the light was all shut out by placing little particles of earth against the glass, thus depriving me of the opportunity of watching their movements within the nest. So I now took the jar to the barrens, and set it by the side of a nest which was about a mile distant from where most of the ants were obtained. Here I carefully broke it, and took the thin shell of glass from around the nest, which did not fall, but stood six inches in height and eighteen inches in circumference. With a large knife I removed a thin layer of earth, which revealed three admirable chambers, with galleries leading

from one to the other. Immediately below there were five chambers well filled with ants, and below these other chambers were scattered irregularly throughout, with only thin partitions between.

At various times I had given the ants moistened sugar on the thick curved leaves of the live-oak, and several of these had been covered while the ants were making their excavations. Two of the leaves were three inches below the surface, and the ants had utilized them by making the inner curved surface answer for the floor and sides of fine chambers; and here a large number of ants, both soldiers and workers, were crowded together. In other chambers I found the larvæ, which were greatly increased in size since I had placed them in the jar; and the larvæ of the carpenter-ant were being reared, as I found some smaller than any I had introduced belonging to the harvester.

Very soon a great crowd of excited ants came from the hill near which I had broken the jar, and began to transport the larvæ, and also the mature ants, to their own dominions. There was no fighting: the ants from the jar submitted to being carried, not offering the least resistance. A small worker would often take hold of a large soldier,

sometimes pushing, sometimes dragging, her through the sand, and she would be as quiet as if dead or dying; but if we touch the little worker, she leaves her burden and rushes about to see what the interference means; and now the soldier straightens up, as bright and lively as the rest, and after passing her forelegs over her head and body, goes of her own accord into the new nest, meeting with no opposition. Some of the ants would coil up and allow themselves to be carried easily. Others were led along by an antenna or a leg, in either case manifesting no resistance. For three hours I watched the proceeding, and could see no fighting. It looked precisely as if the inhabitants of the jar realized their helpless condition, and gladly submitted to be taken prisoners, or to become partners with this new firm.

I left them, and after the lapse of two hours again visited the spot. The seeds that had been in the jar were now being transferred to the other nest, and two new entrances at the base of the mound were being made. And now every little while an ant would be ejected from the nest. One worker would bring another out and lay her down, often not more than three inches away from the door, but, so far as I could see, she

was in nowise injured. Her first movement was to make herself presentable by passing her forelegs over her head and body: as soon as this was completed she returned within the nest. But there was one large soldier which the whole community seemed combined against. She was led or dragged away from the entrance of the nest eight times, and each time left at the base of the mound among the rubbish. Sometimes she was led or carried by one alone, sometimes two or three would conduct her, and then leave her, when she would at once proceed to make her toilet; which completed, she would again return to the door of the nest; when she would be again conducted away, offering no resistance. I now picked her up, which made her very fierce. She seized my glove with her powerful mandibles, and held on with a persistency equal to the most vicious species, at the same time trying to use her sting. As soon as I could free her from the glove I secured her, and on reaching home placed her under the microscope, and found she was not injured, and had strong teeth in her mandibles.

On the next day I returned her to the nest, and again she was met by the indignant police at the door and conducted away.

With her strong mandibles she could have crushed any number of her small assailants; but in no instance did she show the least disposition to rebel against the indignities to which she was subjected. She was often dragged away, with her back on the ground and her legs coiled up, apparently helpless. If all the soldiers had been treated in this way, it would not have been so remarkable; but so far as I could see the rest were allowed to remain, going in and out of the nest as if taking a survey of their new surroundings.

For five months I had these ants under almost constant observation, and yet I was unable to make out the true position of the soldiers in the colony. They stay mostly within the nest. On the warmest days a few will come out and walk leisurely around the mound. They are not scattered irregularly through the nest, but seem to be housed together in large chambers. In one of these chambers I found a wingless queen in their midst. It seemed very fitting for a queen to be surrounded by Amazon soldiers; but, alas! they seemed more like maids of honor than soldiers, for they forsook the royal lady without making an effort to defend her. Not so, however, with the little workers; they rallied around her, ready to guard her

with their lives, and no doubt would have succeeded had it been any ordinary foe.

This phenomenon—the soldiers and queens with smooth mandibles—is very puzzling, and has excited much interest among naturalists both in this country and in Europe. I sent specimens to Mr. Charles Darwin, which he forwarded to Mr. Frederick Smith of the British Museum (who, Mr. Darwin informs me, is the highest authority in Europe on ants and other Hymenoptera). Mr. Smith says: “Your observations on the structural differences in the mandibles of this ant are quite new to me.” I also sent specimens to the eminent naturalist, Dr. Auguste Forel of Munich, who, like Mr. Smith, had never observed this feature of the mandibles in any ant; but he has a theory to account for it—that the smooth mandibles have been worn down by labor. If this theory is true, how can we account for the fact that other ants do not wear down their teeth? The chitinous covering of this harvesting-ant is firm and hard. The stage forceps of my microscope closes with a spring; and in studying this ant I have put thousands of individuals to the test, holding them in the forceps to examine their mandibles; and in no instance do I recollect seeing one injured, while many

other species are easily injured by the forceps. Among these are the two large species of carpenter-ant before mentioned, which work in stumps or fallen timber. These ants all have well-developed teeth, and the shell-like covering enveloping the body is much thinner than that of the harvesting-ant.

If it be urged that hard wood will not wear down the teeth like mining in the sandy soil, I can bring forward another member of this family (*Camponotus socius*, Roger), which lives in the ground, and whose mining and tunnelling are on a much more extensive scale than those of the harvesting-ant. The formicary of this *Camponotus* often extends over several square rods, with large entrances at various points, all connected by underground galleries, requiring a great amount of labor to construct them; while each colony of the harvesting-ant has a close compact nest or formicary, requiring much less work to construct it. The worker major of *Camponotus socius* is very large—larger than the soldier of the harvesting-ant. The formicaries of the two species are often in close contact, so that the nature of the soil is precisely the same. I have examined thousands of *Camponotus socius*, and in no instance have I found the teeth worn down.

There is still another difficulty in the way of Dr. Forel's theory. Careful observations have revealed the fact that all the harvesting-ants that engage in work of any kind are armed with teeth. I took thirty soldiers with smooth mandibles, put them in a glass jar with every facility for making a nest, but they refused to work, scorned all my offers of food, and remained huddled together for three days. I then introduced several workers minor, and they immediately commenced tunnelling the earth and making chambers, into which the lazy soldiers crawled, meeting with no opposition from these industrious little creatures. My experiments did not stop here. I now took about a hundred specimens—soldiers and a few workers major, the last with partially-developed teeth—and placed them in a jar. Some of these made feeble attempts to construct a nest, but they did not store away seeds, and larvæ which I put in the jar they carried about as if not knowing what to do with them.

There is every appearance of an aristocracy among these humble creatures. The minors are the servants who do the work, while the queens and soldiers (especially the soldiers, which more nearly approach the queen in shape of head and mandibles) seem

to live a life of comparative ease, and have their food brought to them by the minors. This may be the reason of the non-development of the teeth among the aristocracy. But how the same parent can produce such differing offspring—some born to a life of ease, with obsolete teeth, and others with well-developed teeth to do the work—is one of the mysteries in Nature. The only way to settle the point with regard to the mandibles beyond dispute is to find the pupæ or very young queens and soldiers, which I was unable to do during my stay in Florida. All the young were in the larval state.

THE END.

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