rents in the use of the latter instrument, though due precautions must have been taken to avoid any possible error from this source. It is unfortunate that the Kelvin type of galvanometer still has to be retained, in most cases at least, on account of the stray field produced by the permanent magnet of the moving coil galvanometers. Dip values obtained with the earth inductor are now consistent to within about one minute of arc. The corrections for individual dip needles usually amount to very much more than this.

The tabulated results of observations are comprised in about forty pages. The data include geographical position, date, hour, and values of declination, dip, and horizontal intensity, for a very large number of stations in all of the continents, the antarctic regions, and chief island groups. No reduction of values to a common epoch is attempted. Intensities are given in C.G.S. units. Physicists may well question the necessity of introducing, at the headings of columns of horizontal intensity, the special symbol Γ, which, we are told, represents one C.G.S. unit. In the already highly be-symboled state of science would we not better rest content with that "perfectly good" name for the C.G.S. unit, which is also a reminder of the father of the science of terrestrial magnetism, the *gauss*?

In connection with the land observations, instrumental and other assistance has been furnished in cooperation with various organizations and expeditions. The Australasian Antarctic Expedition and the Crocker Land Expedition may be especially named. The observers' field reports are replete with notes of interest to the geologist, botanist, biologist and explorer. If one seeks information concerning selection of firearms, feeding of camels, defense against Bedawins, or canoeing in the Canadian wilderness, he will find it here.

A valuable feature of the book is the detailed description of the research buildings recently erected near Rock Creek Park. The main building is of fireproof construction, and so stable that no perceptible vibration is transmitted to the most sensitive galvanometers, even when the machinery in the basement is running. For work demanding freedom from magnetic disturbances, a separate non-magnetic building has been erected. Those interested in the building and equipment of laboratories of any kind will profit by a study of these carefully planned structures.

The only special researches recorded in this volume are some miscellaneous observations made in Samoa at the time of the solar eclipse of April 28, 1911, and a very detailed description of the comparisons of magnetic standards made at various observatories. The present attainable precision in magnetic observations may be learned from the statement that "the corrections, on absolute standards, for the declination and inclination may be in error by 0′.1 or 0′.2 and for the horizontal intensity by about $0.0001H$."

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SPECIAL ARTICLES

SOME SUGGESTIONS ON METHODS FOR THE STUDY OF NITRIFICATION[1]

DURING recent years the use of one gram of dried blood, tankage, cotton-seed meal, bone meal, etc., mixed with 100 gm. of soil, has commonly been employed in laboratory studies on nitrification. In some cases as much as 2 per cent. of these materials has been used. On the other hand, a much smaller amount of ammonium sulfate is usually added because of its greater solubility and recognized toxicity to the nitrifying organisms when present in excessive concentrations. The results are frequently stated in terms of the absolute amounts of nitric nitrogen formed rather than in percentages of nitrogen nitrified. Comparisons and conclusions on the relative nitrifiability of nitrogenous fertilizers are commonly made on the basis of evidence obtained in this way.

In the course of studies on nitrification at the University of California Citrus Experiment Station, the writer recently observed a wide range of variation in the nitrification of

[1] Paper No. 20, Citrus Experiment Station, College of Agriculture, University of California, Riverside, Calif.

dried blood in soil from fertilizer plats of an experiment that has been in progress for eight years. In some cases the use of one per cent. dried blood resulted in no nitrification at all in four weeks' incubation, but rather a partial loss of the nitrates originally present. In soil from other plats, however, vigorous nitrification took place. The soil throughout these plats has been derived from disintegrated granite and is quite sandy and very low in organic matter and nitrogen. In view of the extensive use now being made of dried blood, and the scientific interest attached to the subject, an extended study of nitrification in Southern California soils has been undertaken. Such questions as the relative rates of nitrification of dried blood, bone meal, ammonium sulfate, etc., the effects of lime, the influence of organic matter and other factors are being studied. The investigations are still in progress. Certain of the results already obtained, however, seem of sufficient interest to warrant preliminary discussion at the present time. Later, a more complete presentation of the investigation will be submitted.

At the outset it was found that vigorous ammonification of different organic fertilizers took place in all plats studied and that the addition of lime did not greatly affect either ammonification or nitrification. When the conventional amount of nitrogenous materials was added, however, dried blood was not nitrified in soil from certain plats, while bone meal and ammonium sulfate underwent vigorous nitrification. In soil from other plats no such difference was observed. The following results illustrate the difference in nitrification in two plats. 100 gm. of soil in duplicate was employed in each case.

Materials Added	Increase in Nitric. N. p. p. m. Plot B, Unfertilized	Plot U, Manure, Rock Phos. and Legume
1 gm. dried blood	— 2.8	170
1 gm. bone meal	92.8	154
0.15 gm. ammonium sulfate.	67.8	136

Similar observations have been reported from other soils of California.[2]

[2] Lipman and Burgess, Calif. Sta. Bull. 251 and 260, 1915.

It is of interest in this connection that certain plats in the field experiments, from which the above soils were drawn, have been fertilized annually for eight years with dried blood only, and that marked stimulation has resulted in the growth and vigor of the citrus trees, on the one hand, and in the yield of fruit, on the other. For example, the yield during the past two years has been increased more than 100 per cent. by the use of dried blood. Furthermore, a material increase in the nitrate content of the soil is found at the present time wherever dried blood has been applied, indicating that this material undergoes nitrification in the field.

Two questions, therefore, present themselves. First, why should dried blood fail to undergo nitrification in soil from certain plats but be nitrified vigorously in others, while at the same time bone meal and ammonium sulfate are capable of being vigorously nitrified in each? This question seems especially pertinent since ammonification, generally considered to be essential as preliminary to the nitrification of organic substances, takes place actively. Second, why does dried blood undergo nitrification in the field but not in the laboratory?

Entirely satisfactory answers to these questions can not now be given. Some light has been thrown on them, however, as will appear from the discussion below.

While the proportion of dried blood to soil employed in the above experiments was the same as is commonly used in laboratory experiments on nitrification, nevertheless, the possibility that excessive concentrations of dried blood had been employed was at once suggested. In the field experiments an annual application of 1,080 lbs. of dried blood per acre is now being made to certain plats, applied in approximately equal applications in February, April and July. The addition of 1 gm. per 100 gm. of soil, on the other hand, corresponds to an application of 15,000 lbs. per acre, estimating an acre foot at 3,000,000 lbs. and reckoning that the field application becomes incorporated with the soil to a depth of six inches. Accordingly, a series of laboratory experiments was undertaken, using soil from a number of plats that had been fertilized differently. The samples were drawn on August 14. Varying amounts of dried blood, bone meal and ammonium sulfate were added and the series arranged so as to make possible a fair comparison of the rates of nitrification when approximately equal amounts of nitrogen had been acted upon simultaneously.[3] The following table sets forth a part of the results obtained:

Nitrification[4] with the Use of Varying Amounts of Materials

Nitrogenous Materials Added	Virgin Soil		Plot *M*, Unfertilized		Plot *O*, Fertilized with Manure and Rock Phos.	
	Nitric N Formed P.p.m.	Per Cent. N Nitrified	Nitric N Formed P.p.m.	Per Cent. N Nitrified	Nitric N Formed P.p.m.	Per Cent. N Nitrified
1 gm. dried blood...	−12	0	−16	0	277	20.9
0.25 gm. dried blood	24	7	100	33.3	101	30.6
0.0625 gm. dried blood................	39	47.3	55	66.6	43	52.1
4 gm. bone meal.....	−10	0	− 1	0	149	8.8
1 gm. bone meal.....	75	17.6	76	17.9	181	42.6
0.25 gm. bone meal.	46	43.3	49	46.1	52	48.9
0.6 gm. am. sul......	−19	0	11	0.8	55	4.3
0.15 gm. am. sul. ...	31	9.8	62	19.5	119	37.5
0.0375 gm. am. sul..	35	44.1	54	68.2	73	92.0

Briefly, it was found that 1 per cent. dried blood failed to undergo nitrification in those soils which had not been consistently fertilized with organic manures and that in some cases 0.5 per cent. was not nitrified. On the other hand, when the concentration was reduced to 0.25 per cent. or less, vigorous nitrification took place in every case. It was found, however, that in most cases increasing percentages of the nitrogen added were nitrified as the amounts of dried blood were decreased down to 0.0625 per cent. Hence it would seem that even 0.25 per cent. dried blood, which is only one fourth the concentration commonly used in laboratory experiments, may inhibit nitrification to some extent in some soils. Similar statements may be made regarding the results obtained from the use of bone meal. The addition of large amounts of this material corresponding approximately to the larger amounts of nitrogen added as dried blood, failed to be nitrified in the same soils that showed inability to nitrify 1 per cent. dried blood. The smaller amounts, however, were actively converted into nitrate, but in no case more actively than similar amounts of nitrogen as dried blood.

In the case of ammonium sulfate, the results show that increasing percentages of the nitrogen were nitrified as the concentration decreased and that this material was most completely nitrified when added in the lowest concentration. Comparing the percentage of nitrification when the materials were added in low concentrations, similar to that employed in field practises, it is interesting to note that with only one exception out of the ten series of studies now made on the subject, ammonium sulfate was nitrified no more vigorously than dried blood, and in every case dried blood was nitrified more actively than such a low-grade nitrogenous material as bone meal. This feature of the results, therefore, is in harmony with common knowledge and experimental data obtained in humid regions. It should be added that other series of studies conducted at a different time, fully verify the above statements. The conclusions seem warranted, therefore, that dried blood will undergo nitrification in these soils fully as actively as the other materials studied, provided *an excessive concentration is not employed.*

The above data also indicate that before field comparisons on the nitrifiability of different materials can safely be drawn, it is neces-

[3] When the experiments were begun the dried blood was thought to contain 13 per cent. nitrogen and the bone meal approximately 3 per cent. Analyses later showed them to contain 13.2 per cent. and 4.25 per cent., respectively. Consequently the amounts of nitrogen added as bone meal were higher than had been intended, but this does not materially modify the conclusions to be drawn, since a wide range of concentrations was provided. The ammonium sulfate was Baker's C.P.

[4] The data represent the increase in nitric N over that found in separate portions of soil incubated for the same time under similar conditions, but without the addition of nitrogenous material. The minus sign (—) indicates loss of nitrate.

sary to study the rates of decomposition in equal and varying concentrations of actual nitrogen. It seems also that if practical conclusions are to be drawn, it is necessary to approximate field conditions, as nearly as possible, in laboratory tests. This point, it seems to the writer, has not been sufficiently recognized in many soil bacteriological studies. The conditions ensuing when relatively large amounts of nitrogenous substances such as dried blood, tankage, etc., undergo decomposition, may conceivably become extremely abnormal and greatly dissimilar to those ensuing under field practise. The products arising from the decomposition of 1 per cent. dried blood, under some conditions of bacterial activity may exert, either directly or indirectly, important influences on the further action of the micro-organisms present. Such, for example, is known to be the case in the bacterial decomposition of milk. In fact the course and extent of many chemical and biochemical reactions is known to be greatly modified by the products of the action.

As stated above, dried blood undergoes vigorous ammonification in the several plats studied. It has been suggested that the conditions produced by the high concentrations of ammonia or ammonium carbonate, formed from the larger amounts of dried blood and bone meal, may have been unfavorable to the activity of the nitrifiers. With the hope of securing light on this point, preliminary studies have been made by adding varying amounts of ammonium hydrate and ammonium carbonate in addition to 0.25 per cent. dried blood, using a soil in which no nitrification of 1 per cent. dried blood takes place. The results showed that in every case the addition of either ammonium hydrate or ammonium carbonate partially inhibited nitrification even in the low concentration of 5 mg. per 100 gm. soil. Whether the ammonia was actually toxic to the nitrifying organisms, or reacted unfavorably through physical effects produced or otherwise, can not be definitely stated at the present time.

Evidence has been obtained that there is considerable seasonal variation in regard to the inhibiting effect of 1 per cent. dried blood. With samples drawn from one plat in April and June, respectively, 1 per cent. dried blood underwent active nitrification, while no nitrification took place in samples taken August 14. In each case 0.5 per cent. and less were actively nitrified. Whatever may be the cause of this phenomenon, the fact still remains to be explained that 1 per cent. dried blood brought about toxic conditions in certain plats, but not pronouncedly so in others.

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SOME EXPERIMENTS WITH AGENTS CALCULATED TO KILL THE TROMBIDIUM HOLOSERICEUM

THE *Trombidium holosericeum* or common chicken mite is present in most hen houses throughout the country. It is very troublesome in the hotter months, especially July and August, when it finds climatic conditions favorable for its more rapid multiplication. The mites hide in clusters, in the cracks and crevices of the roost pole and in the crack where the roost pole rests on its support. Here they lay their eggs and the young and old emerge to attack the chickens at night.

The mite finds its way to the hen at night and with its conical piercing apparatus attacks the skin and draws blood. After its feast it leaves the hen and returns to its hiding place.

In searching the literature at hand in the library of the office of poultry investigations and pathology of this station no trace could be found where scientific tests and records had been made to determine just what effect the various parasiticides have upon mites.

There is common belief that tobacco clippings, sulphur, paris green, and a host of liquids are great destroyers of these formidable foes of the poultry house, but no one so far as we could find has actually made the tests. It was thought best to try a score of the more common agents used and to run duplicate tests.

Mode of Tests.—The tests were run either in open tumblers or sauce dishes so as to have an abundance of air present and to have the