"honey ants," is especially attractive because of the accounts of the habits of all the known honey ants of the world. These honey ants have one form in which the abdomen is swollen by stored honey. Such forms occur in six widely separated genera. Our *Myrmecocystus* belong to two species, each with several subspecies and varieties; they inhabit the arid regions of Mexico and the south-western United States. The other paper is an annotated list of the ants of Texas, New Mexico, and Arizona.[10] More ants occur in this region than in all the rest of the United States; 101 species being recorded in this first paper, 41 of which are in the genus *Pheidole*. There are many notes on the habits of the various species, and descriptions of several new forms.

COL. T. L. CASEY has again published on the darkling beetles.[11] This time on the Coniontinæ, a group of moderate-sized insects found in the western states. About two hundred species are treated in synoptic form, more than half are described as new, and almost all are recorded from but one locality. Several new genera are based on species closely allied to *Eusattus* and *Coniontis*.

MAKING its initial appearance in the familiar garb of the French society comes the *Bulletin de la Société Entomologique d'Egypte*. It is published at Cairo in French, and under French auspices. Fascicle 1 has forty pages, and among other articles is one on the beetles found in the Egyptian mummies.

NATHAN BANKS

SPECIAL ARTICLES

REGIONS OF MAXIMUM IONIZATION DUE TO GAMMA RADIATION

1. I have recently standardized the fog chamber by the aid of Thomson's electron. The method (as will be shown elsewhere) is not only expeditious, but leads by inversion, when my old values of the nucleations of the coronas are inserted, to values of e which agree with Thomson's and other estimates. This affords an incidental check on the broader bearings of the work. Thus a series of rough tests made in this way showed $e \times 10^{10}$ to lie between 3 and 4 els. units, agreeing closely enough with the accepted values to prove that both the positive and the negative ions are captured in my fog chambers, even at very high nucleations (500,000 per cu. cm.).

2. The experiments themselves run smoothly and take but a few minutes each; but there is an *inherent* difficulty involved in the interpretation of the distributions of ionization observed in the fog chamber. The radium (10 mg., 100,000, contained in a small thin sealed glass tube) is introduced into the inside of a cylindrical fog chamber, by aid of an aluminum tube (walls 1 mm. thick and about one quarter of an inch in diameter), thrust axially from one end to the other of the horizontal chamber. The inner end of the aluminum tube is thoroughly sealed; the other end lies quite outside the fog chamber, is open, and serves for the introduction of the radium tube. In this way the latter may be moved axially from the glass end of the fog chamber on the right of the observer, to the metal cap which closes the fog chamber on the left.

When the radium is successively placed at distances of about 11 cm. apart within the available 45 cm. the length of the fog chamber, the maximum nucleation (ionization) coincides with the position of the radium when both are near the glass end of the chamber (12 cm. in diameter). The nucleation then falls off rapidly and at first uniformly from the glass end to the metal end, where the coronas are strikingly smaller and the nucleation less than one half of that observed at the glass end. Considered alone, this would appear like the natural effect of an increasing distance from the source, except that the coronas near the distant end approach a constant diameter.

When the radium is moved about 12 cm.

[10] "The Ants of Texas, New Mexico and Arizona," *Bull. Amer. Mus. Nat. Hist.*, XXIV., pp. 399–485, 1908, 2 pls., Part I.

[11] "A Revision of the Tenebrionid Subfamily Coniontinæ," *Proc. Wash. Acad. Sci.*, X., pp. 51–166, 1908.

(one quarter of the length of the fog chamber) from the glass end toward the metal end, the maximum nucleation, moving at a greater rate toward the brass end, has already outstripped the position of the radium and now lies near the middle of the chamber. The coronas and the corresponding nucleations, therefore, fall off rapidly toward both ends. In other words, the *maximum nucleation is seen where there is no radium.*

On moving the radium to the middle of the chamber, the position of the maximum nucleation coincides with the brass end, over 20 cm. beyond the radium. The coronas now fall off from left to right, to a uniform size near the glass end of the chamber, the ratio of the extreme nucleations being at least 200,000 to 100,000 per cubic centimeter in the cases examined. Finally, when the radium is placed in the brass cap of the chamber, the maximum still lies there and the nucleation falls off toward the glass end; but all nucleations are reduced throughout about one half.

It is clear that the two ends of the chamber behave differently. There must, therefore, be some sort of conflict (to use a word that has not been preempted) between the primary and secondary radiations which issue from the ends and other parts of the chamber. The solid walls both contribute nucleation; the glass wall most when close (a few cm.) to the radium, the metal wall at a greater distance (20 cm.) from the radium; but no simple hypothesis of the known properties of the rays will account for the occurrence and location of regions of maximum nucleation, nor for the high nucleation ratios specified. Moreover, plates of lead placed outside over the glass end of the chamber to modify the secondary radiation are quite without effect. Covering the aluminum tube with a thick lead pipe, the phenomenon is slightly reduced in magnitude, but not in character. It follows that the gamma rays are chiefly concerned.

In a region of maximum nucleation there must either be a larger rate of production or a smaller coefficient of decay. The latter may be expected if in the region of maximum nucleation the ions have largely the same sign. The best conception of the phenomenon which I can form at present is thus an explanation in terms of Bragg's[1] theory of neutral pairs for the gamma rays. As such, a region of primary rays may be regarded as devoid of nucleation. On impact, however, these paired rays separate into secondary cathode rays and alpha rays, returning with unequal swiftness from both ends of the fog chamber. In order to exist as separate condensation nuclei, they must, therefore, travel over a certain distance to be recognized as distinct particles by the fog chamber, the distance depending on the intensity of the impact of the gamma rays; depending, therefore, on the buffer, on the strength and distance of the radium from the buffer. In the above experiment this function is performed by the ends of the fog chamber. In case of very weak radium, a minimum of nucleation in the middle of the chamber, and coinciding in position with the radium, was actually obtained, in contrast with the central maxima for the strong radiations, as described above. Possibly the frequent occurrence of the ratio of 2 to 1 between the maximum and minimum nucleations may be similarly interpreted; but much further work is necessary before any definite conclusions can be reached. I am now constructing a chamber about 1 meter long, with the object of ascertaining whether more than one maximum of nucleation is producible; in other words, to interpret the stationary wave resemblances of the phenomenon.

3. A final element of interest is the behavior of the axial aluminum tube after the radium (in small sealed glass or aluminum tubes) has been removed. The internally sealed aluminum tube is distinctly radioactive for several hours, even though gamma rays alone have passed through it. The activity vanishes gradually, and more quickly if the ions are continually precipitated by exhaustion. The behavior of this residual nucleation is very peculiar; if the aluminum tube is pushed into the fog chamber, axially, from the glass end as far as the middle, the

[1] See *Phil. Mag.*, May, 1908.

part of the chamber around the tube shows strong coronas on exhaustion while the other half (toward the brass cap) is blank. Something, consisting of very slow-moving particles, gradually diffuses radially out of the aluminum tube. Of course it is difficult to deny with assurance that merest traces of emanation decaying within the aluminum tube may not possibly account for the activity; but what is remarkable in any case is the existence side by side of a region with nucleation and a region without it, in the absence of anything like a partition. The fog chamber itself must at all times be scrupulously free from infection such as an emanation would produce, and anything of this kind is at once detected.

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A NEW METHOD OF ENUMERATING BACTERIA IN AIR

The development of accurate bacteriological methods for the examination of air has not attracted wide attention in recent years; and this branch of bacteriology is far behind the related subject of water bacteriology in its technique and interpretation.

Bacteriological examinations of air have been carried out by most observers in one of two ways, without much attempt at critical control. The most primitive method consists in the simple exposure of plates of nutrient gelatin or agar for a more or less indefinite period. The colonies developing, correspond in a rough way to the bacterial flora of the air above. The method, however, can not be considered a quantitative one, since the number of bacteria which fall on the plate is not related to any particular volume of air and must vary with all sorts of environmental conditions. Nevertheless, this method is still used in many investigations in which quantitative results would be valuable; as in the important work of Major Horrocks on the presence of bacteria derived from sewage in ventilating pipes, drains, inspection chambers and sewers.[1]

The other method in common use is a modification of the sand-filter method of Pasteur and Petri. It involves the filtration through asbestos, sand, sugar, etc., of a measured volume of air; the washing of the filtering material with sterile water; and the plating of aliquot portions of the wash water in the usual way. Pasteur used asbestos for his filtering material; Sedgwick and Tucker recommended finely powdered sugar; and Petri and most recent observers have used sand. Petri pointed out that the sand should be of such fineness as to pass a .5-mm. mesh. In a recent important study of the air of the New York Subway Soper used both the plate method and the sand-filter method. The sand grains used were "about half a millimeter in diameter" and the sand layer 5 cm. deep.[2] In discussing these methods, in another paper, this author said, "as is well known, there is no precise way to determine the numbers of bacteria in air."[3]

I have been engaged for about a year in a study of bacteria in sewer air; and relied at first upon the sand-filter method. The remarkable results, reported by Major Horrocks in the paper to which reference has been made, led me to revise the detail of my technique with considerable care. In the course of the investigation a modified method of air examination was developed which is here reported in the hope that it may be of assistance to others at work on similar lines.

My aim was to combine the quantitative results of sand filtration with the directness and simplicity of the plate method. Hesse did this after a fashion by slowly aspirating air through a long roll-tube the walls of which were covered with melted gelatin. There was, however, a possibility in such an apparatus that bacteria might be drawn through, without settling out on the walls. My method is really a modification of Hesse's with an increase in the size of the culture vessel relative to the sample of air. I use two liter-and-a-half bottles arranged as shown in Fig. 1. On the

[1] *Proceedings of the Royal Society*, Series B, Vol. 79, No. 531, p. 255.

[2] *Technology Quarterly*, XX., 58.

[3] *Journal of Infectious Diseases*, Supplement No. 3, 1907, p. 82.