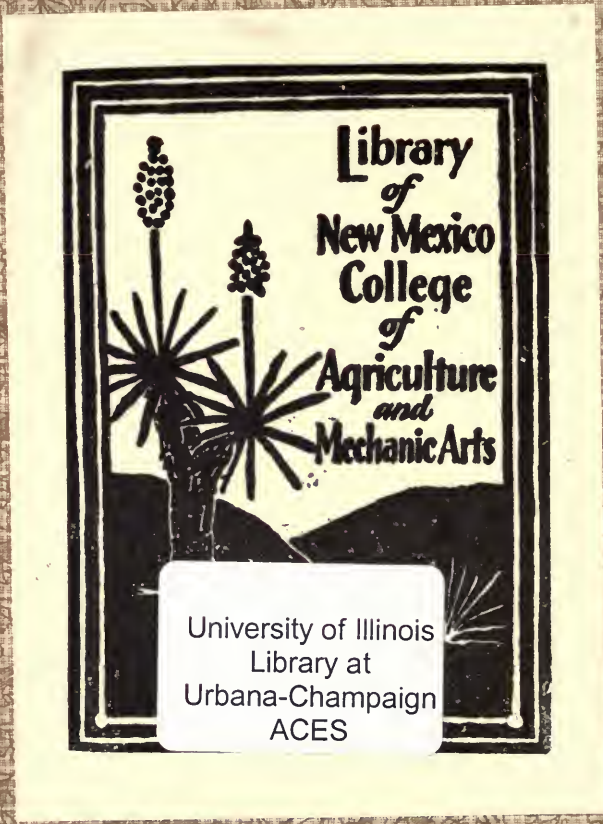


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BULLETIN No. 131

**HABITS AND BEHAVIOR OF THE
CORN-FIELD ANT, *LASIUS
NIGER AMERICANUS***

By STEPHEN A. FORBES
STATE ENTOMOLOGIST



URBANA, ILLINOIS, DECEMBER, 1908

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HABITS AND BEHAVIOR OF THE CORN- FIELD ANT, *LASIVS NIGER* AMERICANUS

BY STEPHEN A. FORBES, STATE ENTOMOLOGIST

The little brown ant notorious for its injuries to corn, and called by us, consequently, the corn-field ant, is not by any means limited to corn fields, but is abundant in all cultivated lands, in pastures and meadows, in dense forests, along hard pathways, and in the sandy soil of dry sunny roads. One sometimes finds it nesting in rotten wood or under bark, logs, or stones, and even opening up its underground burrows to the surface between the bricks of sidewalks and pavements. It is distributed "over the whole of North America, except the extreme southern and southwestern portions, from the tree line on the highest mountains to the sands of the shore."* Wheeler says that it is the most abundant of our ants, and hence of all our insects.

Its homes and habits have been chiefly studied in corn fields, and there it forms rather extensive settlements, mainly centered in the hills of corn, several adjacent hills so occupied by it being connected by underground channels by way of which members of the same family may pass from hill to hill. This is partly, no doubt, because in corn fields it is usually in possession of plant-lice which live on the roots of corn and which contribute to the support of the ants the fluid surplus of their own food, but partly also because in the corn hills it is undisturbed by the cultivator, which is likely to tear up its nests if they are established between the rows.

CONTENTS OF THE NESTS

In the burrows of this ant one may find a rather mixed and varied population, consisting of the eggs, larvæ, pupæ, males, females, and workers of the ants themselves, together with the various species of root-lice harbored by them and certain kinds of mites which share its underground habitations on terms of mutual toleration if not of active friendship. In clover fields it is very likely to have in its nests many mealy-bugs (*Pseudococcus trifolii* Forbes) of a species which infests the roots of the clover plant, and these it treats as it does the root-lice of the corn plant, seizing them and carrying them away when its nest is disturbed, just as it hurries out of sight its own maggotlike larvæ, its egglike pupæ, and its minute, spherical white eggs.

The contents of the nest are not precisely the same at all times of the year. In winter, for example, one finds in it no males or pupæ of the ants, as a rule, but only workers and larvæ, companion mites, and the eggs of root-lice. In some of the large winter nests one or more wingless queens or mother ants may be found, altho we have not been

*An Annotated List of the Ants of New Jersey, by Wm. Morton Wheeler. Bull. Am. Mus. Nat. Hist., Vol. I., p. 393.

able to satisfy ourselves that this is true of all, or even of most, of the winter communities of this species. A careful search and exploration of all the tunnels and chambers of large nests have often failed to bring to light a single queen. Sometimes, however, two or more queens may be seen living contentedly in the same worker family, performing their proper function of laying eggs for the increase of the colony. Besides these large composite and evidently well-established communities, one may often find single females in the ground, sometimes wholly alone, and sometimes with a few of their own eggs, a few larvæ, and a small number of workers which are mainly undersized, but with no root-lice in possession and no companion mites. Late in fall these scattered solitary females may have nothing with them in their pocketlike underground cells except a small cluster of their own eggs. These minor groups with a single female in charge, are the beginnings of a new family, and do not often reach more than a score or so of individuals by the end of the first year. The larger compound groups are older families, how old in any given case we have no present means of knowing.

BEGINNING OF A NEW COLONY

Beginning now with a single female, which came out from an established colony as a winged ant but later broke off her own wings, burrowed in the earth, and began to lay eggs for another generation, we will follow the history of the new enterprise thru the first year, so far as our notes and observations enable us to go. Females and males hatching from pupæ as winged ants in the underground nests from June to October, swarm out of their burrows as if by common consent in August or September. Such an occurrence was noticed by Mr. H. Garman, at Urbana, at 5 p. m. September 14, 1885. Males and females came rapidly up from their burrows under ground and, climbing the nearest blades of grass, took flight one by one, in various directions, the workers in the meantime running rapidly about in a state of great excitement. The males perish before winter, and the scattered females go into the ground, each making for herself an oval or spherical cavity, the beginning of a new family home. Some of these buried females begin to lay eggs in summer and fall—August 15 to November 10, as we have seen them—but others live there alone until spring, depositing their first eggs, according to our observations, from the first to the middle of May, and continuing to lay additional eggs, a few at a time, until September. The minute, maggotlike, footless, and helpless larvæ begin to hatch from these eggs in June, and this hatching process may continue until October. The first larvæ to appear are fed by the female from the contents of her own stomach, which, as she is said to take no food during this period, are believed to come from the nutriment stored up in her own body.* We have found

*Charles Janet has lately shown that the muscles of the wings of the female, used only for a few hours during her whole life, break down within her body into a food supply available for the production of her eggs and the nourishment of her young. *Anatomie du Corselet et Histolyse des Muscles Vibrateurs, après le Vol Nuptial chez la Reine de la Fourmi Lasius niger*. Limoges, 1908.

the oldest larvæ full grown and beginning to pupate from the 12th to the 16th of June, and pupation continues, of course, thruout the season, as larvæ from the later eggs successively get their growth. The first workers to emerge from the pupæ in these small colonies come out early in July—from the 7th to the 11th of that month, according to our experience—and the last emerge in October, or possibly in November.

From solitary queens brought in from the field April 26 to May 3, 1906, and kept in the insectary under natural conditions, the first eggs were obtained May 8, 9, 10, and 15, and the first larvæ from these eggs June 4. The length of the egg stage in the various lots deposited by these females varied from twenty-two to twenty-eight days. The larvæ began to pupate about the middle of June, the larval period being, in four cases, sixteen, seventeen, nineteen, and twenty-three days. The first adult appeared in this cage July 7, and others emerged at intervals thruout the remainder of the year, the pupal stage averaging about eighteen days. Judging by these data, the time from the deposit of the egg to the appearance of the adult is approximately two months. In several cases where second egg-masses were laid on dates definitely ascertained, these dates were found to coincide closely with the time of pupation of larvæ from the previous lot of eggs laid by the same female.

The notes of my field observers make no definite statements as to the numbers thus produced during the first season of the queen's independent life, but three families reared under observation in our insectary, in 1906, gave respectively, 8, 9, and 19 workers as the final product of the season's operations. These numbers are perhaps too small for the average in the field, altho larger than those of families reared during the first year by the carpenter-ant, as reported by Pricer in 1907.* Forty-one first-year colonies of this latter species contained from 2 to 27 workers, with an average of 10; and 19 colonies of a related ant (*Camponotus ferrugineus*) contained from 2 to 19 workers, with an average of only 6.

The process of growth and multiplication are interrupted by winter, during which the ants hibernate in a dormant state in whatever stage they happen to have reached, resuming their activities in spring at the point where cold weather arrested them. The workers open up the nests to the surface, usually in late March or in April, the evidence of this beginning of their seasonal activities being the appearance of circular heaps of minute pellets of earth around the mouths of their burrows. The young larvæ grow little, if at all, as long as the weather is cool, but, fed and cared for by the workers, increase rapidly in size as soon as the weather becomes warm, the oldest of them reaching the pupal state as early as May. Whether males and females appear in the family colony during this second summer is not definitely known, but it is rendered very doubtful by the small size of the family during the

*The Life History of the Carpenter-ant, by John Lossen Pricer. Biological Bulletin, February, 1908, pp. 177-218.

first spring and by Pricer's observations concerning the carpenter-ant, from which he concludes that winged males and females do not appear in the colony until it is more than two years old. Some support for this conclusion as applying to our corn-field ant will presently be given. We can not follow the history of the colony farther at this time, lacking detailed knowledge of the rate of its increase and the form of its organization. We only know that family groups enlarge to contain several hundred workers, and larvæ sometimes by the thousand, with pupæ, males, and queens in much smaller numbers.

SIZE OF COLONIES

The following table shows the number of ants of all stages contained in 20 nests dug out in an oats field by Mr. Kelly August 28, 1906. The fact that the larger numbers are all multiples of 10 or 5 shows that these counts are not to be regarded as exact.

ANTS IN TWENTY NESTS, IN OATS FIELD, AUGUST 28, 1906

Workers	Larvæ	Pupæ	Males	Young females	Old queens	Queen pupæ	Total
41	60	16	0	0	1	0	118
75	50	16	0	0	1	0	142
160	400	30	0	0			590
183	435	15	5	17			655
190	530	60	26	4			810
220	430	75	21	3	1	7	757
260	650	210	11	27			1158
280	340	120	12	20			772
330	150	240	6	24			750
340	150	60	0	5			555
360	750	30	13	33			1186
380	420	35	2	19			856
410	700	120	14	21			1265
475	235	115	0	16			841
540	150	250	6	29			975
585	280	125	0	16			1006
680	240	125	31	12			1088
740	310	180	19	15			1264
860	200	160	16	34			1270
900	450	25	21	38			1434

It will be noticed, on examining this table—the figures for which are arranged in the order of the number of workers in each nest—that the first three colonies are of a different class from the remainder, marked by the absence of winged ants of either sex, and by relatively small numbers of worker larvæ and worker pupæ. These numbers are apparently too large, however, for a first-year colony, and are probably the result of two years' multiplication from the sole queen founder. Possibly the third of the series, with its 160 workers, 400 larvæ, and 30 pupæ, is a third-year family. The small number of males and

females in the remaining families as compared with the workers, larvæ, and pupæ, can not be explained without a better knowledge of the economy of this species. It will be noticed that the fully developed nests, that is, those containing ants in the various stages due at this season of the year, vary in number from 655 to 1434, with an average for the 17 larger nests of 979.

It is probable that families reach their largest size in grass-lands, where they may multiply without disturbance year after year; and consistently with this supposition Mr. Kelly found in following the plow in a field of grass in April, 1906, some of the largest nests of our record. In one nest were nearly 6000 larvæ and 300 workers, with no eggs, no pupæ, and no queen. Thirty-nine other nests in this field were seemingly as large as this.

INTERCOLONIAL HOSTILITIES

The well-known but remarkable hostility of ants of one colony to those of another of their own species is well illustrated by many of the observations of my field and laboratory assistants.

For example, the first of April, 1906, a strange queen introduced to a group of some forty workers of the corn-field ant confined in a formicary, was ruthlessly attacked and killed by them as an intruder. Precisely the same observation was made in another case April 27.

August 15, 1905, a wandering lone queen placed in a formicary inclosure with five males from another locality killed two of them the same day. During the following night two stray worker ants of her species entered the formicary thru a crevice and attacked the queen, one of them seizing her foot with its mandibles and holding fast for an hour and a half, when, as it could not be compelled to release the queen, it was killed to save her.

August 16, 1905, a strange male was first placed among twenty workers in a formicary, but being instantly attacked it was transferred to another containing only a lone queen—one who having rid herself of her wings was presumably already fertilized. The male being dead in the morning, the presumption is strong that the queen killed it. In another case, occurring August 15, four males placed in the nest with a strange queen were immediately attacked by her, and two of them were presently killed. On the other hand, a queen ant still bearing her wings, placed alone with a strange male August 21, made friends with him immediately. The two continued to live in harmony, the queen sometimes caressing the male and even apparently feeding him, until the 26th, when she began to try to pull off her wings and refused to have anything further to do with the male. September 6, altho still bearing her wings, having failed in her efforts to remove them, she began to lay eggs. This seems a possible case of fertilization of the queen within the formicary, but direct observations to that effect are wanting.

August 16, a male from one formicary put in with the workers of another was immediately pounced upon by them, and would evidently have been killed if he had not been promptly rescued.

August 15, worker ants taken from two different nests in the field and placed in the same formicary began at once to fight. They kept up their contest all night, and several of them were dead in the morning. By noon of the following day, however, fighting had ceased and the two groups had separated, occupying different parts of the enclosure. The larger group had taken possession of a corn plant which had been introduced for the use of these ants, and the other colony, which established itself near the edge of the formicary, seemed timid and cowed, apparently fearing even to feed upon the syrup offered them. The dominant group mined actively in the earth about the roots of the corn, and appropriated the root-lice introduced into the cage, evidently feeling themselves masters of their domain.

April 24, 1906, a colony of 100 worker ants with 200 larvæ of various sizes, and eggs of the corn root-aphis, were brought in from the field and established in a two-celled glass formicary. After they had become thoroly at home, nine worker ants and a few ant larvæ—strangers to the original colony—a bunch of aphis eggs, and some young root-aphids, were introduced into this nest, the original family being in the orange or dark cell and the newcomers in the other cell of this cage. As soon as the presence of the strangers was detected they were attacked by the old colony, which dragged the adults about, killing them one by one, ate up their larvæ, ate or pulled to pieces the root-lice introduced with them, and crushed the aphis eggs. The root-lice and eggs brought in from their own nest they were in the meantime caring for as usual.

August 7, some eggs of the corn-field ant brought in from the field and placed with a colony of workers well established in an artificial formicary, were presently found by one of the workers and deliberately crushed, one by one.

These hostilities of ants to strangers may extend even to those of their own sisterhood who have been away from home too long. For example, a young worker separated from its formicary mates August 21, kept alone, and returned to them twenty-one days later, was immediately attacked by them and quickly killed.

The utility to the ants of this inhospitable savagery—this spirit of ferocious clannishness—is doubtless to be found in their social organization, and in the necessity under which they live of keeping always an active, compact, deeply interested group of workers completely devoted to the care and nurture of their helpless young. No young of any animal can be more utterly dependent than those of these ants, and their feeding and protection must be the constant, consuming care of the whole family group.

The workers are, on the other hand, among the most active and enterprising wanderers and foragers among insects, traveling far and wide on foot to distances which make it necessary for them to retrace their steps carefully, whether by the aid of the sense of sight or by antennal senses supposed to resemble what in us is the sense of smell. The homing instinct and the nursing instinct are in them so strong as

practically to rule their lives. They go abroad in search of food for the family, and to the family they must return, however far they may travel and into whatever difficulties and adventures they may fall by the way.

These facts make it necessary that there should be in the economy of ant society some self-acting, self-regulating apparatus for keeping the family groups wholly separate and distinct, for making sure that every foraging worker shall find its way back to its own companions—that it shall neither be liable to lose its way completely nor likely to attach itself to an alien family. From this point of view it is greatly to the general interest that it should find a welcome and a permanent home only among its immediate kindred and habitual companions, and nothing could make this condition more secure than a universally hostile reception to the wanderer in every other family group. Clannishness in ants has thus the same justification that it has among savage men. It is a means of maintaining the necessary concentration of the group for the care of the young, and hence for the preservation of the race.

AREA OCCUPIED BY A SINGLE COLONY

Practical advantage was taken by us of this intolerance of ants towards those of other parentage to ascertain the limits in the corn-field of a single colony or family group. Assuming that specimens from adjacent hills of corn are members of the same family if they affiliate peaceably, but that they belong to different families if they fight, I instructed my field assistant to bring the inhabitants of adjacent hills into contact with each other in artificial nests until all those affiliating with the original group used as a test were distinguished from those about them who refused peaceable affiliation. By a careful application of this method at Elliott, May 23, 1906, two family areas were thus marked out.

The group of hills included in the first experiment occupied an area 10 hills in length by 7 in width, and 20 of these 70 hills were infested by ants. Selecting the inhabitants of a hill from the center of this tract for the purposes of this test, ants from the other infested hills were placed with them successively. By this means it was found that the inhabitants of ten of these hills were members of one community, harmonizing with each other perfectly when commingled, but that those of the other nine were strangers to them, since the representatives of these groups instantly fought when placed together. The ten nests thus identified as related were distributed over an irregular area about 30 feet long by 14 feet in greatest width, and were probably all connected by a network of underground channels. Hills inhabited by hostile ants were in many cases immediately next to others occupied by members of this family group.

The second experiment covered a plot of 130 hills, 32 of which were occupied by the corn-field ant. The occupants of 12 of these hills affiliated peaceably, while the remaining 20 were rejected by the

original colony used in making the test. The family settlement thus outlined, also irregular in shape, was about 30 feet long by 10 feet in greatest breadth. There was no intermingling of hostile groups in either of these family areas, all the ants occupying hills within the boundaries of each being on friendly terms.

RELATIONS TO OTHER SPECIES OF ANTS

Notwithstanding the almost invariable intolerance exhibited by different families of the corn-field ant towards each other, they sometimes live on perfectly friendly terms with ants of other species, both kinds mingling harmoniously in the same galleries among the roots of the same hills of corn. One of the small red house-ants (*Solenopsis molesta*) which often infests kitchens and pantries to the annoyance of the housekeeper, is frequently found at home in the nests of our corn-field species. A mixed settlement of these two ants found in a field near Urbana August 31, 1905, and brought to the insectary and established in a jar of earth, collected their larvæ and pupæ into separate lots without contention, and continued for several days to feed peaceably together from the same food supply. August 29 another species common in corn fields, *Formica schaufussi*, was found by Mr. Kelly inhabiting the nests of *Lasius niger americanus*, the larvæ and pupæ of both being, as he says, mingled in the same heap. Transferred to a Mason fruit-jar and brought to the insectary, they lived together for two days in a Lubbock nest without fighting; but afterwards hostilities broke out and all the *Formicas* were killed save two which remained in hiding, and their pupæ were thrown by their conquerors into the ditch surrounding the nest.

BEHAVIOR WITHIN THE NEST

From a colony of ants obtained August 15 and established in a *Fielde* nest, one of seven queens was removed and placed by herself August 16 in a glass Petrie dish with moist earth, for special observation. She had broken off her wings the previous day, and was hence presumably fertilized, altho she apparently had not left her native nest. She began at once working in the earth as if to make a burrow. This is the queen which killed a male placed with her, as described on another page. She worked restlessly in the earth for several days, helping herself to the sugar syrup offered her, and deposited six eggs August 25. It is commonly supposed that a fertile queen does not feed after leaving the family nest until she has reared workers capable of supplying her with food. Possibly her nest was kept too dry and the syrup was taken as drink rather than as food.

Another queen brought in from the field August 15, pulled off three of her wings within the next two days, but did not succeed in ridding herself of the fourth until August 25. This queen was reported by Mr. Kelly to partake once or twice a day of the syrup placed in her cell. She busied herself with piling up the dirt beside a bit of wet sponge, sometimes undoing at one time what she had done at another. She laid no eggs, and died September 6.

The significance of males in the ordinary life of the colony is very small, and I have but few notes on their habits and behavior. July 31 a worker, a male, and a pupa were placed together in a Petrie dish, the pupa almost mature. This is a situation of great responsibility for the worker ants, whose aid is necessary to the successful emergence of the adult, and the single worker upon whom these labors fell made every effort to discharge her duties alone, the male doing nothing in her aid. The anxious and affectionate worker divided her attentions between the helpless pupa and this idle male, caressing and feeding him, and when, thru a misadventure, his wings were stuck to the cover of the cell in the moisture which collected there, doing her best to pull him loose. When the pupa was ready to yield the adult the end of the pupa-case was bitten off by the worker ant, and its inmate pulled out head first in a helpless condition, unable even to stand. In about three hours, however, it was walking about.

When the workers were moving the family from one cell of the formicary to another, they were often seen dragging the males along to the new quarters, as if ants of this stupid sex were unable to get any idea of what was going on, and must be dealt with by physical force.

The responsibility of the workers for the successful transformation of the pupa and the appearance of the adult is well illustrated by an observation recorded by Mr. Kelly under date of August 17. In a glass Petrie dish in which three workers and three pupæ of the corn-field ant had been placed for observation August 2, a worker emerged from a pupa-case, two of the workers in the cell assisting. One of these bit off the black tip of the pupa-case and slowly pulled the young ant out, taking three minutes for the operation. The head of the newborn worker was cleaned off and its antennæ were straightened out by the mouth-parts of one of its nurses, while the other loosened and straightened its legs. At the end of sixteen minutes from its release it made its first attempts to walk. In this, as in other cases observed, the workers rewarded themselves by devouring the empty pupa-case.

The constant attention which the worker ants pay to their eggs and larvæ is so well known that it scarcely requires illustration. Many of their ministrations, it is true, seem aimless and mechanical, mere restless movements of their charges from place to place, but the constant attention given by the workers to their young is an effective safeguard against any ordinary injury.

The eggs, deposited by the female, are gathered together by the workers, kept in a pile or ball convenient of transportation in a mass, and carried up and down in the nest according to the weather; and as they hatch the young are separated from the mass of eggs and kept by themselves, usually assorted according to size as they increase in number and differ in age. Larvæ and pupæ are likewise commonly kept distinct, the various lots doubtless requiring somewhat different care.

The workers feed their larvæ almost constantly from the contents of their own stomachs, and often mouth and hover them, a mass of

the ants clustering around and over them in a way to conceal them from view. When the colony is established in a two-celled nest, one covered with clear glass and the other with orange, the workers convey their young to the orange cell, the light transmitted by orange glass being, as shown by Miss Fielde, inappreciable by ants.

Even after the workers have emerged from the pupa-case they are still watched and cared for by their more experienced relatives, and often fed in the nest by foragers returning from outside. This operation was illustrated in our breeding-cages when pale young workers remaining within the orange cell were fed by the darker, older ones from food exposed to them in the light cell of the formicary.

The nursing instinct of the workers is so overruling that it extends to all the inmates of the nest excepting only strangers of their own species. A common resident of the nest of these ants is a species of mite (*Macrocheles mæstus* Banks) often found crawling about among the eggs and larvæ, altho never detected in any depredation upon them. It is probably a scavenger of the domicile, and is thus possibly entitled to the protection which it receives. When a nest containing these mites is disturbed, they receive the same attention as its other inmates from the alarmed and anxious workers. In several nests for example, plowed up April 24, in an old oats field, mites were commonly present, and the ants seized them in their mandibles and carried them away as they did their own young.

ADAPTATION OF BEHAVIOR TO CHANGING CONDITIONS

The movements of ants in their outdoor habitations often show a surprising adaptation of habit and behavior to changing conditions in the field. It was repeatedly noticed, for example, that during warm dry weather in early spring the aphid eggs would often be brought near the surface while the larvæ of the ants were kept at a depth of five or six inches below. The effect of this treatment must be to hasten the hatching of the aphids and at the same time to retard the development of the larvæ of the ants. The growth of the latter is thus kept practically at a standstill while food is scarce in spring, but proceeds at a rapid pace after the aphids have hatched and are yielding an abundant food supply to the colony. In periods of summer drouth the burrows are extended downward to a depth of twelve or fifteen inches, and eggs, larvæ, and pupæ are carried down into relatively moist earth. The ants then mass up in the depths of their burrows and are rarely seen abroad, but communicate with their root-louse herds by means of underground passageways, sometimes several feet in length. When soaking rains come, these hidden colonies open up their burrows to the surface again, as the ground dries off, and resume their more active habits as general foragers.

Under certain conditions of serious deprivation and suffering, however, this whole system breaks down, and the ants may devour, for their own temporary maintenance, the very objects to which they have previously devoted their entire existence. When infested plants wither

and die, and no others can be found to which the aphids may be transferred, these are themselves eaten by the workers as a food material too valuable to waste. When suffering from a lack of sufficient animal food, the workers in our formicaries have occasionally helped themselves to a living pupa of their own species, or have even devoured the larvæ in their charge, to the last one. The corn-field ant is, in fact, essentially a carnivorous insect, and forages actively for animal food, especially when it is without a sufficient number of root-lice. Much of our breeding-cage work came to naught thru the mysterious death of the workers, apparently because their liking for a watery syrup was regarded as evidence that this was a sufficient food for them. In the field and in the insectary we have seen ants feed at various times and under various conditions upon cutworms, carabid larvæ, white-grubs, dead May-beetles, dead beetles of the corn root-worm, dead grasshoppers, root-lice, myriapods, earthworms, their own pupæ and larvæ, and the pupal envelopes vacated by adults on transformation. Occasionally they have been seen injuring corn by hollowing out the soft seed either before or after sprouting, and in one case at least they were reported by an insectary assistant as feeding on the fibrous roots of the plant.

AN INJURY TO CORN BY ANTS

Under certain conditions, indeed, this corn-field ant may do considerable injury to corn by a direct, unaided attack. During the cool wet spring of 1905, when the softened kernels lay long in the earth without sprouting, and the young plants grew very slowly for a time, a field of corn following oats, heavily infested by ants which had no root-lice in their possession, was considerably damaged by the ants, which gnawed and hollowed out the seed, thus either killing it, or so diminishing the food reservè that the plant made a slow and feeble start.

This field of forty acres, lying near Champaign, had been in oats in 1904, in corn in 1903, and in grass in 1902. The corn was said by the tenant to have been injured by root-lice in 1903, the part worst infested yielding not over 22 bushels to the acre, while the remainder of the field gave a yield of 55 to 60 bushels. Owing to a report that the young corn was being injured by ants, Dr. J. W. Folsom, of the University department of instruction, examined it for me May 31, digging up sixty-one hills in a way to expose the whole root system. Forty-one of these hills were in a part of the field but moderately infested with ants, and thirteen were in an adjacent part in which ants were very abundant. In both cases the hills examined were taken as they came, one after the other in the row. Seven hills additional were dug up here and there, because of an especially noticeable infestation. The corn in this field was unequal in condition, the poorer hills being most numerous where ants were most abundant. This unthrifty corn was four or five inches high, and of a yellowish hue, while the better plants were six or seven inches high, and of a good green color.

In the less-infested row six hills out of forty-one were infested by the corn-field ant, one of them containing also the red house-ant

(*Solenopsis debilis*). In five of the six infested hills a single kernel of corn had been more or less eaten by the ants. No observations of injury to the roots were reported, but the amount of stunted corn in this part of the field could scarcely be accounted for except on the supposition that some other injury was being done than this to the kernel in the hill. In the worse-infested part of the field thirteen hills were examined, eleven of which were infested, and eight of them contained kernels which had been more or less eaten by the ants. In five of the hills all the kernels had been thus injured, and in the others only one kernel to the hill. The ants in these hills were all the common corn-field species except in one instance, where only *Solenopsis* was found. In the seven hills selected because of their visible infestation, all the kernels were eaten by ants in two, and a single kernel out of two or three in each of the others, the ants in all these hills being the common corn-field species. Rough estimates of the number of ants to a hill ranged from ten workers as a minimum to a maximum of a thousand. In one case only were ant larvæ present.

In all these sixty-one hills the corn root-aphis was found but four times—twice a single winged female, once a winged female with three large and thirty small wingless females, and once four winged females with between forty and fifty wingless ones, nearly all of them young. There were, in fact, more of the common grass root-louse (*Schizoneura panicola*) in the field than of the corn root-aphis, some on the roots of corn, with ants in charge, and others on smartweed and ragweed roots, and also accompanied by ants.

From these observations we may infer that ants living in the meadow-grass in 1902 with grass root-lice in their possession, infested the corn the following year; that they continued in the field through 1904, when a crop of oats was raised, carrying a small percentage of their grass root-lice over on roots of weeds in the field; and that when the ground was planted to corn in 1905 they were still abundant there, but with so few root-lice in their possession that they availed themselves of the softened corn kernels in the earth for food, probably gnawing away, also, root hairs and the finer roots, as they have been seen to do in confinement.

EFFECT OF A CHANGE OF CROP

The effect of a change of crop—from corn to oats, for example—on the ant population of a badly infested field, was illustrated by an account in my Thirteenth Report of the disappearance, during the latter part of May, of both ants and aphids from an oats field formerly in corn. By this time the weeds in the field were practically all dead, the oats having reached a height to overshadow and sap them. A similar occurrence, more closely observed, is reported by Mr. Kelly in a series of notes running from April 21 to June 22, 1906. In a forty-acre field of oats fifty nests of the corn-field ant were located and marked near two sides of the field, one next a field of corn and the other separated from corn by a hedge fence and a road. That this

field had been heavily infested by root-lice the preceding year was shown by the number of aphid eggs and young aphids in possession of the ants—the aphids on roots of smartweed and grasslike weeds in the field. The ants themselves lived mainly under ground, at least by day, rarely opening their burrows to the surface, until the 4th of May, when, as the weather warmed up after a heavy rain, they made their presence known by a deposit of pellets of earth at the surface around the openings of their burrows. The oats at this time were about four inches high, and smartweeds and ragweeds about half as tall. Both the latter had many root-lice on them, but none were on the roots of the oats, and the aphid eggs were not yet all hatched. Nests of the ants were very abundant in the grass outside the borders of the field, and several of these which were opened up contained corn root-aphids on the roots of the grass. From the 8th to the 10th of May the ants were actively running over the ground as if in search of food, but, so far as could be seen, with meager result. The second generation of aphids had by this time begun to appear, and many of the smartweeds were dead at the root. The ground was very dry for the next few days, and both grain and weeds grew very slowly, many of the oat plants being dead. Thus matters went on, with no material change except that the ants were found feeding freely on dead June-beetles and other insects, until June 5, when it was noticed that the ants were leaving the field.

“As I was returning home last evening,” says Mr. Kelly, “I noticed crossing the lane beside this field a colony of *Lasius niger americanus*, composed of ants going in both directions between the field of oats and the corn field on the opposite side of the road. I followed the column thru a hedge fence and about twenty feet into the oats, where they were coming out of their nest. Some of those going outward were carrying larvæ, but none of those returning in the other direction. The line of march was indirect, and about fifty-seven feet long, ending in the grass on the opposite side of the road, where a new nest was being formed. The colony was still moving at 6 the following morning, evidently having been at work all night. They had finished the transfer before 8 a. m., nothing remaining in the nest from which they had emerged. No root-lice were in their possession, but only their own larvæ.”

Finally, on the 22d of June, a thoro search was made of the sites of all the nests marked as originally occupied by ants. Forty-nine of the fifty were identified, the remaining one being lost. Forty-four of these nests had been completely deserted, and only five were still inhabited by ants. These were in rather open spots in the field, with an abundance of grass about them. There were no corn root-lice on this grass, however, but only the grass root-lice (*Schizoneura panicola*) and a few *Geocica squamosa*. The oats at this time reached about to the knee, and were beginning to head.

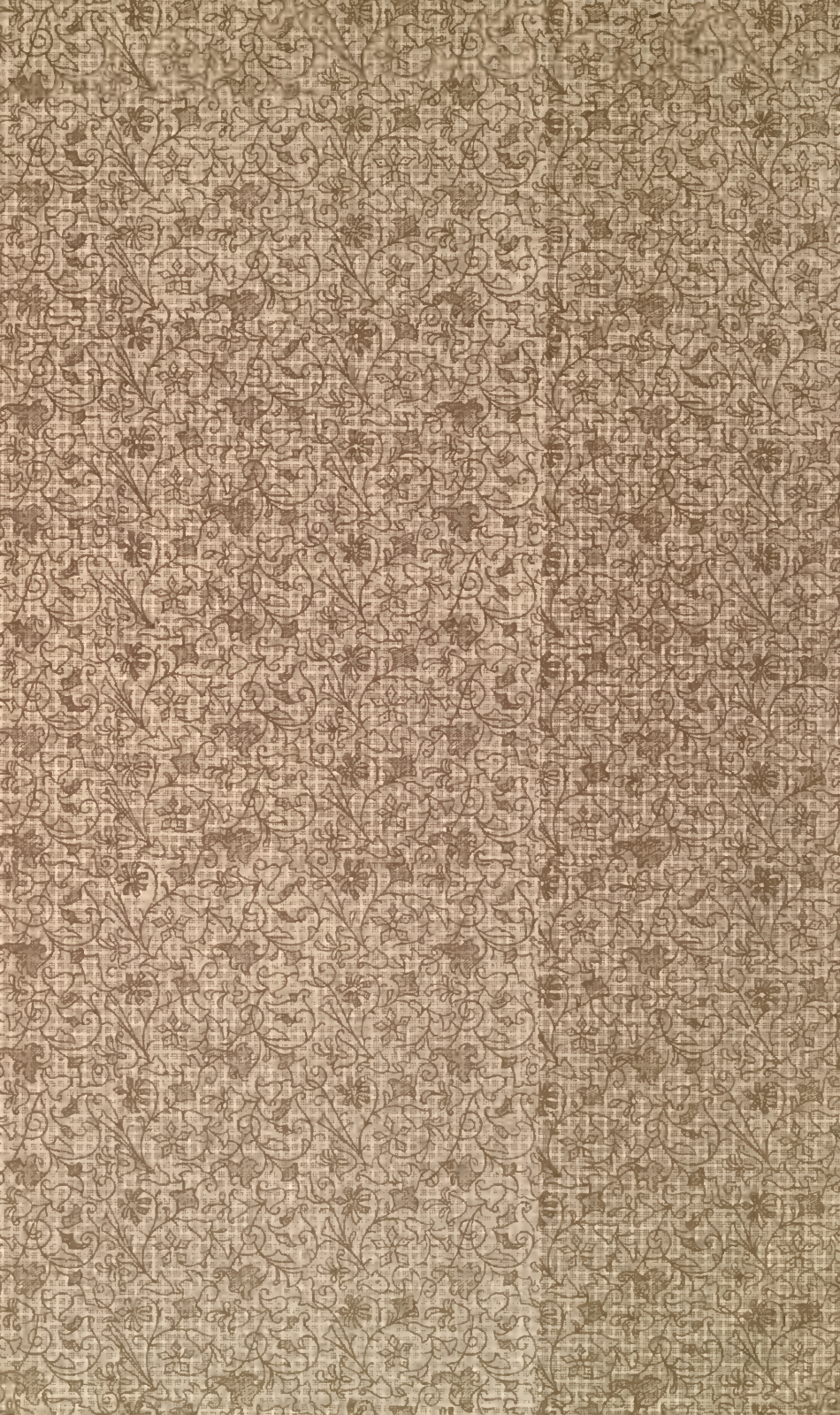
From these data, combined with those previously published, we may infer a gradual but general migration of the ants from the old

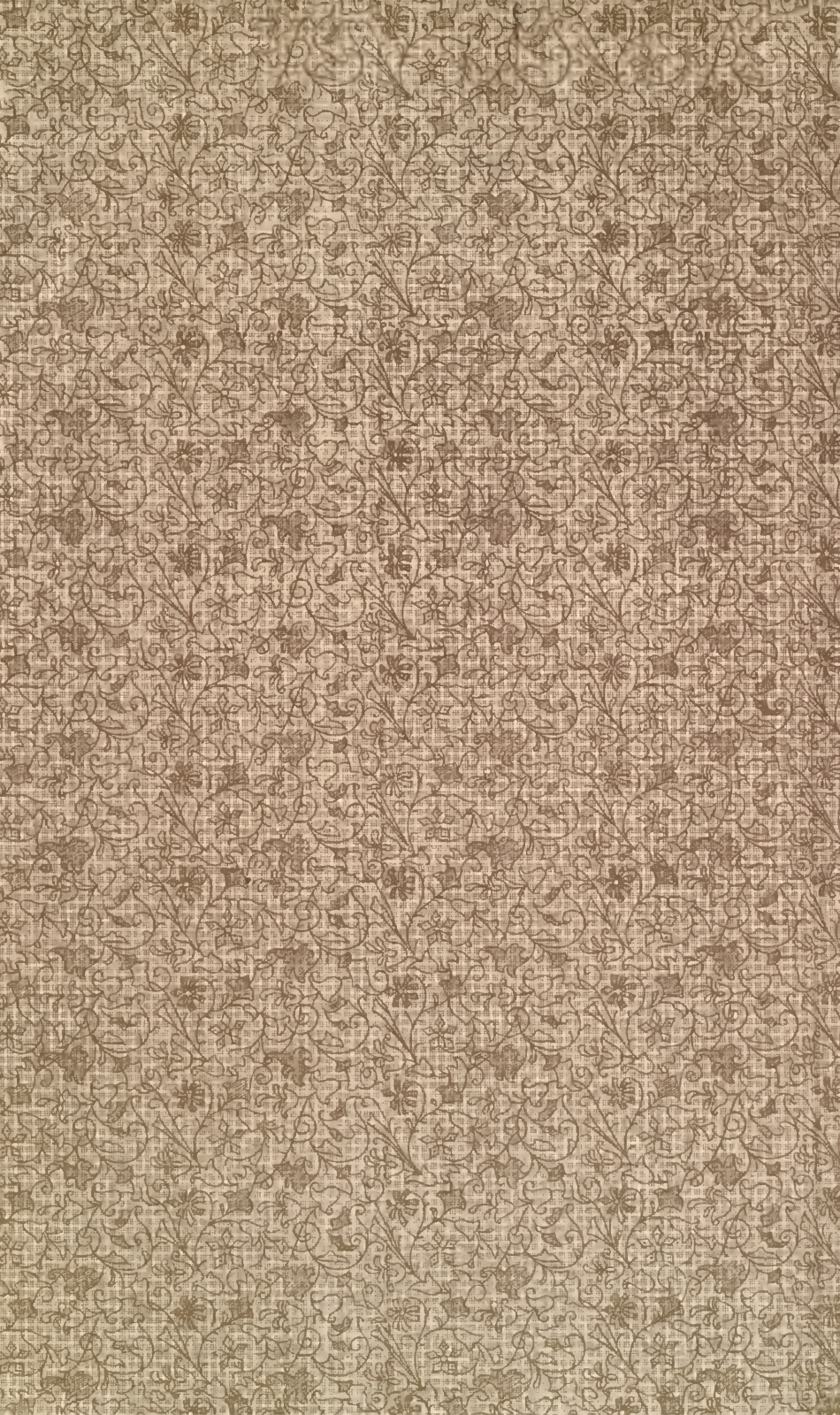
corn field, now in oats, to more favorable locations,—a migration which included all the ants, of whatever age or condition, but in which their aphid possessions were apparently sacrificed—probably eaten by their owners as a last resort of domestic economy. Not all the aphids of the oats field were thus lost, however, but some seem to have been transplanted to grasses near by, and others, which acquired wings as food began to fail, escaped by flight. Such winged aphids were repeatedly seen to be captured by wandering ants, who took them in charge and placed them on the roots of suitable plants. Others, lighting by chance on a corn plant, made their own way down the stalk, and thus found a lodgment on the roots, where they were doubtless afterwards found and cared for by ants. Nevertheless, the loss of rootlice consequent upon a change of crop, altho not complete, must have been enormous, only now and then one of the aphid inhabitants of the field being fortunate enough to fall upon favorable conditions; and crop rotation remains one of the most effective means of checking the multiplication of these destructive insects.



PLATE I.

STAGES OF THE CORN-FIELD ANT (*Lasius niger americanus*): worker; larva; winged male; pupa; winged female; female with wings removed.





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