adapted to this apparatus in order to keep the rate of aspiration uniform and of a known velocity. The flow-meter was connected with the aspirator at the point "D."

Reagents Used

Standard Hydrochloric Acid Solution........ 0.2 N.
Standard Barium Hydroxide Solution........ 0.2 N.
Phenolphthalein as Indicator.

In order to give an idea of the suitability of this apparatus for respiration studies the following data, which were obtained as the result of five consecutive determinations, each of one hour duration, are presented.

Type of sample	Determination	No. of apples	Wt. of sample	Storage temp.	Mg. CO_2 per kilo. hour
Grimes Golden					
apples	1	70	8659 gm.	30° F.	3.31
"	2	"	"	"	3.65
"	3	"	"	"	3.62
"	4	"	"	"	3.62
"	5	"	"	"	3.62

SUMMARY

A respiration chamber of low original cost was used, which because of its large size was adapted to handling samples of considerable bulk or quantity. The most important feature of the chamber was its wide mouth, which permitted easy insertion and removal of samples.

With the double system of connections, either total or intermittent determinations were made with only momentary stoppage of the air-stream.

The flow-meter proved very satisfactory in maintaining a known and uniform rate of aeration.

The apparatus described was admirably adapted to the determination of carbon dioxide as a measure of respiration on apples, tomatoes and cut flowers.

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APPLE RUST ON HOST TISSUE IN CULTURE DISHES

YOUNG York Imperial apple leaves were removed from the tree, washed, treated with 1–1,000 bichloride of mercury for about two minutes, rinsed in sterile water and inoculated with sporidia of *Gymnosporangium juniperi virginianae.* Inoculation was accomplished by placing a large culture dish containing several leaves under a bell-jar in which was suspended a rust gall discharging sporidia. The leaves were allowed to remain there for about one to two minutes and were then placed in culture dishes containing modified Pfeffer's solution plus .5 per cent. glucose. The cultures were placed in a well-lighted room. Such inoculated leaves developed visible rust spots and pycnia in approximately the same period of time which would have been required if infection had taken place in leaves on the tree. The leaves were frequently transferred to fresh nutrient solution. Cutting away large portions of the leaf did not interfere with development of the disease in the remaining portions. Some specimens were maintained in culture for nearly five months without evidence of deterioration. Pycnospores were produced in great abundance, and one apparently normal aecium was formed, but it was accidentally destroyed without being examined to determine if spores were present. A special type of culture dish has been devised which should enable us to carry the cultures free from contamination for a longer period of time.

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SPECIAL ARTICLES

NORMAL MUSHROOMS FROM ARTIFICIAL MANURE

DURING the past fifteen years there has been in the United States a remarkable expansion of the business of growing mushrooms. According to the present practice, the growers must rely entirely on composted horse manure for making their beds. The industry consumes at least 150,000 tons of horse manure annually, and is still developing rapidly, while the horse is little more than holding his own. In view of these conditions, it is evident that the mushroom growers in the near future must have a substitute or supplement for horse manure. Several growers have succeeded in supplementing their manure to a certain extent by adding straw to the compost heaps, and a few have been experimenting with artificial compost. But it is apparent that there is a need for a further systematic search for material other than horse manure which is suitable for mushroom culture. To the writer, a straw compost made according to the principles laid down by Hutchinson and Richards[1] seemed to be a good starting-point. Therefore, in the summer and fall of 1928, several compost heaps were made

[1] This is now a patented process. It was originally published as follows: H. B. Hutchinson and E. H. Richards, "Artificial Farmyard Manure," *Journ. Minn. Agr. Great Britain*, 28: 398–411. 1921–1923.

up and used for growing mushrooms on shelf beds in a room which was equipped to simulate conditions in a standard mushroom house. Four tons of wheat straw were used in making the compost. It was divided into sixteen small heaps which were treated in duplicate in eight different ways. The chemicals used per thousand pounds of dry straw were as follows: (1) 25 lbs. ammonium sulphate, 25 lbs. ground limestone and 7 lbs. acid phosphate; (2) 40 lbs. ammonium sulphate, 50 lbs. ground limestone and 7 lbs. acid phosphate; (3) 25 lbs. ammonium sulphate, 50 lbs. ground limestone and 7 lbs. acid phosphate; (4) 25 lbs. ammonium sulphate and 50 lbs. ground limestone; (5) 10 lbs. urea and 7 lbs. acid phosphate; (6) 15 lbs. urea and 7 lbs. acid phosphate; (7) 10 lbs. urea alone; (8) 75 lbs. Adco. The small heaps of straw were built up in one-foot layers and the chemicals were scattered between the layers. The heaps were systematically replicated and packed side by side into one large rick about four feet high, eighteen feet wide and fifty feet long. This rick was wet down and composted in much the same way as horse manure is composted for mushroom culture. It was surprisingly easy to keep the small heaps separate in the larger rick. The compost heated and was turned, watered and aerated five times at weekly intervals. At the time of the second turning a two-inch layer of soil was mixed into the rick. When the material seemed suitable, that is when it resembled mushroom compost in physical texture, it was placed in standard mushroom shelf beds eight inches deep. A pair of beds containing ten square feet of surface was made from each small heap, thirty-two experimental beds in all. These beds were spawned uniformly with cultures of *Agaricus campestris* L. and *Agaricus brunescens* Pk.,[2] which are known to the trade as the "Snow white" and "Brown" varieties. They were then cased and given approximately the same care that beds would receive in a commercial mushroom house. Notes were taken on: the temperature of each heap during fermentation, the character of spawn run, pH value, moisture content and degree of decomposition of the compost in each heap, and finally the daily yield of each bed throughout the cropping period.

Normal sporophores of *Agaricus campestris* and *Agaricus brunescens* developed on all the beds; there was a normal run of mycelium in many of the beds, and, although the average yield was low, approximately one fourth pound per square foot, there were four beds (from two different compost heaps) which yielded more than two thirds of a pound per square foot. This was approximately one half of the yield of composted horse manure, which was included in the experiment as a check. The comparatively high yield obtained on these four beds was apparently not due to the specific chemicals used on the straw or to any particular care given the high yielding beds during the growing period. It seemed rather to trace back to specific conditions which developed within the small experimental heaps during the period of fermentation. The compost from duplicate experimental heaps which had received the same chemical treatment was often quite different in pH value, moisture content, degree of decomposition, ability to support a run of spawn and to produce a crop of mushrooms. This may be illustrated by the fact that the duplicate heaps corresponding to both the high yielding heaps were poor yielders. That this was not due to differences in the care given the beds in the house is indicated by the fact that in all cases the yields of duplicate beds, coming from the same experimental heap, were very nearly alike. Apparently, certain experimental heaps, in spite of similar chemical treatment and subsequent handling, attained distinct individuality while composting which made the compost either favorable or unfavorable for the growth of *Agaricus*.

Under these conditions it seems quite probable that there were differences in the microbial flora of the different experimental heaps. The effect of these differences in the flora of the compost on the growth of *Agaricus* in the beds is problematic but it is a factor which deserves serious consideration. Certain observations also suggest that the microbial flora in all the artificial compost made in these experiments was quite different from that in compost heaps which mushroom growers make from horse manure. In the first place, the artificial compost as a rule did not ferment at temperatures higher than 120° F., while horse manure usually reaches temperatures of 150° F. to 160° F.; secondly, the pH value of the artificial compost varied considerably from one heap to another and in no case was it more alkaline than pH 7.2. On the other hand, when horse manure is composted for mushroom culture, it is quite uniform in reaction and normally alkaline. The courteous cooperation of several commercial mushroom growers enabled us to test more than 150 samples from twenty-eight different compost heaps. The pH values of these samples ranged from pH 7.2 to pH 8.4 with a mean value of pH 7.7. It was also shown by dilution experiments that the buffer content of the artificial compost was lower than that of composted horse manure. Evidently there was a comparatively low "alkaline reserve" in the artificial compost. This may have been

[2] These cultures were identified by C. H. Kauffman as *Psaliota campestris* and *Psaliota brunescens*. The generic name *Agaricus* is used here to conform with the usage in the U. S. Department of Agriculture.

partly responsible in a direct way for the low average yield of the artificial compost because *Agaricus* mycelium produces acid in culture, and spent beds which have borne a good crop of mushrooms are almost invariably acid.

In general, then, we have learned that under certain conditions synthetic manure will yield fair crops of normal mushrooms, and, under other conditions, practically none at all. The factors responsible for these differences are as yet obscure. For the man seeking an immediately usable substitute for horse manure in mushroom culture, the results will probably be disappointing, but they are decidedly promising to one interested in the possibility of eventually developing an artificial compost which can be used as a substitute.

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SEVENTH ANNUAL MEETING OF THE INTERNATIONAL ASSOCIATION FOR DENTAL RESEARCH

UNTIL recently research in dentistry consisted mainly of the development of patented inventions, chiefly under commercial auspices. This research, mechanical almost exclusively and directed to immediate and obvious remedial needs, has been very desirable and useful in the attainment of its important objectives. Lately the biological aspects of dentistry, with special reference to the prevention of oral maladies, have been receiving increasing attention, and promise soon to be the major concern of research in dental schools. This significant development has been accelerated by great improvements in dental education and by the stimulating influence of the International Association for Dental Research, which, founded in New York in December, 1920, is now a federation of active sections in Ann Arbor, Boston, Chicago, Halifax, Minneapolis, New York, Philadelphia, Pittsburgh, St. Louis, San Francisco, Toronto and Vienna, with a total of 174 members.

The seventh general meeting of the International Association for Dental Research was held in Chicago, Illinois, on March 23 and 24, 1929, at the Dental School of Northwestern University, where every facility for the successful conduct of the meeting was provided. Forty-seven members and an equal number of visitors attended the morning and afternoon sessions each day, and thirty-six papers on research were subjected to animated and instructive discussion. Most of these papers, besides treating of general biological aspects of dentition, such as the growth of the molar teeth after eruption, by H. H. Donaldson, of Philadelphia, and the dental arches of identical twins, by Samuel Goldberg, of Chicago, described research in "medical" sciences applied to dentistry, only two having been devoted chiefly to mechanical phases of dental practice. Close correlations with medical practice were considered in papers on bone regeneration, dental infection as a factor in chronic colitis and autointoxication, influence of oral infections on conditions of the blood, paroxysmal hemoglobinuria caused by organisms in dental infection, anaphylactic response to sensitization from shallow cavities in teeth, polyarthritis and carditis secondary to oral infection, etc. Abstracts of all the papers will be published in an early issue of the *Journal of Dental Research*, the association's official medium of publication, which is now in its ninth volume.

On the evening of March 23 the members, after a dinner at the Medical and Dental Arts Building, at 185 North Wabash Ave., held there the annual business meeting, which included an address by the president, Leroy M. S. Miner, D.M.D., M.D., dean of the dental school of Harvard University; also the election of new members and officers, as follows:

NEW MEMBERS

Boston—Benjamin Tishler; *Chicago*—H. C. Benedict, E. P. Boulger, E. D. Coolidge, R. H. Fouser, S. D. Tylman; *Halifax*—R. J. Bean, E. G. Young; *Minneapolis*—J. T. Cohen, J. F. McClendon; *New Haven*—W. G. Downs, Jr.; *New York*—Isador Hirshfeld; *Philadelphia*—S. E. Pond; *Vienna*—Bernhard Gottlieb, Ernst Kellner, Emerich Kotanyi, Rudolf Kronfeld, Moriz Leist, A. M. Schwarz, Georg Stein, Josef Weinmann, Herman Wolf.

OFFICERS FOR 1929–30

President—Arthur D. Black, Northwestern University; *President-elect*—U. G. Rickert, University of Michigan; *Vice-president*—A. E. Webster, University of Toronto; *Treasurer*—William Rice, Tufts College; *Secretary*—William J. Gies, Columbia University.

The next general meeting will probably be held in Toronto, in March, 1930.

WILLIAM J. GIES,
General Secretary