

Observations on Ants, Bees, and Wasps.—Part XI.

By Sir JOHN LUBBOCK, Bart., M.P., D.C.L., LL.D., F.R.S.

[Read 1st December, 1887.]

ON THE RELATION BETWEEN *Formica sanguinea* AND ITS SLAVES.

IT is well known that *Polyergus rufescens* is entirely dependent on its slaves. Huber long ago found that this ant will starve in the midst of plenty, and will not even put food into its own mouth. I have shown that isolated specimens will live for months if they are allowed a slave for an hour or so every two or three days to clean and feed them. It is said, on the contrary, that our only slave-making species, *Formica sanguinea*, can manage without slaves. Indeed, it appears that nests are sometimes found in which there are mistresses alone, entirely without slaves. Forel thinks that he has observed in such nests generally a larger proportion of small individuals than in nests which possess slaves. This would be interesting as tending to show that in such nests the young are less well nourished than when they have slaves to attend upon them.

The question remains, of what advantage are the slaves to the *F. sanguinea*? Forel says, I do not quite understand why, “Je ne veux pas trop rechercher le motif qui pousse les *sanguinea* à se faire presque toujours des esclaves.” “Peut-être,” he adds, “le sentiment de leur force, et le désir de travailler moins, pour faire plus à leur aise la chasse aux *Lasius flavus* et *L. niger*, est-il le mobile qui les pousse à cet acte. Celui-ci leur serait peu à peu devenu plus ou moins instinctif puisqu’il était avantageux à la conservation de leur espèce.” This suggestion seems very probable, and may be partially correct; it is not, however, I think, a complete explanation. I have had under observation several nests of *F. sanguinea*. One of them I owe to the kindness of M. Forel himself, who sent it to me in June 1882. There was no queen, and, though the nest was very healthy, of course the numbers gradually diminished. At the beginning of January 1886 the last slave died, and there then remained only about 50 *F. sanguinea*. Under these circumstances the *F. sanguinea* began to die off rapidly; by the middle of the year only six remained alive, and these, no doubt, would not have survived long. On July 1st I got some pupæ of *F. fusca* and placed them outside the nest. The *sanguineas* soon discovered

them, carried them into the nest, and from that day until December 1887, more than six months, there was only one other death. [Two of the *F. sanguinea* are still (August 1888) alive.] Although then it may be true, as to which I express no opinion, that there are nests of *F. sanguinea* without slaves, still this observation seems to indicate that the slaves perform some important function in the economy of the nest. It still remains to be determined in what exactly this function consists.

ANT-GUESTS.

Dr. Wasmann has recently published * an interesting memoir on certain of these "Ant-guests." His observations relate exclusively to some of the beetles which live with ants.

He confirms V. Hagen's statement that the specimens of *Atemeles emarginatus* which live with *Myrmica lævinodis*, a yellow ant, are paler in colour than those which share the nests of the black *Formica fusca*. He entirely confirms the statements of previous observers that the *Atemeles* is actually fed by the ants, who also clean them just as they do their own fellows. The *Atemeles* also, on their part, perform the same kind offices for the ants. He also repeatedly saw the ants licking the bunches of golden hairs on the abdomen of the *Atemeles*.

The *Atemeles* has adopted very closely the habits of the ants with which it lives. They pair, moreover, in the nests of the ants. Still, they are not entirely dependent on their hosts, like some of the other ant-guests, but are able to feed themselves. Indeed the *Myrmicas* seem to drive them out of the nest towards the beginning of May. Dr. Wasmann is disposed to attribute this to the anxiety of the ants for their young. In *Myrmica* the pupæ are naked, and he thinks the ants are afraid that the *Atemeles* would be unable to resist the temptation of eating them. In support of this suggestion, he observes that in the nests of *Formica sanguinea*, whose pupæ spin a silken cocoon and are therefore protected, he has found *Atemeles* as late as the end of June. He has not been able to satisfy himself whether the larvæ of *Atemeles* are brought up in the ants' nest or not; but inasmuch as while the *Atemeles* are far from rare, he has only found among them a single larva which could belong to the species, and even this was not certainly identified, it seems probable that the larval stage is passed elsewhere.

* Deutsche Entom. Zeitschrift, 1886, p. 49.

Lomechusa strumosa has been recorded from the nests of *Formica sanguinea*, *Myrmica rubra*, *Formica congerens*, and *F. rufa*; but Dr. Wasmann, like V. Hagen and Forel, has never found it except with *F. sanguinea*. It is fed by the ants in the same manner as *Atemeles*, and has very similar bundles of golden hairs on the abdomen, which are licked by the ants like those of *Atemeles*. While, however, the ants seem to communicate with the *Atemeles* mainly by means of the antennæ, in the case of *Lomechusa* the parts of the mouth are brought more into play. He has found *Lomechusa* in the ants' nests up to the end of June.

Dinarda dentata is a still more frequent inmate in the nests of *F. sanguinea*, but plays a very different part. The ants seem indifferent to them, and when they take any notice it is of an unfriendly character. Nor can this be wondered at, for according to M. Wasmann the principal food of the *Dinardas* consists of any ant which may chance to die, or any other weak insect which falls in their way. The ants seem thoroughly to distrust them, and it is curious that they should be tolerated. Grimm, indeed, thought he had seen ants licking the *Dinardas*, as they do *Atemeles* and *Lomechusa*. Wasmann, however, considers that this was a mistake; at any rate he has never seen anything of the kind. If an ant meets a *Dinarda* she either treats it with indifference or threatens the beetle with her jaws, and the *Dinarda* then raises its abdomen, which appears always to drive away the ant. It is possible that the *Dinarda* has the power of producing an odour distressing to the ants, or perhaps they eject poison like the *Formicas* themselves. They seem always to remain in the nests of the ants, and pass through their transformation in them. *Formica sanguinea*, like *F. rufa* and *F. congerens*, changes its nest periodically twice a year; such, at least, is said to be the case on the continent; I am not aware whether the same habit has been observed in this country. The summer nests are looser and opener, the winter ones lower and more compressed. In their migration from one nest to the other, which are occasionally at some distance apart, the ants are accompanied by the *Dinardas*. On one occasion, when the ants were flitting, Dr. Wasmann in 20 minutes captured among them thirteen specimens of *Dinarda*; while under other circumstances he never saw one outside the nest.

Heterius ferrugineus, belonging to a totally different family of beetles, the Histeridæ, and which inhabits the nests of *Polyergus*

rufescens, *Formica sanguinea*, *F. pressilabris*, *F. fusca*, *F. rufibarbis*, *F. rufa*, *F. exsecta*, *Lasius niger*, and *Tapinoma erraticum*, appears to agree in its habits with *Dinarda*, and to devour dead and wounded ants, as also do the *Myrmedoniæ*.

Dr. Wasmann confirms entirely my observations, in opposition to the statements of Lespès, that while ants are deadly enemies to those of other nests, even of the same species, the domestic animals, on the contrary, may be transferred from one nest to another and are not attacked.

He justly observes that, no doubt, many interesting discoveries are in store for us as to the relations between ants and their guests. The marvellous and grotesque antennæ of the *Paussidæ* will doubtless, one of these days, tell a wonderful story to some patient and fortunate observer.

MIMICRY AMONG ANTS.

Prof. C. Emery has published in the *Bull. della Soc. Ent. Italiana*, 1886, a short, but interesting note on the habits of *Camponotus lateralis*. Of this species there are two varieties: one black, like its nearest allies; the other red, with the abdomen and part of the thorax black. They live in small colonies, and make expeditions up trees to collect honey-dew from the *Aphides*. The black type (*C. foveolatus*, Mayr, *C. ebeninus*, Emery) sometimes goes in troops, but generally a few join the troops of other black ants, such as *Formica gagates* and *Camponotus æthiops*. Prof. Emery suggests that, their numbers being small and their sight not very good, they find it convenient to accompany other ants which live in larger communities, and that they perhaps escape detection from the similarity of colour.

This suggestion derives some support from the fact that the red variety accompanies in a similar manner the troops of *Cremastogaster scutellaris*, which is red and black, and at first sight curiously like the red variety of *C. lateralis*. *Cremastogaster scutellaris* lives in immense communities among the pine woods along the shores of the Mediterranean, and is, as I know to my cost, a very pugnacious species. Prof. Emery suggests that the black form of *C. lateralis* is the original type, resembling as it does its nearest congeners; and that the red variety has the advantage, from its similarity to *Cremastogaster scutellaris*, of using that species as its guide and of sharing, undetected, in the produce of its flocks and herds. Prof. Emery observes

that he only suggests this explanation. The facts he mentions are very interesting, and it is to be hoped that he will continue his observations.

ON THE COLOUR-SENSE OF ANTS.

Prof. Graber* has published an interesting memoir on this subject. He confirms my observations on ants and *Daphnias*, in which I showed that they are sensitive to the ultra-violet rays, by similar observations on earthworms, newts, &c. It is interesting, moreover, that the species examined by him showed themselves, like the ants, especially sensitive to the blue, violet, and ultra-violet rays. Prof. Graber, however, states that he differs from me, inasmuch as I attributed the sensitiveness to the ultra-violet rays exclusively to vision; that it is "ausschliesslich durch die Augen vermittelt." I would not, however, express that opinion as applying absolutely to all animals, though it is, I believe, true of ants, where the opacity of the chitine renders it unlikely that the light would be perceived except by the medium of the eyes and ocelli.

Graber has demonstrated in earthworms and newts, and Plateau in certain *Myriapods*†, that these animals perceive the difference between light and darkness by the general surface of the skin. But more than this, Graber appears to have demonstrated that earthworms and newts distinguish not only between light of different intensities, but also between rays of different wavelengths, preferring red to blue or green and green to blue. He found, moreover, as I did, that they are sensitive to the ultra-violet rays. Earthworms, of course, have no eyes, but thinking that the light might perhaps act directly on the cephalic ganglia, Graber decapitated a certain number, and found that the light still acted on them in the same manner, though the differences were not so marked. He also covered over the eyes of newts, and found that the same held good with them. Hence he concludes that the general surface of the skin is sensitive to light.

These results are certainly curious and interesting; but, even if we admit the absolute correctness of his deductions, I do not see that they are in opposition to those at which I had arrived. My main conclusions were that ants, *Daphnias*,

* "Fundamental Versuche über die Helligkeits- und Farben Empfindlichkeit augenloser und geblendeter Thiere," Sitz. Kais. Akad. der Wiss. Wien, 1883.

† Journ. de l'Anatomie et de la Physiologie, 1886, p. 431.

&c., were able to perceive light of different wave-lengths, and that their eyes were sensitive to the ultra-violet rays much beyond our limits of vision. His observations do not in any way controvert these deductions: indeed the argument by which (p. 234) he endeavours to prove that the effect is due to true light and not to warmth, presupposes that sensations which can be felt by the general surface of the skin are still more vividly perceived by the special organs of vision.

Prof. Graber's observations have been followed up by M. Forel*. He took fifteen specimens of *Camponotus ligniperdus*, which is a large species and, moreover, possesses the advantage, for this purpose, of having no ocelli, and carefully covered the eyes with opaque varnish. He then placed them in a box with ten normal specimens of the same species (to which he subsequently added five more), and covered over one half of the box with cardboard and the other half with a layer of water. In this way the one half of the box was darker than the other, but the temperature of the two sides was approximately equal. In four experiments the numbers were as follows:—

Under the cardboard.		Under the water.	
Hoodwinked Ants.	Normal Ants.	Hoodwinked Ants.	Normal Ants.
3	9	12	1
13	7	3	3
9	9	5	1
3	8	12	2
—	—	—	—
28	33	32	7

It will be seen that a very large majority of the normal ants in every case went under the cardboard; while it was practically indifferent to the hoodwinked ants in which side of the box they rested. Moreover, every time the water and the cardboard were transposed, the normal ants were much excited and began running about to avoid the light, while the hoodwinked ants were quite unaffected.

These experiences therefore proved that the varnish did, in fact, render the ants temporarily blind, their instincts being in other respects unaffected.

He then replaced the cardboard and water by a solution of

* Rec. Zool. Suisse, 1887.

esculine, which is impervious to the ultra-violet rays, and a glass of deep cobalt, which stopped most of the other rays but permitted the ultra-violet to pass. The results then were:—

Under the Esculine.		Under the Cobalt glass.	
Hoodwinked Ants.	Normal Ants.	Hoodwinked Ants.	Normal Ants.
11	8	3	1
11	13	4	2
9	12	5	3
5	13	9	2
10	12	4	3
3	11	12	3
12	13	3	1
—	—	—	—
61	82	40	15

Thus, then, a very large proportion of the normal ants preferred to avoid the ultra-violet rays by going under the esculine. To the varnished ants, on the contrary, it was indifferent whether they were under the esculine or the cobalt. The slight preponderance in favour of the esculine was probably partly due to having started the experiments with a larger number of ants in the side of the box then covered with esculine, and partly from the fact that the hoodwinked ants would have a tendency to accompany the others.

From these and other experiments M. Forel comes to the same conclusion as I did, that the ants perceive the ultra-violet rays with their eyes; and not, as suggested by Graber, by the skin generally.

EXPERIMENTS WITH *Platyarthrus*.

In connection with this subject I may add that I do not at all doubt the sensitiveness to light of eyeless animals. In experimenting on this subject I have always found that though the *Platyarthrus*, which live with the ants, have no eyes, yet if part of the nest be uncovered and part kept dark, they soon find their way into the shaded part. It is, however, easy to imagine that in unpigmented animals, whose skins are more or less semi-transparent, the light might act directly on the nervous system, even though it could not produce anything which could be called vision.

ON THE FUNCTION OF THE COMPOUND EYES AND OCELLI.

Forel agrees with Réaumur, Marcel de Serres, and Dugès, that in insects which possess both ocelli and compound eyes the ocelli may be covered over without materially affecting the movements of the animals; while, on the contrary, if the compound eyes are so treated, they behave just as in the dark. For instance Forel varnished over the compound eyes of some flies (*Calliphora vomitoria* and *Lucilia cæsar*), and found that if placed on the ground they made no attempt to rise, while if thrown in the air they flew first in one direction and then in another, striking against any object that came in their way, and being apparently quite unable to guide themselves. They flew repeatedly against a wall, falling to the ground and unable to alight against it as they do so cleverly when they have their eyes to guide them. Finally, they ended in flying away straight up into the air and quite out of sight.

Johannes Müller inclined to the opinion that insects saw near objects with their ocelli. Plateau satisfied himself that the movements of insects are not affected by the ocelli being covered over, and hence concluded that they are rudimentary organs. The complexity of their structure, however, seems fatal to this conclusion.

Forel confesses that the use of the ocelli still remains an enigma, but he is disposed to think that they enable their possessors to see in comparative darkness. He observes* that they are specially developed in insects which require to see both in bright light and also in comparative obscurity. Aerial insects do not generally require or possess ocelli.

Lebert expresses the opinion† that in spiders some of their eight eyes—those which are most convex and brightly coloured—serve to see during daylight; the others, flatter and colourless, during the dusk. Pavesi has observed‡ that, while the species of *Nesticus* possess normally eight eyes, in a cave-dwelling species (*Nesticus speluncarum*) there are four only, the four middle eyes being atrophied. This suggests that the four central eyes serve specially in daylight.

SENSE OF SMELL.

In my previous memoirs I have recorded a few experiments which convinced me that ants are gifted with a very highly developed sense of smell, and that this resides in the antennæ.

* *L. c.* p. 181.

† *Die Spinnen der Schweiz*, p. 6.

‡ “*Sopra una nuova specie di Ragni appartenente alle collezioni del Museo Civico di Genova*,” *Ann. Mus. Civ.* 1873, p. 344.

Forel, Graber, Lefebvre, Perris, and other recent writers have come to the same conclusion, and there can, I think, be no reasonable doubt that in very many insects the antennæ serve as organs of smell. At the same time it does not necessarily follow that the sense of smell should be confined to them. Even in ourselves it is not always easy to distinguish the sense of taste from that of smell.

Graber deprived a beetle (*Silpha thoracica*) of its antennæ, and then tested it with oil of rosemary and asafœtida. A beetle of the same species, but with antennæ, showed its perception by movement in half a second to one second in the case of the oil of rosemary, and rather longer, 1 second to 2 seconds, in the case of the asafœtida. The *Silpha* without antennæ showed its perception of the oil of rosemary in 3 seconds on an average of eleven times, while in no case did it show any indication of perceiving the asafœtida even in 60 seconds.

Prof. Graber infers, "dass der eine Geruchsstoff (Assa-fœt), der nichts weniger als ein sehr feiner ist, nur durch das Medium der Fühler perzipiert Bewegungen auslöst, während der andere (Rosmarinöl) ähnliches auch ohne Vermittlung dieser angeblich spezifischen Geruchsorgane bewirkt."

Graber questions some of the experiments which seemed to me to demonstrate the existence of a sense of smell in ants. He says:—

"Da Lubbock noch hinzufügt, dass keiner, der das Benehmen der Ameisen unter diesen Umständen beobachten würde, den geringsten Zweifel an ihrem Geruchsvermögen haben könnte, wählte ich auch diese Methode, um zu erforschen, wie sich etwa der Fühler beraubte Ameisen verhalten, würden. Ich war nicht wenig überrascht zu finden, dass auch diese (es handelt sich um *Formica rufa*) vor dem Riechobjekt umkehrten. Um ganz sicher zu gehen, versuchte ich's aber noch mit dem gleichen Arrangement aber *mit Weglassung des Riech-stoffes*, und siehe da! sie kehrten auch jetzt noch um! Bei genauerer Beobachtung der von einer Ameise vom Anfang an auf dem Papiersteg zurückgelegten Strecke stellte sich auch bald heraus, dass es sich bei dem gewissen Umkehren lediglich um ein versuchsweises Abschreiten oder Ausprobiren des unbekannten Weges handelt, oder dass sich die Ameisen ähnlich benehmen wie wir selbst, wenn wir etwa auf einem schwanken Brette eine tiefe Gebirgskluft überschreiten sollen."*

* V. Graber, "Vergl. Grundversuche über die Wirk. und d. Aufnahmestellen chem. Reize bei den Thieren." Biol. Centralblatt. vol. xiii. p. 449 (1885-6).

M. Graber's observation is, I doubt not, quite correct, but his inference is not well founded, nor was his experiment the same as mine. It is quite true that if an ant be started off along a narrow paper bridge, she will after awhile turn round and come back again. I do not, however, think that this is due, as he suggests, to any sense of giddiness. Ants which habitually climb trees are not likely to be affected by any such sensation. It is rather, I believe, that they feel they are being sent on a fool's errand. Why should they start off and run straight forward into a strange country? They turn round in hopes of finding their way home, whether the bridge is high or low, broad or narrow, or indeed whether they are on any bridge at all. M. Graber has not observed that I expressly stated that in each case they stopped exactly when they came to the scented pencil.

SENSE OF DIRECTION.

Fabre has made a number of experiments from which he concludes that bees have a certain sense of direction. My own experiments led me to the opposite opinion. I have now repeated some of them, and made others, which all led to the same conclusion. For instance I put down some honey on a piece of glass, close to a nest of *Lasius niger*, and when the ants were feeding I placed it quietly on the middle of a board 1 ft. square and 18 inches from the nest. I did this with 13 ants and marked the points at which they left the board. Five of them did so on the half of the board nearest to the nest, and 8 on that turned away from it; I then timed 3 of them. They all found the nest eventually, but it took them 10, 12, and 20 minutes respectively. Again, I took 40 ants which were feeding on some honey, and put them down on a gravel-path about 50 yards from the nest, and in the middle of a square 18 inches in diameter, which I marked out on the path by straws. They wandered about with every appearance of having lost themselves, and crossed the boundary in all directions. I marked down where they left the square and then took them near the nest, which they joyfully entered. Two of them, however, we watched for an hour. They meandered about, and at the end of the time one was about 2 feet from where she started, but scarcely any nearer home; the other about 6 feet away, and nearly as much further from home.

I prepared a corresponding square on paper, and having indicated by the arrow the direction of the nest, I marked down the spot where each ant passed the boundary. They crossed it in all

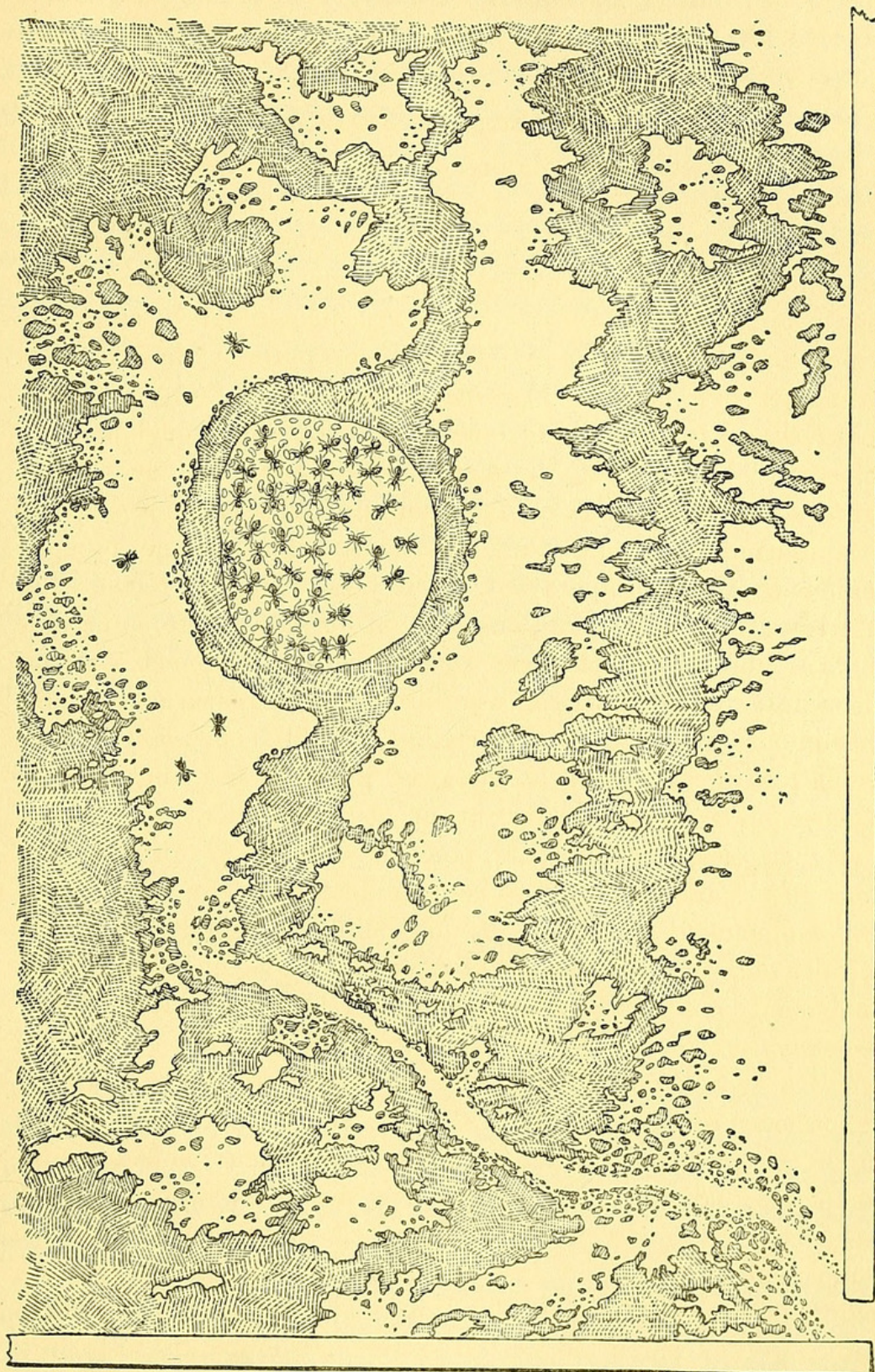
directions; and if the square were divided into two halves, one towards the nest and one away from it, the number in each was almost exactly the same.

RECOGNITION OF FRIENDS.

In the interesting memoir already cited Forel says:—"Lubbock (*l. c.*) a cru démontrer que les fourmis enlevées de leur nid à l'état de nymphe et écloses hors de chez elles étaient néanmoins reconnues par leurs compagnes lorsqu'on les leur rendait. Dans mes *Fourmis de la Suisse*, j'avais cru démontrer le contraire. Voici une expérience que j'ai faite ces jours-ci: le 7 août, je donne des nymphes de *Formica pratensis* près d'éclore à quelques *Formica sanguinea* dans une boîte. Le 9 août quelquesunes éclosent. Le 11 août, au matin, je prends l'une des jeunes *pratensis* âgée de deux ou trois jours seulement et je la porte à la fourmilière natale dont elle était sortie comme nymphe seulement 4 jours auparavant. Elle y est fort mal reçue. Ses nourrices d'il y a 4 jours l'empoignent qui par la tête, qui par le thorax; qui par les pattes en recourbant leur abdomen d'un air menaçant. Deux d'entre elles la tinrent longtemps en sens inverse chacune par une patte en l'écartelant. Enfin cependant on finit par la tolérer, comme on le fait aussi pour de si jeunes fourmis (encore blanc jaunâtre) provenant de fourmilières différentes. J'attends encore deux jours pour laisser durcir un peu mes nouvelles écloses. Puis j'en reporte deux sur leur nid. Elles sont violemment attaquées. L'une d'elles est inondée de venin, tirillée et tuée. L'autre est longtemps tirillée et mordue, mais finalement laissée tranquille (tolérée?). On m'objectera l'odeur des *sanguinea* qui avait vécu 4 jours avec la première et 6 jours avec les deux dernières. À cela je répondrai simplement par l'expérience de la page 278 à 282 de mes *Fourmis de la Suisse*, où des *F. pratensis* adultes séparées depuis deux mois de leurs compagnes par une alliance forcée avec des *F. sanguinea*, alliance que j'avais provoquée, reconnurent immédiatement leurs anciennes compagnes et s'allièrent presque sans dispute avec elles. Je maintiens donc mon opinion: les fourmis apprennent à se connaître petit à petit à partir de leur éclosion. Je crois du reste que c'est au moyen de perceptions olfactives de contact."*

I have, however, repeated my previous observations with the same results.

* August Forel, "Expérience et Remarques critiques sur les Sensations des Insectes." Recueil Zool. Suisse, tome iv. (1887), pp. 179-180.



Part of one of my Ant-cases, showing circular nest of *Tapinoma*, with pathway leading to the opening. The Ants enter the circular fortification by one or two tunnels not visible in the figure.

At the beginning of August I brought in a nest of *Lasius niger* containing a large number of pupæ. Some of these I placed by themselves in charge of three ants belonging to the same species, and taken from a nest which I have had under observation for rather more than 10 years. On the 28th August, I took 12 of the young ants, which in the meantime had emerged from the separated pupæ, selecting some which had all but acquired their full colour. Four of them I replaced in their old nest, and four in that from which their nurses were taken.

At 4.30. In their own nest none were attacked.

In their nurses' nest one was attacked.

5. In their own nest none were attacked.

In their nurses' nest all four were attacked.

8. In their own nest none were attacked.

In their nurses' nest three were attacked.

The next day I took six more and marked them with a spot of paint as usual, and at 7.30 replaced them in their own nest.

At 8 I found 5 quite at home. The others I could not see, but none were attacked.

8.30	„	5	„	„	„
9	„	3	„	„	„
10	„	4	„	„	„
11	„	5	„	„	„
12	„	3	„	„	„
1	„	3	„	„	„
4	„	4	„	„	„
7	„	1	„	„	„
9	„	2	„	„	„

The next morning I could only see two, but none were being attacked and there were no dead ones. It is probable that the paint had been cleaned off the others, but it was not easy to find them all among so many. At any rate none were being attacked nor had any been killed.

These observations, therefore, quite confirm those previously made, and seem to show that if pupæ are taken from a nest, kept till they become perfect insects, and then replaced in the nest, they are recognized as friends.

When we consider the immense number of ants in a nest, amounting in some cases to over 500,000, it is a most remarkable fact that they all know one another. If a stranger, even be-

longing to the same species, be placed among them, she will be at once attacked and driven out of the nest. Nay, more, I have already shown that they remember their friends even after more than a year's separation, and that it is not by any sign or password, because even if rendered intoxicated, so as to be utterly insensible, they are still recognized. As regards the mode of recognition, Mr. McCook considers that it is by scent, and states that if ants are more or less soaked in water, they are no longer recognized by their friends, but are attacked. He mentions a case in which an ant fell accidentally into some water:—

“She remained in the liquid some moments and crept out of it. Immediately she was seized in a hostile manner, first by one, then by another, then by a third; the two antennæ and one leg were thus held. A fourth one assaulted the middle thorax and petiole; the poor little bather was thus dragged helplessly to and fro for a long time, and was evidently ordained to death. Presently I took up the struggling heap. Two of the assailants kept their hold; one finally dropped, the other I could not tear loose, and so put the pair back upon the tree, leaving the doomed immersionist to her hard fate.”

His attention having been called to this, he noticed several other cases, always with the same result. I have not myself been able to repeat the observation with the same species, but with two at least of our native ants the results were exactly reversed. In one case five specimens of *Lasius niger* fell into water and remained immersed for three hours. I then took them out and put them into a bottle to recover themselves. The following morning I allowed them to return. They were received as friends, and though we watched them from 7.30 till 1.30 every hour, there was not the slightest sign of hostility. The nest was moreover placed in a close box, so that if any ant were killed we could inevitably find the body, and I can therefore positively state that no ant died. In this case, therefore, it is clear that the immersion did not prevent them from being recognized. Again, three specimens of *Formica fusca* dropped into water. After three hours I took them out, and after keeping them by themselves for the night to recover, I put them back into the nest. They were unquestionably received as friends, without the slightest sign of hostility, or even of doubt. I do not, however, by any means intend to express the opinion that smell is not the mode by which recognition is effected.

LONGEVITY.

It may be remembered that my nests have enabled me to keep ants under observation for long periods, and that I have identified workers of *Lasius niger* and *Formica fusca* which were at least 7 years old, and two queens of *Formica fusca* which have lived with me ever since December 1874. One of these queens, after ailing for some days, died on the 30th July, 1887. She must then have been more than 13 years old. I was at first afraid that the other one might be affected by the death of her companion. She lived, however, until the 8th August, 1888, when she must have been nearly 15 years old, and is therefore by far the oldest insect on record.

Moreover, what is very extraordinary, she continued to lay fertile eggs. This remarkable fact is most interesting from a physiological point of view. Fertilization took place in 1874 at the latest. There has been no male in the nest since then, and, moreover, it is I believe well established that queen ants and queen bees are fertilized once for all. Hence the spermatozoa of 1874 must have retained their life and energy for 13 years, a fact, I believe, unparalleled in physiology.

In some plants (Rues) the pollen-tube takes as long as two years to reach the ovule. Indeed the pollen has some claims to be regarded as a separate organism, for it certainly possesses the power of growth and of assimilating nourishment. There is not, however, so far as I am aware, any other case which can compare with that of my queen ant as regards the longevity of the male element. One is even tempted to wonder, under such circumstances, whether there is any multiplication of the spermatogenic cells.

Moreover the case is not altogether isolated. I had another queen of *Formica fusca* which lived to be 13 years old, and I have now a queen of *Lasius niger* which is more than 9 years old, and still lays fertile eggs which produce female ants.

ANTS AND SEEDS OF *Melampyrum pratense*.

M. Lündstrom has recently called attention to the interesting fact that the seeds of this plant closely resemble pupæ of ants in size, shape, and colour, even to the black mark at one end. He has suggested very ingeniously that this may be an advantage to the plant by deceiving the ants, and thus inducing them to carry off and so disseminate the seeds. There seemed, however,

some improbability in the idea that ants should be deceived as to their own sisters. M. Lündstrom has found seeds of this species in ants' nests, but has not actually seen ants carrying them off, and I thought it would be worth while to determine this.

Accordingly I took 10 seeds and placed them just outside one of my domesticated nests of *Lasius niger*. A certain number of ants were outside, and I saw several come up to the seeds, but they took no notice of them. I left them lying there for two days. I then tried them with another nest, the roof of which consisted of two plates of glass, side by side, but with an interval between them. I placed the seeds in this interval, and uncovered one of the sides. The ants immediately began carrying the pupæ which were thus exposed to the light to the other, covered part of the nest, in doing which they necessarily passed close to the seeds, but they did not take the slightest notice of them. This operation was finished by 11 A.M., and I left them undisturbed till 12, the seeds remaining unnoticed and untouched. I then moved the cover from one half of the nest to the other, and the ants immediately began transporting the pupæ to the shaded half. One or two of them examined the seeds, not one of which, however, was moved. This took about an hour. At 4 P.M., however, three of the seeds had been carried in, and the next day, at 7 A.M., two more seeds had been carried in. I then removed them, and put them just outside one of my nests of *F. fusca*.

Aug. 31. 7 A.M. None have been touched. I now put the covering close to, but not over them. The ants took no notice of them.

Sept. 2. I now placed them just in the entrance of the nest and covered over a part just outside. The ants collected as usual under the cover. I then removed the cover just inside the nest, so that the ants to reach it had to pass among the seeds. They, however, came in, but did not move a single seed. I once again moved the cover outside, and they followed it as before, but without moving the seeds.

So far as these observations go it would seem that *F. fusca* takes no notice of these seeds, but that they really are under certain circumstances carried off by *Lasius niger*.

WASPS.

Mr. and Mrs. Peckham have published in the 'Proceedings of

the Natural History Society of Wisconsin^{*} a very interesting paper on the special senses of wasps, and their conclusions concur closely with mine.

It appears from their observations that some wasps stay out all night and return early in the morning before the others begin coming out. For instance, on the 18th Aug. the first wasps left the nest at 7.25; 10, however, had already returned, 3 of them before 5 A.M. It appears from their observations that the average time a wasp is absent from the nest, that is the average length of each excursion, is 43 minutes. They observe that this may appear inconsistent with my observations, when the trips were shorter and more numerous, one of my wasps having paid me 116 visits in 15 hours and a half. But, as they justly observe, the cases are not comparable. My wasps and theirs were like Jacob and Ishmael—mine had everything ready prepared for them, theirs had to hunt for themselves.

As regards the sense of hearing, they repeated some of my experiments with the same results. They seem to consider that as regards the sense of colour their conclusions are somewhat at variance with mine.

As regards the supposed sense of direction they say †:—"Sir John Lubbock, in dealing with the sense of direction in ants, concluded, after a number of observations, that they were endowed with this sense in a high degree. Subsequently he discovered, quite accidentally, that the ants found their way by observing the direction in which the light was falling." My conclusion was, however, the result of many observations carried on under varied conditions, and I should hardly call it an accident.

They came to the conclusion, as I had done, that wasps have no sense of direction, that is to say in the form of a mysterious additional sense, but that, if they do not know where they are, they rise higher and higher into the air, circling as they do so, until they discover some high treetop or other object that had before served them as a landmark, and that in this way they are able to make their way home. This entirely tallies with my own conclusion. It is interesting as showing that the vision of wasps must be good for somewhat distant objects.

They also found, as I had done, that their memory varied greatly in different individuals.

^{*} April 1887.

[†] Proc. Nat. Hist. Soc. Wisconsin, April 1887, p. 113.

Lastly, I give two illustrations which will convey an idea of some of my ant-nests.

That on p. 129 represents about a quarter of one of my frames. The shaded part represents the earth, which will be seen to have been arranged by the ants into a sort of circular fortification, or zereba, access to which is obtained by one or two tunnels, not visible in the illustration, and to which a pathway leads from the entrance.

The second (facing this page) represents a nest of *Lasius niger*. It shows the entrance, a vestibule, and two chambers, in the outer and larger one of which the ants have left some pillars, almost as if to support the roof. The queen is surrounded by workers, those in her immediate neighbourhood all having their faces turned towards her. There is a group of pupæ, and several of larvæ, sorted as usual according to ages. There are also a number of the blind woodlice (*Platyarthrus Hoffmanseggii*).

Notes on some of the Birds and Mammals of the Hudson's Bay Company's Territory, and of the Arctic Coast of America.
By JOHN RAE, M.D., LL.D., F.R.S., &c. (Communicated by G. J. ROMANES, F.L.S.)

[Read 16th February, 1888.]

DURING twenty years' residence in various parts of the Hudson's Bay Company's Territory, embracing the extreme south of the shores of James's and Hudson's Bays, and north to the Arctic Sea, I have had, as a sportsman, many opportunities of devoting considerable attention to the habits and peculiarities of animals, especially birds, over a very extensive field of observation, the result of which I shall attempt to give in the following remarks, some of which may possibly be new, other points disputed or perhaps already well known.

My first ten years were spent at Moose Factory, the principal depot of the Hudson's Bay Company in the Southern Department, lat. 51° N., long. 81° W., where the marshes along the coast form the favourite feeding-grounds of a variety of geese, ducks, &c. on their migrations to and from their breeding-places in the north. A great part of my spare time at these seasons, spring and autumn, was spent in shooting these birds, and at the same time acquiring some knowledge of their peculiarities.



Lubbock, John. 1888. "Observations on Ants, Bees, and Wasps.-Part XI." *The Journal of the Linnean Society of London. Zoology* 20(119), 118–136.

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