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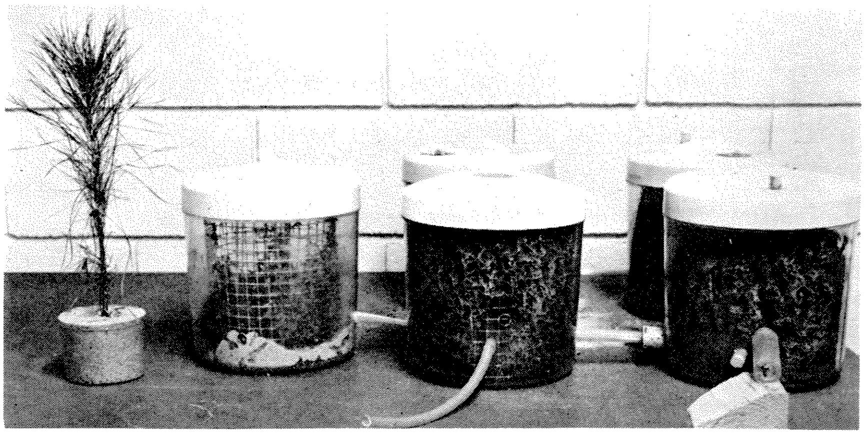
Small nest 56 days after establishment. The queen and 3 workers are visible on fungus garden, along with eggs, larvae and pupae.



This laboratory nest enables researchers to observe activities that ants carry out below ground. The pine seedling was stripped of all needles 2 hours after photograph was taken.

Probing the Secrets of THE TOWN ANT

by JOHN C. MOSER

Structures of small, new nests are studied by filling them with watery cement and digging around the cast after it has hardened. This nest had a single gallery extending 12 feet into the ground, and three small cavities.

"DARN those town ants!" These, and stronger words, are heard time and again in the hill country of east Texas and west-central Louisiana—the only part of the world that this ant calls home.

Why all the fuss about an ant that doesn't even sting? The answer lies in the bare remains of a vegetable garden, or in a bed that was full of flowers yesterday and empty today, or in a pine plantation stripped naked of every needle.

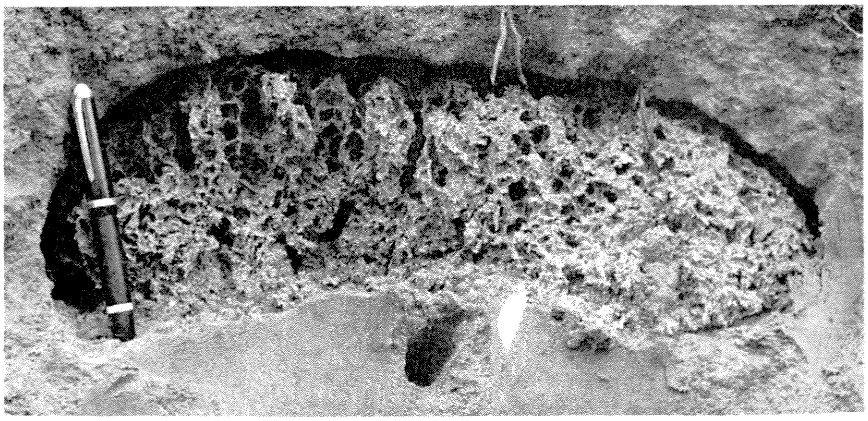
Town ants are not a new problem—they were here when the first settlers arrived. Despite the battle to stamp them out, they are as widespread now as 100 years ago.

The trouble does not seem to be in the weapons employed against the ants. Methyl bromide and carbon disulfide, used to fumigate nests, are heavy gases capable of penetrating every gallery in the vast underground network. Both fumigants give satisfactory control, but the ants are not easily defeated. New nests are started by queens from adjacent areas about as fast as the old ones are poisoned. Consequently, continual vigilance is needed to protect farm crops and pine plantations. The farmers and foresters who must inspect many acres of newly planted land would be enthusiastic about a new type of control.

To improve control methods is the aim of a basic research project—the only one of its kind on this ant—recently started by the Southern Forest Experiment Station's research center at Alexandria. Here, the deepest secrets of the ant's nests and biology are being probed for a vulnerable point. This article summarizes three years' work, and shows how findings to date will guide future investigations.

Spade Work in the Library

Digging (if you include the slang meaning) for information on town ants was not restricted to field work. Town ants have a number of close relatives in South America that also destroy crops to obtain green vegetation. So great is their damage that researchers have studied them for more than four decades, but many of the findings are reported in Portuguese, Spanish, and German. Qualified translators, if they could be found, were too expensive for most investigators. Recently, the Alexandria Research Center spent the necessary money and time to obtain



Typical fungus garden cavity about one foot wide. There are also dormancy and dump activities.

Summarizing Three Years of Research and Study of Laboratory and Underground Nests, Which Sometimes Occupy Over Five Acres

and study translations of the South American publications. These papers helped shape and guide the entire town ant research program.

In South and Central America, where labor is inexpensive, nests are opened by meticulous hand excavations. At Alexandria a bulldozer, used with skill and planning, was "delicate" enough to prove that Louisiana town ant nests are basically the same as those excavated by hand in South America. This was a tremendous step, for it allowed scientists to build upon the accumulated wealth of South American information. In doing so, they have advanced knowledge of the town ant farther and faster than would otherwise have been possible.

Two facts stand out from the South American work: control measures are almost identical to ours, and rapid reinvasion prevents complete eradication of ants—fumigating the nests merely holds the ants in check while crops are grown.

The Ants—Good Farmers

Town ants vary in size, ranging from ⅛- to ¾-inch long. Queens, the largest, are rarely seen because they spend their entire lives underground, except for one brief mating flight. Contrary to popular belief, a nest may contain more than one queen—Alexandria scientists found seven in one nest. Variations in the number of queens may explain why some nests enlarge slowly while others expand with startling rapidity.

Medium-sized workers do most of the foraging—and thus most of the damage. They pilfer green vegetation which they take, piece by piece, into the nests for the garden "soil" on which to grow a fungus that is the only known food of the ant.

As the leaf pieces arrive underground, small and medium-sized farmer ants take this material and carefully lick it over and over. Their saliva apparently contains an antibiotic which kills foreign fungi that might contaminate and destroy the food-fungus. Next, the ants cut the leaves into smaller pieces, and place them on the top and sides of the fungus garden. Thousands of pieces of green material are needed for each garden, and a sizeable nest may contain 100 or more gardens. Great numbers of the smaller workers constantly care for the gardens, keeping them free of contaminating organisms. They must be good farmers, for a fungus garden destroyed by foreign fungi has never been observed, even though the chances are great for contamination through the new material continuously brought into the nest.

Large worker ants, which are relatively few, serve a dual role for the colony. They forage along surface trails with the other workers, but also stay ready to use their powerful jaws to defend the nest against predators.

Architects and Engineers

Town ants are marvelous architects. Their underground nests consist of hundreds of fungus-garden cavities, dormancy cavities, and dump cavities, plus tunnels and galleries that connect these cavities with each other and with the surface of the nest. These features are not constructed haphazardly, but in a highly efficient manner and in a way that protects vital parts of the nest from flooding.

The underground nest may occupy more than five acres, even when the mounds on the surface cover an area not much more than 50 feet in diameter. After a bulldozer gets 15 feet down it has usually exposed most cavities, but almost always there will be galleries leading still deeper. Galleries are of course destroyed by bulldozing, but they can be studied by making casts of them—pouring down watery cement and digging away the surrounding soil after the cement has hardened.

Just uncovering one of these huge nests is a big job, but think of the engineering feats necessary to build such an elaborate underground network—a grain at a time, and in complete darkness!

Fungus-garden cavities, located near the center of the nest, are dome-shaped, and average a foot in diameter. Occasionally, one is big enough for a man to stand inside. Gardens are found more than eight feet below the surface in the winter, and clustered close together. In warmer weather, gardens are more numerous and are in cavities closer to the surface, where they are dispersed over a broader area. It appears, then, that winter fumigation is best since gardens are less numerous and are closely grouped.

Garden Structure

Fungus gardens are the heart of the nest, and it is here that the ants display their finest engineering. The cavities containing the gardens are protected against flooding by air traps. If water runs into the nest, air pockets keep it from filling the cavities and ruining the fungus. Vertical galleries extend deep below the nest in areas around the gardens, presumably to drain off water that may get into the town.

As the material of the gardens is depleted of nutrients, it is deposited in dump cavities. These cavities are all sizes and shapes, and are generally isolated from the fungus gardens. Dormancy cavities are a mystery to researchers. They are multi-shaped chambers packed with fresh "soil," ants, eggs, larvae, pupae, and some times green leaves or sand. The ants in these cavities are torpid, but quickly become active when exposed. Why or how thousands of ants pack themselves together and remain inactive continues to baffle entomologists. Fumigants penetrate these cavities readily, and kill almost all dormant ants.

Galleries connect the three types of cavities. They are merely oval or round pathways for the ants' travel inside the nest, from one cavity to another.

Tunnels are the narrow outlets of a nest, used by the ants in foraging. They connect outlying holes, where leaf fragments are first taken below ground, to the fungus-garden cavities. About the diameter of a cigar, they radiate in all directions from the nest. Well-defined surface trails may extend 100 feet or more beyond these so-called "feeder holes" to trees or other plants being stripped of leaves.

The internal structure of a nest is so extensive that fumigation with a heavy gas, as now done, still appears most practical. There does not seem to be much chance of controlling the ants with insecticidal or fungicidal dusts blown into the nests.

Watching the Queens

The town ant's love life is one of the strangest and most difficult aspects of its biology to study. Larvae of the sexual forms are reared deep in the nest in the winter. By late March, they transform into winged males and females, called alates. In early May, they are mature enough for their mating flights.

Whether through accident or instinct, mating flights appear to take place only when conditions are ideal to protect the alates. At any rate, all flights observed thus far by the entomologists at Alexandria have occurred shortly before daybreak, on dark, still, moonless nights. Moreover, flights have been confined to periods following rain, when the soil is wet enough for easy digging by the newly mated queens.

The dark nights chosen for flights have prevented researchers from learning how high and far queens go during and after the mating flight. But they know that huge numbers of sexuals are produced in the older nests. In 1961, for example, about 6,500 sexuals—half of which were queens—were counted as they issued from four nests. No wonder the ants can quickly invade areas previously fumigated!

A colony's males and females do not all emerge and fly in one night. Rather, flights occur over a period of several weeks. Thus the colony is protected against a catastrophe—an unfavorable change in weather or an abundance of predators, for example —that might destroy all the sexuals at once.

After mating in the air, a queen drops to the ground, clips off her wings, and immediately digs a small gallery. She plugs the entrance and begins to lay her eggs. During her mating flight, she carries in her mouth a small piece of fungus with which she starts a garden in her new nest.

Predators

Control through natural enemies is always a hope of the entomologist working on a tough insect problem. Unfortunately, there is little promise that such a solution will be possible with the town ant.

Birds eat males and queens during the mating flight. Armadillos, birds, and ground beetles capture some mated queens as they drop to the ground. Otherwise, the ants live virtually free of enemies other than man.

More than 40 species of insects have been found in the towns excavated at Alexandria, but none were observed to prey on the ants. Most were in the dump cavities, not closely associated with ants. The eight species found intermingled in fungus garden cavities apparently live in peaceful coexistence, but further investigations may show some to eat brood or fungus.

Searching for insect predators is time consuming. Not only is it necessary to find the insects, but enough observations are needed to determine if they are harming the ants. Although no predator has yet been found, researchers continue to keep a watchful eye for potential enemies.

Laboratory Colonies

With nests deep in the ground, the town ant almost defies detailed study in the field. Therefore, the Alexandria Research Center regarded it as a real triumph when, after several years' trials, it successfully established three colonies in the laboratory. This is the first time that even one reproducing town ant colony has thrived in artificial surroundings. Ants and fungus are in transparent, plastic canisters that are connected with plastic tubes, which serve as galleries. Two colonies have queens, while the other is functioning without a queen. Leaves placed outside the canisters are readily foraged and added to the gardens. In one nest, the fungus garden, which was the size of a baseball when the colony was moved in from the field, now fills four one-gallon canisters; the ant population has more than doubled.

The artificial towns are only 10 months old, so their full potential has not yet been realized. But in this short time they have yielded valuable information. For the first time, researchers have carefully watched queens laying eggs, workers cutting and licking leaves prior to placing them on the gardens, and the painstaking care of the fungus by tiny workers. Future observations should give valuable information on the longevity of workers and queens, the production of larvae of sexual forms, the effects of poisonous baits and forage material treated with fungicides, and many other mysteries.

What's Ahead?

In the future, researchers at Alexandria will concentrate largely on how ants reinvade areas that have been fumigated. The distance of the queens' honeymoon flight must be measured so that estimates can be made of the size of buffer zones needed to keep areas free of ants. New nests must be observed closely to learn how rapidly colonies grow, at what age they are large enough to cause serious damage, and how old the nests are when they begin to produce sexuals.

As about one nest in five now survives initial treatment, improvements in control measures are also needed. The best placement of fumigants to obtain high kills must be determined. If real progress against the town ant is to be made, nests must be treated when they are relatively small, before they are capable of infesting surrounding areas. Therefore, the possibilities of applying cheap insecticides to the surfaces of small nests must be fully explored.

As the laboratory colonies grow, individual canisters with ants and fungus will be removed for work with fumigants, insecticides, and fungicides. One of the many possibilities to be tested is whether ants can be induced to carry toxic materials into the nests.

Cooperative work with the Entomology Research Department at Louisiana State University was recently initiated to extract trail-marking and excitory substances from the glands of the ants. If the chemicals can be identified, it may be possible to manufacture them synthetically so that they can be used to disrupt the ant's behavior.

Town ants are tough opponents that have withstood man's best efforts to eradicate them. The only hope for devising more effective treatments is through research to obtain a clearer knowledge of their life history and biology.

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