The Honey Ants*

Notes on an Insect of Curious Habits, Found in Mexico and Southwestern United States

By Percy Leonard

EVER since I have first described a Mexican honey ant in 1832, these insects have been more or less before the public notice, and yet there are many obscure points to be cleared up in respect to their habits.

The following notes are a contribution to the subject, and are based upon nearly a year's observations of these ants, both in the wild state and in captivity.

In opening up a nest of honey ants we are liable to meet with six distinct phases. First, and most numerous, are the workers, the undeveloped females, which occur in three sizes, the majors, the minors, and the minors, and the so-called "queens," who exercise no regal power, but are simply the egg producers and mothers of the community. They have deprived themselves of their wings and inhabit the darkest recesses of the nest. Next come the virgin females, adorned with gauzy wings of great beauty, and lastly, the almost brainless males, likewise provided with wings.

Besides these, we find the repletes, which are not, however, a distinct phase, but are simply workers (usually majors), whose crops are so distended with honey as to justify their generic name, *Myrmecocystus*, i. e., ant bladders. These ants have evolved their distinctive habit with reference to climatic conditions. In the Californian springtime the hills are covered with flowers and flowering shrubs. The juicy shoots of many plants are also infested with aphides, which excrete the "honey dew." These insects use only a part of the sweet sap sucked from the growing shoots, the surplus being excreted, and the foraging ants lap it up from the surface of the leaves, or directly from the excretory orifice of the aphides. The quantity of syrup thus produced is extraordinary. As an extreme case we may mention an aphid living on the sugar maple which excretes forty-eight drops in twenty-four hours.¹

During the season of plenty a certain number of the workers, usually majors, are set aside to store up the supplies collected by their foraging sisters. They hang motionless from the vaulted ceilings of the underground chambers, and are always ready either to relieve a returning collector of the contents of her crop or to regurgitate a drop or two to feed a hungry member of the community. The swallowed honey is not "consumed," but simply stored. It remains in the crop, and is returned to the mouth in the same condition as when first swallowed. A minute quantity is, of course, passed on to the stomach proper for the sustenance of the individual, but the crop contents are available for the use of the community "on demand."

The tendency to active exertion, common to ants, is held in abeyance, and the patient replete resigns herself to the monotonous occupation of serving as a simple container for the fluid wealth of the community.

During the dry season the whole community depends upon the honey stored in the repletes supplemented by dead bees, wire worms, and other insects. The replete, when appealed to by the antennæ of another ant, opens her mandibles to their fullest extent, and the recipient sucks up the honey with mandibles almost shut. In two or three minutes the meal is over, and it is usual for the party served to lick the replete all over and massage the abdomen, as she is powerless to perform her own toilet. The crop, which expands to fill almost the entire gastric cavity, has no glands discharging into it, and as its walls are composed of non-absorbent chitine,² it is, to all intents and purposes, as cleanly a container for fluids as a glass bottle.

MYRMECOCYSTUS MEXICANUS MOJAVE.

Early in March, 1910, some boys of the school at Point Loma, San Diego, brought me some honey ants. Their gasters looked like partly deflated bladders, or half-dried raisins. This was because their honey contents had been almost exhausted by the winter consumption of the nest, and the spring blossoms having not yet opened, no fresh supplies were available.

It is a golden moment in the myrmecologist's career when, with a few blows of a mattock on the hard, tough sandstone sub-soil, he lays open the honey vaults. In the bright sunshine the repletes glitter like jewels. They look like highly-polished amber beads, clear and translucent, as they hang from the domed ceilings. So firmly do they cling that only one or two are dislodged by the shock of the mattock. Many of the workers huddled

together, like frightened sheep, in one of the chambers, and made no effort to defend their citadel, but doubtless they were paralyzed by the sudden glare. All the chambers and passages were spotlessly clean and absolutely free from smell. Although they look quite helpless, the heavily laden repletes are perfectly well able to regain their position in the dome when shaken to the floor. William M. Wheeler comments on the need of keeping the nest dry to prevent the crumbling of the walls and to prevent the growth of the molds on the repletes.³ My observations, continued daily for nearly a year, have convinced me that they actually prefer a moist soil. I have found many chambers of repletes about four inches below the surface of the flower beds in a garden which was repeatedly irrigated during the summer months. A wild nest under observation was situated at the bottom of a steep bank, where it received not only its own rainfall, but the surface water shed by the adjoining slope. The soil crumbles very readily when moist, and how the nest escaped disaster is not very apparent; nevertheless, it appears to be a strong and populous formicary.

At first it seems almost incredible that these ants, whose mandibles cannot pierce a plum skin or the rind of a pear,⁴ should be able to drive tunnels in the hard sandstone subsoil. The sandstone, however, must appear to the ants as Lilliputian masonry, the stone being represented by the sand grain, the mortar by the yellow clay which binds them together. It is not a question of cutting through the tiny blocks of silica, it is only necessary to moisten the clay matrix with saliva and remove the loosened grain. Lafcadio Hearn's statement that ants can bore tunnels in the solid rock is therefore seen to be misleading. William M. Wheeler states his belief that the relatively large nest opening is an adaptation for increasing the ventilation.⁵ My own view, based upon observation, continued for many months, is that the large entrance is required for the removal of nodules of iron encountered while excavating. During the hot weather of July and August the entrance was almost entirely blocked up with little clods; but when the first autumnal rain fell, softening the soil and favoring excavation, the hole was enlarged to a size somewhat greater than that of a ten-cent piece (which measures eighteen millimeters in diameter). Six or eight workers unite their efforts to drag out a nodule. Each grasps it on its equatorial line with her mandibles, and their bodies radiate outward from this center like the spokes of a wheel. Those in front drag, while those behind push, and, after very heavy exertions, the heavy burden is deposited outside the entrance. To allow egress for a team of eight workers surrounding a nodule necessitates a commodious gangway. The constant stream of ants circulating through the galleries is probably sufficient to prevent the accumulation of stagnant air. The nursery chambers are invariably situated in the upper portion of the nest, and one may sometimes see a worker carrying a cocoon outside the nest, as if to give it an airing.

One usually associates ants with dry weather and sunshine, but these ants come out only at night. A thick fog drifts in from the ocean spangling the scanty grass blades with glittering drops. The landscape is shrouded in darkness; but the little circle, illuminated by the lantern, is a scene of bustling activity. A constant stream of amber-colored ants pours out of the entrance hole, each carrying a small pellet of sand-grains in her mandibles. Some leave their burden just outside, others laboriously plod as far as three or four feet before they drop their load and hurry back for another. The underground workings are being extended almost every day in the year. I have seen the ants at work at 9 P. M. in the pouring rain and at a temperature as low as 44 deg. Fahr. They do not leave their holes until about half an hour after sunset. Thus they escape the birds and the lizards, their only enemies being the night-prowling toads and ant lions.⁶ If we smear a little honey on a piece of glass it is quickly surrounded by forty to fifty ants, who climb upon each

*"Honey Ants, With a Revision of the American *Myrmecocysti*" (page 380).

¹"Ants: Structure, Development and Habits" (page 177).

²"Ants: Structure, Development and Habits" (page 375).

³Since writing my nest was raided by driver ants (*Eciton sumichrasti*) on June 12th, 1911. The invaders poured into the nest and emerged carrying larvae. They were repulsed by spraying them with kerosine oil. "The ant's most dangerous enemies are other ants, just as man's most dangerous enemies are other men."—*Forel*.

others' backs to reach the tempting fluid. In two or three minutes they are loaded to the limit of their capacity, and then they stagger off toward home. They are perfectly ready to regurgitate when appealed to on their way home by a hungry comrade. The ant's antennæ, in which the "contact-odor" sense resides, are constantly being cleaned to free them from dust, which must dull their sensibility. The eggs and larvae are continually being licked over, probably as a sanitary precaution to prevent the growth of molds, to which they are very subject in the damp recesses of the nest.

As evidence of individuality in character I give the following anecdotes.

An ant had fallen into the moat surrounding my artificial nest and was rescued in a moribund condition, and laid upon the surface of the island. Two of the workers came up, inspected the sufferer and passed by without the slightest effort to help. Presently a minor worker arrived and showed the liveliest concern.

For many minutes she vigorously kneaded the patient's gaster, and worked the stiff legs until at last the half-drowned ant revived.

On another occasion, after a team of six workers had deposited a nodule outside the nest opening, one major stayed behind and by strenuous exertion dragged the load one third of an inch further away. Its exact location was a matter of absolute unimportance; but the major's notions of exactitude had to be satisfied.

For more than nine months I was unable to get the least indication as to the source of their honey. Occasionally foraging ants would drag a dead bee or other insect into the nest; but I could never find any foragers returning with distended crops.

On March 16th, 1911, however, it seemed as if the whole population was on the move, and streaming up and down the trunk of a neighboring pepper tree (*Schinus molle*). An examination of the tree by daylight showed a quantity of blossoms, but I could find only one or two scale insects. My captive ants greedily lapped up the nectar from these flowers. I have found these ants "milking" the aphides upon roses and carnations at night. It is probable that almost all the wild flowers are visited by the foraging ants. I know they get nectar from the "rattlesnake weed" (*Euphorbia setioba*), the honey plant (*Echium simplex*, a cultivated flower), and the blossoms of that fragrant wild shrub, *Ceanothus cuneatus*. As evidence of the stay-at-home habits of these ants, I can certify that a honey plant was in full bloom twenty-seven feet away from their nest, and yet it was three weeks before the foragers discovered it.

The honey stored in a replete of average size I found to weigh 0.1885 of a gramme, and if we take McCook's figure of 600 repletes in a nest of the *hortileorum* variety⁷ to be approximately true of *M. M. Mojave*, this would give us 113.10 grammes, or a grand total of about a quarter of a pound of honey. Small though it may appear to us, I fancy that the knowledge of a share in this provision imparts a certain dignity to every individual member of the nest.

These ants do not display such a wolfish eagerness to acquire chance scraps of food, as is shown by other species, who live from hand to mouth. To show the inoffensive character of the ants under consideration, I may mention that once a troop of little black ants (*Dorymyrmex pyramicus* var. *niger*) gathered round to lap up some honey which I had put at the nest entrance, but there was no resentment expressed toward them.

When watching the nest at night one may sometimes see crickets hop about among the ants who cover the ground outside the entrance; but no notice is taken of these intruders, and they hop away in a leisurely manner. Once I saw a tiny cricket emerge from the nest among the moving throng of ants, and markedly differentiated from his companions by his sudden, jerky action of progression. He skirmished about for a minute or two and then retreated down the hole. Evidently he was one of the "pets" of the nest.

Among the solitary insects, such as the flies, the moths and beetles, only a very small percentage of their numerous offspring ever reach maturity, owing to parental neglect. Among ants, under favorable conditions, the infant mortality is practically nil, so that if every female produced eggs the population would very soon outrun the means of subsistence. It has been very plausibly suggested that the ants regulate the supply of "queens" by rearing a selected number of female

⁷"Nature's Craftsmen" (page 104).

*A paper read before the San Diego Society of Natural History.

¹"Ants: Structure, Development and Habits" (page 341).

²"Ants: Structure, Development and Habits" (page 33).

larvæ on a full diet, while the great majority of them are so insufficiently nourished that their reproductive organs never develop. The feminine trait of taking delight in nursing the larvæ survives, however, in its full strength in these stunted females, and they devote themselves passionately to the care of the little, white, semi-translucent grubs, which resemble a crook-necked squash in general form. I think I have never looked into my artificial nest at any time during the day or night without seeing the nursing ants employed in caring for the larvæ.

On October 28th, 1910, I caught a worker near my wild nest who was carrying about a cocoon in her mandibles. I placed her upon the island nest, where a quantity of other workers were wandering about, not yet having begun to excavate tunnels. There arose immediately a tremendous competition to nurse the cocoon. The lucky possessor was constantly surrounded by eager applicants for the privilege. Sometimes they showed their impatience by stamping violently on the ground or jerking their bodies forward in their uncontrollable desire to caress the helpless pupa. A few days afterward the covering was stripped off, and the pale, unfinished infant was carried to and fro without a moment's peace, as one ant after another acquired possession of it. Every worker wanted to be good to it, and in the end it died, killed by kindness. If the care of the luckless pupa had been entrusted to one nurse all would have gone well, but by a perversion of the nursing instinct a tragedy resulted.

On October 16th, 1910, after the first real rain of the winter season, I noticed a number of ants peeping out of their hole in great excitement. To produce the effect of nightfall I inverted a box over the entrance. On raising the box after a few minutes I saw the ground alive with ants and among them a virgin queen, which I secured. This is the first capture of this phase of *M. M. Mojave*. The general coloring and markings remind one of a wasp. Although many nests have been searched, only two queens of this species have been found.

During the hot spell of weather at the end of August, 1910, the ants stayed underground. The entrance was almost closed with little clods of earth, which seems to show that the extraordinarily large nest opening is needed not so much for ventilation as to afford egress for ants removing nodules.

For some time I had noticed ants come out of the nest carrying what seemed to be the corpses of ants in their mandibles. I casually noted that they dropped their burdens and returned to the nest. Later on, I discovered that these burdens were live ants, and that when deposited, both parties plodded away in opposite directions without showing the slightest trace of emotion. Other observers who have witnessed similar occurrences have thought them to be a kind of play; but what I saw was much too solemn to be called a frolic. I would suggest that the ants carried out were "callows," that is ants newly emerged from the chrysalis, and that after being allowed to harden their shells for some days in the shelter of the nest they were thus formally introduced to the world as a hint that they might now undertake the regular work of the nest.

Professor Wheeler has established the fact that it is only "callows" which are capable of becoming repletes. Once an ant gets thoroughly matured and hardened it appears to lose the elasticity required in order to allow of the enormous distention of the crop which characterizes the replete. An ant in process of becoming distended to the proportions of a replete can never be confounded with a replete who has fed away her store and is slowly collapsing to her normal condition. In the former case the gaster is tense and more or less spherical, in the latter the skin is corrugated into folds and the segments stand out as ridges.

MYRMECOCYSTUS MEXICANUS.

These ants have never been found in the United States until 1910, and our discovery of a nest on Point Loma was the third reported occurrence of this species in the year.

On November 6th I dug up a nest in a soil composed of disintegrated shale. They are hardly distinguishable to the casual observer from the preceding species, except by a slightly darker color.

There were many semi-repletes moving about the galleries, and about eight laying females.

When opened up the resulting hole was only three feet deep and two feet in diameter—evidently a new nest. The laying females, in pleasing contrast to the queens in a beehive, are very friendly, and spend hours with their heads together, caressing one another with their antennæ. On January 30th, 1911, I found a solitary female in a little hole in a bank. The excavation could not have been more than a day or two old. Had she been undisturbed, in due time a new colony would have been produced by her unaided efforts.

Shortly after I had established an island nest in a basin and had moistened the earth, a minor worker was struck with the idea of sinking a shaft. Accordingly she scratched away at the soil, using her fore legs just like a terrier. Her energy was so infectious that a major joined her, and presently a minim was drawn into the undertaking. Ants digging in pure sand are obliged to remove it grain by grain, but the slightest admixture of clay permits the formation of pellets, thus enormously economizing labor. The loose dirt is first scraped into a heap under the ant. The gaster is then curved forward and downward as in the act of stinging,* and the front pair of legs is used to pat the earth against the opposing lower surface of the gaster. The loose soil granules are thus packed into a solid pellet, which is seized in the mandibles and carried out. When digging a gallery against the inner wall of a glass tumbler the digging consists for the most part in tugging at the sand grains and detaching them by main force. The gallery is afterward enlarged to give passage room for the females. One of the nests under observation had its entrance against the edge of a level slab of smooth concrete, so that the circular area over which the ants deposited their excavated soil was divided into two parts; one extended over a flower bed, the other over a surface of cement.

Every day the concrete slab is swept, so that on any given morning the loose earth is exactly half of the total amount brought up during the preceding night. On January 24th, 1911, the radius of the circle of debris was 7 feet 4 inches. The night had been calm, so that in sweeping up the deposit I am sure that I collected no wind-borne particles. The weight was 23.6489 grammes, and by doubling this figure we get the total output of loose dirt for the night. When poured into a cubic inch measure it almost exactly filled it. Under favorable conditions, therefore, these ants can excavate nearly two cubic inches in a night. During a colder night, a few days previous, the radius of the circle was only 4 feet 8 inches. Quite early in the evening some ants will be seen traveling to the very circumference of the circle, passing by bare spaces where we might imagine they would be perfectly justified in getting rid of their load.

Professor Wheeler, in speaking of repletes, remarks that they "are, of course, imprisoned for life;" but I have found my ants gradually resume their original figure when their contents are exhausted. In the nest I excavated November 6th, 1910, there were two or three dozen semi-replete majors whose gasters were no larger than those of the fertile female's, and who could walk about quite freely. Others had apparently been entirely emptied, owing to the lapse of time since the spring honey harvest, and their gastric segments were in a distressing condition of misfit. They did not overlap smoothly, but were warped and twisted out of shape. But another course is open to a replete who finds her honey content diminishing. *She may swallow air*, and thus maintain her size. This is done by both *M. M. Mojave* and the present species. In my artificial nest I found a full-sized major replete three quarters full of honey and with an air bubble occupying the upper region of the crop. I stinted supplies of honey to bring about diminution of her stock, and as she fed away her store the air bubble increased, until it filled three quarters of her capacity, while the remaining quarter of honey lay in the lower part of the crop.

I now frequently found her lying on the floor of the little grotto where she lived, with six or eight workers gathered around to be fed. The reason for her recumbent posture is at once apparent. So long as she was hanging from the ceiling, the air bubble occupied the upper portion of the crop, and her efforts to regurgitate honey could only result in an escape of the imprisoned air; but if she lay upon her side, or ventral surface, on the principle of the spirit level the air rose to the highest point of the gastric wall, and then any contraction of the proventriculus, or pumping stomach, forced the honey out at the mouth. Contrary to the observations of McCook on the hortideorum variety, I have found that these ants very economically lap up the honey content of dead repletes, after depositing the heads and thoraces in the moat round their nest. It was very amusing to watch the workers of this species feeding their larvæ with eggs. The nurse holds the egg in her jaws and squeezes it into the mouth of the helpless baby, who shows great eagerness to be fed. After the larva has got what it can, the nurse cleans out the shell, and regurgitates the remnant into the larva's mouth. Frequently the nurse sticks an egg on to the back of the larva's neck by saliva, so as to have it ready for the next feeding time.

*N. B.—No ant of the Subfamily Camponitinae, to which the genus *Myrmecocystus* belongs, possesses any sting. They have a large poison bag, the contents of which are used to spray their enemies and their prey.

Although these ants have no stings, they can spray some poisonous fluid into the wounds made by their mandibles, from a gland situated in the tip of the gaster. Two caterpillars, an inch and a half long and a quarter of an inch in diameter, succumbed to the spray in a few minutes, and were dragged down into the nest for food. It is quite common to find dead insects, termites, flies, etc., lying among the larvæ, and in wild nests and among captive communities it is usual for two or three repletes to hang from the ceilings of the nursery chambers. Sometimes the larger larvæ remain for a long time with their heads thrust into the thoraces of dead flies, devouring the muscular tissues.

The high development of ants is shown by the long period of helpless infancy and absolute dependence upon the care of the nursing workers. Although they lie upon the bare earth of their caves, they are protected from actual contact with the soil by stiff bristles which are set in their soft skin, and which allow of a free circulation of air all round them. Living as they do in damp subterranean caverns, they are peculiarly liable to be attacked by various molds, and it is for this reason that the nurses are indefatigable in licking their charges to remove the spores from which these vegetable parasites take their rise. Larvæ isolated from the attentions of the workers very quickly succumb to these exhausting growths. It is probably due to the need of a certain amount of ventilation that the larvæ are usually found in the upper chambers, thus presenting a parallel with the case of the short-tailed field vole (*Microtus agretis*) of England. The ordinary retreat of these rodents is a burrow situated far below the surface; but their young are reared in a nest of split grass, built upon the very surface of the ground. They are exposed to innumerable dangers, of course; but a litter of six or eight young mice would probably be suffocated if confined in a deeply situated nursery.

As showing the preference of these ants for moist surroundings, I may mention that for some months I kept a colony upon a porous earthenware saucer inverted in a basin of water and completely covered by a mound of clay and sand. When I eventually broke up the formicary, I found that the chambers and galleries had all been hollowed out in the soil immediately above the damp earthenware surface, the saucer itself forming the floor. The higher and drier portion of the mound had not been inhabited at all.

PRENOLEPIS IMPARIS

is found here in great abundance, and is common from the Atlantic to the Pacific. We will content ourselves, therefore, with merely recording its occurrence. It ascends the blue gum (*Eucalyptus globulus*), and may be found by the dozen resting half hidden among the fragrant anthers.

MYRMECOCYSTUS MELLIGER FOREL.

The typical form has not yet been found here, but a variety which appears to be intermediate between varieties testaceus and semirufus has been identified by Professor Wheeler.

MYRMECOCYSTUS MELLIGER LOMAENSIS.

Another variety or sub-species has been found here, only previously reported from Riverside and Whittier by Mr. Quayle.

This ant is strictly diurnal in its habits, and has been seen feeding upon the white flowers of *Mesembryanthemum æquilaterale*.

In an artificial nest these ants were fed with a drop of bee's honey in a leaf. Instead of greedily lapping it up, as the first two species here treated of would have done, they became violently agitated. They flung themselves upon the honey and sprayed it with their poison, snapping at it furiously with their mandibles, and it was some time before they realized that it was good for food. Is it possible that, being diurnal in their habits, they have a perennial feud with honey bees when they compete with them for the contents of the nectaries of flowers, and that the smell of the honey forcibly suggested bees to their minds, and provoked the customary hostilities? Whereas the honey bees require a hollow tree and household furniture in the shape of waxen cells for rearing brood or storing honey, the ants can carry on their lives with nothing more than food and a few cubic feet of soil. They use no implements, utensils, nor bedding, and the sole garment they require is the swaddling gown of woven silk that wraps them in the pupal state. Ants have no personal ambition. The only end they have in view is to cover the earth with colonies of their own particular species, and, urged by this remote, impersonal desire, they spend their lives in ceaseless toil. The instinct which impels the ants' unselfish labor is probably as irresistible as that which forces human beings to pursue their personal advantage. The personality of ants appears to be dissolved, and every individual seems to act as if it was the agent for that nameless,

universal will that urges on the slow advance of cosmic evolution. Without compulsion or direction their social life is carried on in perfect harmony. Each ant is a law to herself; but as the aim of all is identical, a spirit of perfect harmony prevails. The ants have shown the possibility of a perfect communal life, and have proved that individuals can be incited to the maximum of effort with the minimum of personal advantage, and that the little states, based on unselfish sisterhood, are supremely fitted to survive in the struggle for existence.*

Why Flat Surfaces Adhere

By H. T. Wright., A.R.C.Sc.(Lond) A.M.I.Mech.E.

GAGES having such surfaces—optical surfaces really—are much used in the best class machine work at the present day, and especially for the testing of limit gages. The Newall end measuring blocks are guaranteed to be lapped parallel with errors not exceeding 0.0001 inch. Gages which are even better suited for experimental work on adhesion are being manufactured in large quantities by Johansson, of Eskilstuna, Sweden, although the manufacturing methods are not generally known.

These gages are guaranteed true to 0.00001 inch, and are made in sets, the individual gages varying from 0.1001 inch to 0.1009 inch by 0.0001 inch; 0.101 inch to 0.149 inch by 0.001 inch; 0.05 inch to 1.0 inch by 0.05 inch; and from 1 inch to 4 inches by 1 inch. These gages will wring under suitable conditions, and a number of gages so arranged will give a length so nearly equal to the nominal length that the error cannot be detected in an ordinary measuring machine. The results of experiments on specially made gages and on those referred to above prove that the adherence is due principally to the surface tension of the liquid film between the faces.

For instance, if gages heated in an oven are allowed to cool in an enclosure free from water vapor, they will not adhere, but will fall apart under their own weight. Also, if gages are wrung together under normal conditions and are then placed in a vacuum, the force necessary to separate them is less than the theoretical amount, due to atmospheric pressure.*

This may be due to the fact that some air finds its way in between the more separated parts of the surfaces. The force due to atmospheric pressure also increases with a thicker film, and this may be due to the fact that there is less distortion of the blocks in the process of wringing, and that the air is more impeded.

By assuming a continuous film it follows that:

$$d = 2 \frac{a \cdot t}{P}$$
where d = distance between the faces,
 a = Area of face,
 t = Surface tension of liquid,
and P = Force of attraction between the faces.

If we use a liquid with a known surface tension, and the experimental value of P , we can calculate d . Experiments on paraffin have given a calculated value of d which approximates to 1/200000th inch. From this we see that gages having four sets of faces wrung together would have an aggregate length which would exceed the nominal length by 1/50000th inch, an amount which could be easily detected and measured. As no such variation in length can be determined, it follows that the calculated value of d is far too large. The true explanation is probably to be found in the value of a used in the formula. It is doubtful whether the liquid film covers the surfaces—and the opinion now generally held is that the film covers part of the surface in concentric rings, starting at the points of nearest approach. Thus any reduction in a would give a corresponding reduction in d . Reference has been made to the fact that gages left wrung together for a considerable period require to be struck smartly to bring about separation. This is due to slight corrosion, which may lead to rusting of the surfaces. Incidentally this proves the existence of a liquid film between the surfaces. The results

*This paper would be incomplete without an expression of grateful acknowledgment to Professor William Morton Wheeler for his kindness in identifying the various species of ants to which reference has been made. Without this help in naming specimens, and the assistance derived from this correspondence, the production of the paper would have been indefinitely delayed. It may be of interest to note that I have in my possession specimens of replete Honey Ants collected at Coronado, San Diego, in 1890, by Dr. F. E. Blaisdell, formerly a member of the San Diego Society of Natural History. They evidently belong to the species *Myrmecocystus Mexicanus*, but whether to the pure type, or to one of the sub-species or varieties, it is impossible to determine, owing to their defective state of preservation.

*Results of experiments are given by H. M. Budgett, B.A. *Proceedings Royal Society*.

obtained by various experimenters may be stated briefly as follows:

1. Volatile liquids give no adhesion.
2. Viscous liquids produce very little effect.
3. Condensed water vapor gives better results than light oils, and light oils give better results than heavy oils.
4. Approximately, from 70 per cent to 80 per cent of the adhesion is due to surface tension, and the remainder to atmospheric pressure.
5. The force due to atmospheric pressure is greater with heavy oils than with light oils.
6. With well cleaned surfaces—free from film—no adhesion can be obtained.
7. Molecular attraction is negligible.—*English Mechanic*.

Correspondence

[The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.]

An Unusual Experience With Ignis Fatui

TO THE EDITOR:

The ignis fatuus, or will-o'-the-wisp as it is often popularly called, is a well-known phenomenon supposedly due to the spontaneous combustion of gas arising from decaying vegetable or animal matter. For this reason it appears most commonly over marshy places. It appears as a faint, colorless flame fitting about in the air slightly above the surface of the ground. The rarity of the phenomenon and the usually lonely setting have caused it to be looked upon with superstitious awe. Its origin is plausible enough, but inasmuch as the writer has met with no persons who have witnessed such an extensive display of this phenomenon as he was fortunate enough to encounter, it appears of interest to describe this experience briefly.

During one winter the writer was tramping about in southern Nevada on a prospecting expedition and met with this experience late in January. The region is devoid of vegetation except for scanty bushes of sagebrush, greasewood and a few grotesque cacti. About ten days preceding this night a snow had fallen high in the mountains, accompanied by rain on the lower desert areas or "dry lakes," as the regions between the mountain ranges are called. This water settled in spots on the flat desert areas and varied in depth from one to several inches where the ignis fatui were encountered. The writer obtained the information at a distant mining camp that this was the first time water had stood in that desert for years. On this night the writer was tramping from Goodsprings, Nevada, to Ivanpah, California, and at 2 A. M. encountered a water-covered area. The flitting lights did not begin to appear until after some progress had been made through the water. The night was very dark and suddenly one of these lights appeared to float in the air about five feet above the ground. However, owing to no knowledge regarding its size, it could readily be imagined to be the light from a cabin window at some distance but for the fact that there was no habitation within twenty miles of the spot. Suddenly this light ceased to float complacently and sailed swiftly away to the left for some distance, then stopped. It was easy to imagine that it was waiting and coaxing—living true to its name in attempting to "lure benighted travelers to destruction." Soon others appeared, some floating apparently stationary, others shooting here and there. Little wonder that the peasantry of ancient times viewed this phenomenon with superstitious awe!

When the display was at its height hundreds of individual lights were visible simultaneously. The display was continuous during the hour or more that the water-covered area was being traversed. It possibly continued for days. At first it appeared to be very chaotic, but after observing it for a time, during which the writer continued walking, the individual lights seemed to progress rather jerkily or spasmodically in the same general direction. This led to a theory formulated at that time which may or may not be tenable.

The desert air was very quiet, as was often the case at night, as indicated by the slow drift of smoke from the campfire. It is easy to imagine a great number of minute generators of gas in such a case as this, which appeared to be extraordinarily favorable for such a display of ignis fatui. A thread of gas might arise from each of these generators and slowly drift away in a crooked path as determined by the slow drift of air currents. How this gas ignites will not be considered, but the grotesque antics of the individual lights can be readily explained in this manner. An individual light appeared to float stationary when the direction

of the thread of gas was directly away from the observer. When the direction of the thread was at any other angle it was easy to account for the varying speeds with which the light apparently traveled. Thus by imagining an irregular path the grotesque antics of individual lights can be accounted for. The lights were quite faint and of no definite shape except that they appeared as spots of finite sizes, so that it was impossible to gage their distances.

The writer has never read of such a multitude of ignis fatui having been witnessed at one time, and oddly enough has never encountered a person who has seen even a single one. This would indicate that the phenomenon is rare and that this experience was quite unusual. Although the writer recognized the phenomenon as the ignis features, it is needless to state that the lonely setting, the vocal accompaniment of coyotes, and the knowledge that the nearest human beings were twenty miles away, aroused emotions which contributed much to the experience which can be readily imagined.

M. LUCKIESH.

SCIENTIFIC AMERICAN SUPPLEMENT

Founded 1876

NEW YORK, SATURDAY, DECEMBER 9th, 1916
Published weekly by Munn & Company, Incorporated.
Charles Allen Munn, President; Frederick Converse Beach, Secretary; Orson D. Munn, Treasurer;
all at 233 Broadway, New York

Entered at Post Office of New York, N. Y., as Second Class Matter
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The Scientific American Publications
Scientific American Supplement (established 1876) per year \$5.00
Scientific American (established 1845) " " 4.00
The combined subscription rates and rates to foreign countries, including Canada, will be furnished upon application
Remit by postal or express money order, bank draft or check

Munn & Co., Inc., 233 Broadway, New York

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