The average number of bacteria and moulds which developed is as follows:

	Bacteria.	*Moulds.*
Agar agar	86	3
Glycerine agar	73	7
Beef gelatine	64	20
Wort gelatine	41	34

Ten tests of water gave the following result:

	Bacteria.	*Moulds.*
Agar agar	2,370	12
Glycerine agar	2,260	15
Beef gelatine	1,470	60
Wort gelatine	480	88

Ten tests of milk gave the following results:

	Bacteria.	*Moulds.*
Agar agar	7,967	2
Glycerine agar	11,207	7
Beef gelatine	7,416	12
Wort gelatine	1,700	47

Agar agar shows the highest number of colonies of bacteria, and wort gelatine the highest number of moulds. The inference is that a statement of the number of forms found in anything should be accompanied by a statement of the media used and how prepared.

THE EFFECT OF FORMALIN ON GERMINATING SEEDS. BY M. B. THOMAS.

Having had occasion during the past year to investigate the application of formalin as a germicidal agent, I became greatly interested as to the possibility of its use as a fungicide.

Some very imperfect laboratory experiments suggested the probability of its value in connection with the destruction of the smut of corn, oats and wheat, and accordingly plans were made to carry out a series of experiments with this in view. More careful thought on the subject convinced me that such experiments would prove too expensive unless some accurate data were at hand regarding the effect of formalin, in solutions

of varying strength, on the germination of seeds. Accordingly, as a preliminary investigation, I began in connection with Mr. C. E. Crockett, a student in the department, a careful series of such experiments with the seeds of grains and other plants.

All of the details of the experiments were carefully arranged to prevent a possibility of error and a very pure solution of formalin was secured. In all cases parallel experiments were conducted and check tests made with the seeds soaked in pure water.

The work was carried on in the green house, where the soil was kept at a nearly constant temperature. The seedlings usually began to appear above the ground by the fifth day, and were measured daily for two weeks, then weekly until well advanced in their development. Seeds were grown both in pure sand and rich earth to determine the possible effects of soils on the treated specimens, but in all of the experiments no difference was noticed from such varying conditions, as the seeds planted in the sand compared in every respect in their behavior with those grown in rich soil. In all cases the temperature of the solution in which the seeds were soaked was about 19° C.

With the wheat ½ and 2 per cent. solutions were used, and the time of treatment varied from one-half to four hours. The results show that of the seeds soaked in the ½ per cent. solution for one-half hour, 76 per cent. germinated; for one hour, 56 per cent., and for 3½ hours, 36 per cent. While of those treated for one hour in a 2 per cent. solution none germinated.

Wheat seemed to be about the most easily affected by the formalin of any seed, and even the use of a ½ per cent. solution for one-half hour is not safe. A ¼ per cent. solution for about this length of time will prove the most satisfactory.

The results of the experiments showed that the plants of the treated seeds developed as rapidly and perfectly as those of the untreated ones. In a few instances, where retarded germination was evident as a result of this treatment, the plants soon made up this deficiency and at the end of two weeks could not be distinguished from the others. The fact that wheat was one of the easiest affected of any of the grains is no doubt due to the very imperfect protection of its embryo.

With oats, of those soaked in a ½ per cent. solution for one-half hour, 96 per cent. of treated and a less number of untreated germinated, and

one, two and three and a half hours, soaking did not materially decrease the relative percentages, while with those treated with a 2 per cent. solution for one hour only 48 per cent. germinated, and none showed life after four hours soaking. It will therefore be seen that oats can endure the treatment much better than wheat.

An interesting condition in the increased percentage in the germination of the treated seeds as compared with the untreated ones in all of the tests can allow of little explanation. The plants of the seeds treated up to four hours were, after a few days, quite a little larger than those of the untreated ones, and this condition remained constant throughout the development of the plant. It seemed that in this case the formalin must have in some way contributed to the development of the plant, notwithstanding the statement of T. Bokorny* that this substance ununited was not beneficial to growth.

It is evident, however, that oats can safely be treated for three hours in a ½ per cent. solution of formalin without danger of injury to the germinating power of the seed.

With rye, 44 per cent. germinated after soaking in a ½ per cent. solution for one hour, with but a slight decrease in the number after four hours treatment. With the 2 per cent. solution none germinated after three and a half hours treatment. It is therefore evident that rye will not endure the treatment as well as wheat.

In the case of corn, after soaking in a ½ per cent. solution for one hour 92 per cent. germinated, equaling the per cent. that developed from the untreated seeds. After two hours in the solution a very slight decrease was noted, and after three and a half hours only 52 per cent. germinated. After the use of a 2 per cent. solution for one hour but 56 per cent. developed. Corn, therefore, seems to endure the treatment fairly well, and the use of a ½ per cent. solution for one hour will not decrease the per cent. of seeds that germinate.

Buckwheat, millet, beans and other seeds were treated with quite satisfactory results, and while no use can probably be made of such a treatment with these seeds, yet their behavior was interesting as illustrating the general effect of formalin on germinating seeds and developing seedlings.

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*Landsw. Jahrb., 21 (1892), pp. 445–446.

After the use of solutions that seemed to be about the maximum strength allowable, germination was often delayed for two or three days as compared with that of the untreated seeds, and in one case with treated oats some did not germinate until the third week.

In the case of all plants studied the use of formalin did not in any way change the character of either the stem, leaves or root in those that germinated, as far as could be observed, except as above stated in certain exceptional cases. No corrosive action was observed, as is found in the case of extended treatment with copper sulphate, that seems to act quite freely on the tip of the radicle.

If, as has been predicted, formic aldehyde in very dilute solutions prove an efficient fungicide, there seems to be no reason why it should not take the place of the well-known copper—sulphate or hot-water treatment for smut of grains.

The great reduction in price, the ease of manipulation and its general all-round efficiency as a germicidal agent will make its use more certain by the agriculturist, especially in place of the hot-water process, where no little inconvenience is experienced in arranging for treatment and in keeping the hot water at a correct temperature.

This paper is intended to be suggestive rather than exhaustive, and the full statistics now on hand will be published at some future time, if the practical field experiments to be conducted in the spring warrant the continuing of the investigation.

Since the work covered by this paper was completed I have been able to find in some cases an indirect reference to the use of formalin in 1: 10,000 for destroying the spores of smut.*

SUMMARY.

The use of formalin for destroying smut spores is very clearly an important proposition.

The small expense of the treatment and the facility of its application commend it for a thorough trial, at least.

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* (1) Low. Ueber einen Bacillus, welcher Ameisensäure und Formaldehyd assimiliren kann. Central. für Bak. und Parasitenkunde. Bd. XII, S. 462.

(2) Comptes Rendues, 1892.

(3) Annales de Micrographie, 1894–95.

(3) Recherch. sur la valeur de la formal. u. s. w. Arch. de pharmacodynamie, 1894, Vol. I.

(4) Bericht id. Gesellschaft für Morphologie und Physiologie. München, 1888.

The use of a 2 per cent. solution is too strong for all grains, even with a short application.

A ½ per cent. solution is about right for oats, and the treatment may be continued for as long as two hours without injury to the seed.

For wheat a treatment with a ¼-per-cent. solution for one-half hour is safe, while a ½ per cent. solution for the same time will not decrease the germinating power of the seeds to any considerable extent.

Corn may be treated for two hours with a ½ per cent. solution without injury.

Rye is injured in a ¼ per cent. solution for one hour.

When germination is slightly retarded by the treatment, the plants soon equal in their development those of the untreated seeds.

A List of the Mycetozoa Collected Near Crawfordsville, Indiana. By E. W. Olive.

The accompanying list comprises forty-three Myxomycetes, thirty-two of which are not reported in Dr. Underwood's "List of Cryptogams of Indiana," in the Proc. Ind. Acad. Sci., 1893, p. 30.

Duplicates have been deposited in the herbarium of Prof. M. B. Thomas, Wabash College, Crawfordsville, and in the Cryptogamic Herbarium of Harvard University.

The determinations have been made according to the descriptions in the Monograph of the Mycetozoa, by A. Lister.

The collections were made mostly in August, 1897, and with few exceptions the species seemed to be comparatively abundant, several gatherings being made of many of them. The majority of the species were found upon decaying stumps and logs, while a few were fruiting upon living leaves and stems, and still others on moss and fallen leaves.

Two instances were noted of a curious growth of the very abundant *Physarum cinereum* Pers. A circle about six feet in diameter was clearly outlined in both cases by the grayish sporangia fruiting upon the living leaves and stems of grass and Plantago. The border of the ring was pretty regular and five or six inches broad. Here and there within the ring were small groups of sporangia, but the most were confined to the outer border. The plasmodium had probably been feeding upon the dead grass stems lying close upon the ground, and, as it grew