Transactions of the Wisconsin Academy of Sciences, Arts and Letters. volume XVII, Part II, No. 6 1914

Madison, Wis.: Wisconsin Academy of Sciences, Arts and Letters, 1914

TRANSACTIONS

OF THE

WISCONSIN ACADEMY

OF

SCIENCES, ARTS, AND LETTERS

VOL. XVII, PART II, NO. 6

MADISON, WISCONSIN
1914

CONTENTS

	Page
The Water Mites. (With Plates XCII–XCIII) - - - - - - - *Ruth F. Marshall,*	1300
The Problem of Milk Supplies. (With Plates XCIV–XCV, and seven Figures) - *William Dodge Frost,*	1305
Proceedings of the Academy, List of Members Corrected to March 1, 1914, Charter - - - - -	1366

The annual half-volume of the Wisconsin Academy of Sciences, Arts, and Letters is issued in six numbers, under the editorial supervision of the Secretary.

The price of this number is 35c.

SOME NEW AMERICAN WATER MITES.

Frontipoda americana nov. spec.

RUTH MARSHALL.

(Plate I, fig. 1–8)

The genus Frontipoda has been represented until recently by one species only *F. musculus* (Müll.). This, however, is found widely distributed over Europe. In 1911 Dr. Halbert found a new species in Ireland, which he calls *F. carpentari;* and in the same year, Dr. Karl Viets described another new species, *F. oxoidea* from Africa. There is now added an American species; this will probably be found to be widely distributed. It has already been found in four places in Wisconsin (near Spooner, Cable, Delton, Madison), and in small pools near Ludington, Michigan, by the author; by Dr. E. A. Birge at New Orleans, and in collections from Sebago Lake, Maine, received from Mr. A. A. Doolittle. In all, twenty-four individuals have been examined. So far no other American species has been described.

The most striking peculiarity of these water mites is the great compression of the body laterally. Moreover, the epimera are so completely united as to leave but traces of their outlines, and the shield thus formed covers almost the entire ventral surface, and even extends over the lateral surfaces to very near the center of the dorsal side, leaving but a narrow furrow extending from the region of the eyes to the posterior end. The genital area lies almost completely surrounded by this epimeral shield, the medium posterior parts of the last epimera not quite approaching each other. The eyes lie close together. The genital cleft is guarded by two long flaps, and each has three elongated acetabula.

The legs are short, and their position is another striking peculiarity of the genus. The posterior ones have been pushed forward so that they come to lie almost in the same straight line with the palpi, one above the other on the sides of the body. The first three pairs end in claws; the fourth ends in a long saber-like spine. The palpi are small, and the fifth segment is cleft at the end.

F. americana resembles *F. musculus,* but it is smaller, and it differs, moreover, in several details from the European form. Its length is about 0.51 mm., and the color is yellow green on the dorsal side, yellow on the sides. The eye region projects conspicuously beyond the anterior border of the body, and the posterior end has a similar, though smaller projection. The palpi are stouter than in *F. musculus.*

A pair of large glands, like those described for the genus *Lebertia* were found, the tubes opening on the capitulum.

Lebertia distincta nov. spec.

(Pl. II. fig. 21–23)

This new species of Lebertia was found, a single individual, in Sebago Lake, Maine, Aug. 1911, by Mr. A. A. Doolittle. The epimeral shield somewhat resembles that of *L. porosa;* but it is more extensive and more completely encloses the genital plates. The outlines of the fused epimera are not so fully obliterated as in most species of the genus, a character which has suggested the specific name. The genital area is elongated and widens preceptibally at the posterior end. The body and plates are finely papilliated. The palpi are rather slim and bear a few coarse hairs. The first pair of legs have no swimming hairs, the second and third have a few short ones on the fifth segment, while the fourth have a few on the fourth segment. All of the legs bear bristles The body is about 0.92 mm. long. The color was destroyed by the preserving fluid.

Arrhenurus elevatus nov. spec.

(Pl. I fig., 12–15; Pl. II, fig. 16)

This species closely resembles *A. longicaudatus* Mar. in the possession of a long slender appendix; but it differs conspicuously from it in the greater height of the dorsal hump on the

middle of the appendix. In addition, the area inside of the dorsal line is depressed, not elevated as in the related species; and in the small structures on the end of the appendix on the dorsal side the two species do not agree. The palpus is characterized by the great length of the saber-like hair on the fourth joint, and by the presence of a small bunch of hairs on the inner side of the second.

But one specimen is known; this was found in Sebago Lake, Maine, Aug. 4, 1911. The entire length of the body is 1,28 mm.; the color is orange green.

Arrhenusus crenellatus Mar.

(Pl. I, fig. 9–11)

In collections from Sebago Lake, Maine (Aug. 4, 1911), there were found six males of this species, and one female which examination of the palpi proved to be *A. crennellatus* also. The epimera of the female are like those of the male. The wing-shaped genital areas completely enclose the genital plates as shown in the figure. The dorsal enclosed area is an oval of the usual form. The second joint of the palpus of this species has an area of fine hairs; the former description of these hairs (1908) as blade-like is now found to be an error. The color of the preserved female is dull yellow; the length of the body is 0.87 mm.

Notes on the Arrhenuri

Collections made since 1910 (the last published notes on the genus), together with collections from the East very kindly contributed by Mr. A. A. Doolittle of Washington, D. C., have added one new species to the genus and the female of another species, as already described, while the range of still other species has been extended. Some details of structure not given in earlier studies are given in the plates, and the list of species is given below.

In pools at Epworth eight, near Ludington, Michigan, were found

A. scutulatus Mar. (Pl. II, fig. 17, 18)
A. infundibularis Mar. (Pl. II, fig. 19)
A. scutuliformis, Mar., female, (Pl. II, fig. 20.)
A. pseudocylindratus Piers.

A. semicircularis Piers.

A. manubriator Mar.

A. marshalli Piers; found also in Lake Mason, Briggsville, Wisconsin

A. megalurus Mar; found also in Lake Mason.

A. americanus Mar; found also in Lake Mason and at Urbana, Illinois.

A. magnicaudatus Mar, in Lake Mason.

In Sebago Lake, Maine, there were found six species, all here recorded for the first time from this state:

A. crenellatus Mar. (Pl. I, fig. 9–11)

A. scutuliformis Mar.

A. marshalli Piresig.

A. parallelatus Mar.

A. elevatus nov spec. (Pl. I, fig. 12–15; Plate II, fig. 16)

A. americanus Mar; found also in Long Lake, near Sebago; at Clinton, New York, and at Princeton, New Jersey, the first record for the latter state.

A. birgei Mar. was also found for the first time in New Jersey, at Princeton, Carnegie Lake; and *A. major* Mar. for the first time for Maryland in Carderrock pool, near Washington, D. C.

EXPLANATION OF THE PLATES

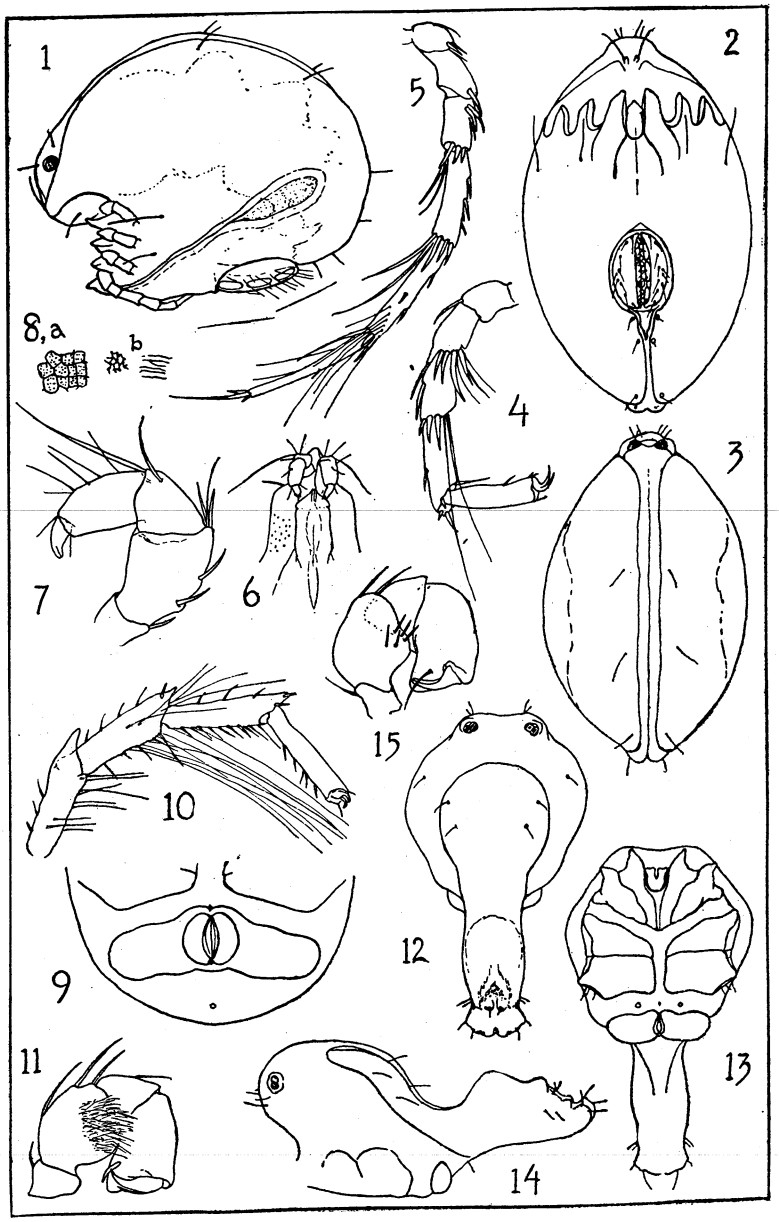
PLATE XCII

Fig. 1, *Frontipoda americana* nov. spec., lateral view
" 2, *Frontipoda americana* nov. spec., ventral view
" 3, *Frontipoda americana* nov. spec., dorsal view
" 4, *Frontipoda americana* nov. spec., 1st leg
" 5, *Frontipoda americana* nov. spec., 4th leg
" 6, *Frontipoda americana* nov. spec., palpi and maxillary shield
" 7, *Frontipoda americana* nov. spec., right palpus, inner side
" 8, *Frontipoda americana* nov. spec., surface markings, *a*, young adult; *b*, older adult
" 9, *Arrhenurus crenellatus* Mar., female, genital field
" 10, *Arrhenurus crenellatus* Mar., four joints of the left 4th leg, male
" 11, *Arrhenurus crenellatus* Mar., left palpus
" 12, *Arrhenurus elevatus* nov. spec., dorsal view
" 13, *Arrhenurus elevatus* nov. spec., ventral view
" 14, *Arrhenurus elevatus* nov. spec., lateral view
" 15, *Arrhenurus elevatus* nov. spec., left palpus

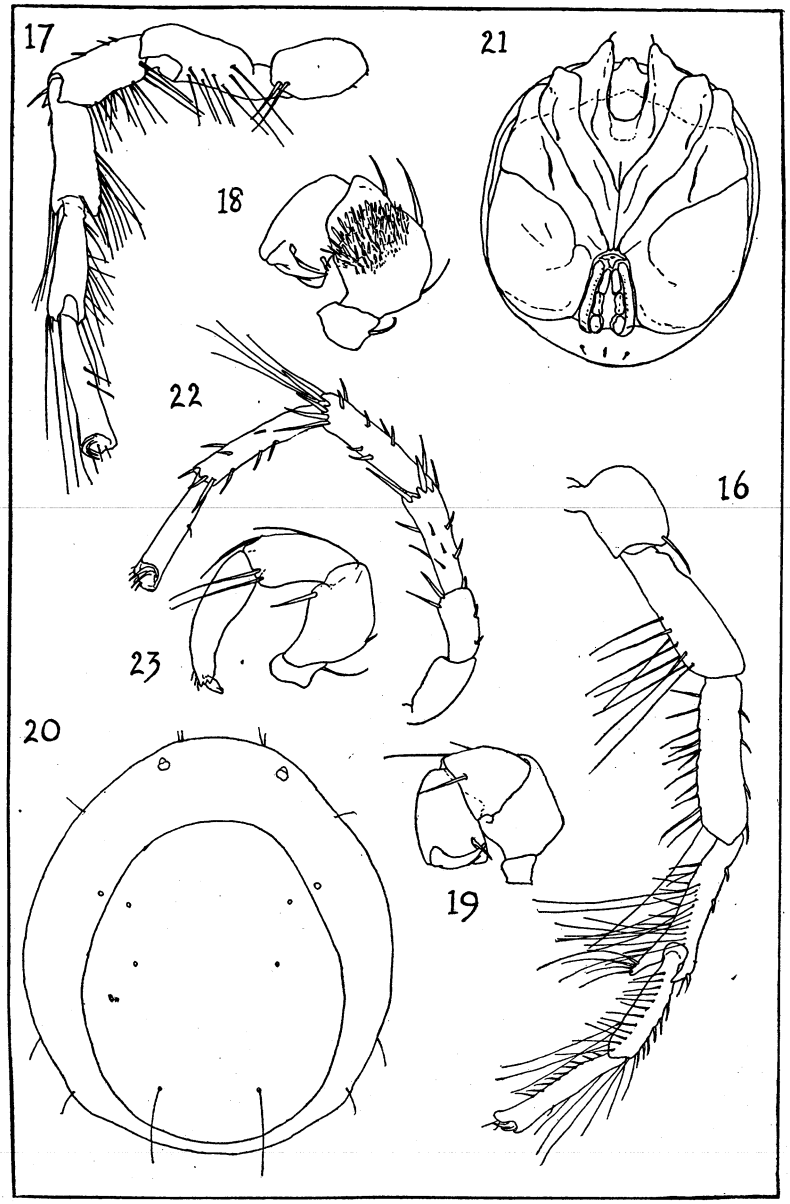
PLATE XCIII

Fig. 16, *Arrhenurus elevatus* nov. spec., left 4th leg
" 17, *Arrhenurus scutulatus* Mar., right 4th leg
" 18, *Arrhenurus scutulatus* Mar., right palpus
" 19, *Arrhenurus infundibularis* Mar., palpus
" 20, *Arrhenurus scutuliformis* Mar., female, dorsal view
" 21, *Lebertia distincta* nov. spec., ventral view
" 22, *Lebertia distincta* nov. spec., right 4th leg
" 23, *Lebertia distincta* nov. spec., left palpus

Biological Laboratory,
Rockford College.



MARSHALL: WATER MITES



MARSHALL: WATER MITES

THE BACTERIOLOGICAL CONTROL OF PUBLIC MILK SUPPLIES.*

WILLIAM DODGE FROST

I. INTRODUCTION.

The question of a safe milk supply is a subject on which much good bacteriological work has been done in recent years. There is, however, a great deal still to be done before the bacteriologist can check up and satisfactorily control the production of a sanitary milk supply. In the past little has been done in bacteriological milk analyses beyond making a quantitative determination of the bacteria present. Granting that this is the most important single item that can be determined, it still leaves much to be desired. In times of epidemics special search is sometimes undertaken for the suspected bacteria of disease. In certain laboratories, tests are regularly made for the streptococci, but as yet there is no concensus of opinion as to what their presence means. In other laboratories B. coli is sought for and regarded as an index of pollution. It is, however, still an open question whether or not it can be regarded with the same suspicion in milk as in water. Still again, Bact. welchii, in England particularly, is regarded as an index of fecal contamination.

The necessity for reliable methods of differentiating pure from contaminated milk is now all the more urgent because of the widespread use of the pasteurizing process. Modern methods of pasteurization employ a degree of heat so little above the thermal death point of dangerous bacteria that the treatment of milk in this way commercially will give a false idea of security to the consumer unless the sanitarian can quickly and accurately determine any failure to sufficiently heat the milk.

* Submitted as a thesis for the degree of Doctor of Public Health, Harvard Medical School, Boston, Mass., May, 1913.

This investigation was undertaken with the following purposes in view: first, to study, criticise, and, if possible, improve some of the bacteriological methods occasionally used in milk work; second, to try out certain of these methods on different classes of milks, with special reference to the ease and reliability with which they may be used to differentiate good (or safe) from bad (or dangerous) milks; third, to determine, in a general way, the conditions of the milk supply of a large city by means of the technique selected.

II. BACTERIOLOGICAL METHODS OF MILK ANALYSIS.

A. Collection of Samples.

Description of Collecting Case. It seemed necessary to have considerably more milk than could be collected in a test-tube such as is provided for in the milk-collecting outfit of the Boston Board of Health, or that used by Miss Schroeder in her work for the New York City Board of Health work.*

Four ounce bottles with metal caps which screw on and which are ordinarily known as oil sample bottles were used. In these bottles about one hundred cubic centimeters can be placed and still leave plenty of room for shaking.

As a carrying case a fiber handbag was secured, 8 inches wide, 8 inches high, and 16 inches long. Inside of this a copper box was fitted, somewhat smaller than the bag, and so arranged that there would be an air space all around it of an eighth to a quarter of an inch. The box was divided into three compartments by partitions, one to contain eighteen of the above bottles, held in place by a metal rack. This rack can be collapsed if necessary, so that pint milk bottles can be carried. Another compartment is for ice, and the third, rather narrow and the full length of the box, was fitted with a pipette case. This was held up to the top by lugs, leaving an empty space below into which the used pipettes can be placed. The pipettes used were sixteen inches long and made of glass or aluminum tubing, having about 3/8 of an inch as inside diameter. The general arrangement is shown in the accompanying figure. Fig. 1, Plate XCIV.

* Jour. Infect. Dis., 11, p. 2.

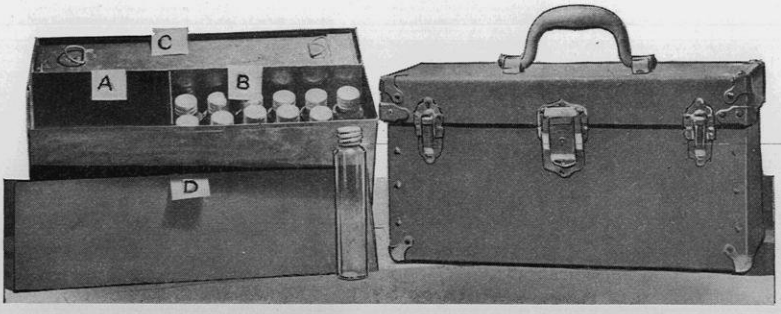


FIGURE 1

FIGURE 2

COCKAYNE—BOSTON

B. Quantitative Methods.

1. Media. The media used, agar and gelatine, were prepared according to the standards recommended by the Committee of the American Public Health Association.* The reaction varied at the time it was made and before sterilization from +0.7 to +1.

2. Dilution Methods.

a) *Water Blanks*†.

All laboratory workers know that "water blanks," made for the purpose of diluting the sample to be analyzed, change in volume during the process of sterilization. The committee having in charge the preparation of standard methods of milk analysis recognize this for they made the following statement: "In order that the bottles and tubes may contain 99 and 9 c. c. respectively after sterilization, they should be filled a little above these marks".‡ No one, however, seems to have determined just what this loss amounts to or how it can be avoided. In fact, there seems to have been little or nothing written on this phase of the subject of quantitative analysis. It is, nevertheless, an important matter for the reason that this is one of the steps that ought to be precise. Certain factors are in the nature of the case indefinite, as for instance, inherent errors in sampling, the probability that certain colonies are descended from a group of germs rather than a single one and the difficulty of measuring very small quantities of fluids with the pipettes used. For this reason it is very important that appreciable errors in technique should not be introduced where it is possible to avoid them. It seemed worth while, then, to determine the extent of, the error in this connection and how it could be avoided.

I. Loss of Weight in Autoclaving.

A definite amount of water, accurately determined, was placed in bottles; these were plugged with cotton and autoclaved and then the water remaining was carefully determined. At first

---

* Standard Methods for the Bacterial Examination of Milk. Am. Jour. Pub. Health.
Standard Methods of Water Analysis. Am. Jour. P. H., 1912.

† This section read before the Soc. of Am. Bact. New York. 1913.

‡ Proc. Assoc. of Am. Med. Milk Commissions, 1910, Vol. 4, p. 242.

the determinations were volumetric, but later, and principally, gravimetric methods were used. This was done by weighing the bottle empty and then adding a definite weight of water. After sterilization the bottles were again weighed and the loss determined to within five one-hundredths of a gram. In most of the experiments eight ounce Blake bottles were used. These were filled with a hundred grams of water. The results obtained in a considerable number of experiments are shown in the following table:

TABLE a.

Loss of Weight in Autoclaving 100 Grams of Tap Water.

No. bottles.	Greatest loss.	Smallest loss.	Average loss.
20	7 grams	4 grams	5.20 grams
20	7 "	1 "	4.65 "
10	5 "	3 "	3.75 "
10	5 "	4 "	4.00 "
10	8 "	7 "	7.70 "
10	5 "	3 "	4.00 "
10	4.1 "	3.6 "	3.9 "
3	6 "	4.4 "	4.80 "
10	8.8 "	7 "	7.62 "
10			
Average total loss			5.07 or 5.07%

It will thus be seen that the amount of loss is considerable and variable. An explanation of these facts is sought in the following experiments.

II. A Comparison of Several Different Autoclaves.

The autoclave used in the above experiments was a large (No. 6) Kny-Scheerer Co. Steam Pressure Dressing Sterilizer (A). To show that loss noted was not due to any imperfections of the particular autoclave or the method of using it, several other sterilizers were tested, and in most cases these other autoclaves were run by the person ordinarily using them, and not by the writer. These other autoclaves may be described as follows:

(B) A small size of the same type as above.

(C) Similar in its general construction to the above but without a name plate. The steam in this case was generated by an electric generator.

(D) A vertical cylinder after the French type. The steam is generated from a layer of water in the bottom.

(E) A Bramhall Deane autoclave. Steam from high pressure steam system.

In the comparative tests the following results were obtained:

TABLE b.

Comparison of Several Different Autoclaves.

Loss in grams per 100 grams or per cent.

Autoclave.	Number of bottles.	Greatest loss.	Smallest loss.	Average.
A	123	8.8 grams	0.1 grams	5.07 grams
B	10	1.9 "	0.9 "	1.51 "
C	10	3.5 "	2.7 "	3.23 "
D	10	8.7 "	6.2 "	7.73 "
E	10	2.8 "	1.8 "	2.32 "

III: Cause of Loss.

The loss by evaporation is very evidently due to the fact that condensation of the steam filling the sterilizing chamber occurs during the process of sterilization. This permits the ebullition of the fluids being sterilized. Undoubtedly this goes on during the entire process but is perhaps most pronounced at the end after the steam has been shut off. When the autoclave is allowed to cool off gradually by shutting off the steam a diminished pressure is produced. In autoclave A this varies, as determined by experience, from five to fifteen pounds. Under these conditions of reduced pressure it would seem that the hot fluid must boil with great vigor. If, however, the loss were due solely to the boiling at this time, the amount of liquid lost would be independent of the time of exposure, but this is not in accord with the facts observed. It was found that a series of bottles autoclaved for five minutes and allowed to cool slowly, lost on the average 4.8%, while another series run under exactly similar conditions, but for an hour and five minutes, and allowed to cool slowly, lost 7.6%, or nearly twice as much.

IV. Prevention of Loss by Use of Closed Autoclave.

A little reflection convinces one at once that it is possible to prevent this ebullition by closing the autoclave while cold and keeping it closed until the process of sterilization is completed and the autoclave cooled down, thus retaining air. It has been

the custom of various laboratories to use the autoclave in this manner for the purpose of sterilizing blood serum, and it is very evident that the boiling of the serum must be absolutely prevented here. The following table gives the results when this method is used:

TABLE C.
Loss in the Closed Autoclave.

Number of bottles	Greatest loss.	Smallest loss.	Average.
10	0.4 grams	0.1 grams	0.26 grams
10	0.4 "	0.1 "	0.26 "
10	0.5 "	0.2 "	0.37 "
10	0.6 "	0.1 "	0.36 "
10	0.5 "	0.0 "	0.27 "
Total average			0.30

It will be seen from the above table that there is very little loss when the autoclave is run in this way, namely, only 0.3 of one per cent.

V. The Efficiency of the Autoclave Containing Air and Steam.

The question, then, naturally arises, does the autoclave sterilize when run in this manner?—i. e., can it be relied upon to sterilize? The following experiments bear upon this point: The autoclave (A) was run for 20 minutes at 15 lbs. as in the previously described experiments, and several tubes of freshly prepared and unsterilized bouillon were run with each lot of bottles. The bouillon tubes were then put in the incubator at 37° C. In all cases the tubes remained sterile. Attempts were then made to test the efficiency of this method of sterilization more thoroughly as follows: Bouillon was made in the usual way except that it was allowed to cool down and was then infected with spore-bearing material; namely, street dust, chopped hay and sewage. It was then filtered through paper and run into bottles and autoclaved. All ten bottles remained sterile for many weeks. As proof of the fact that the material was difficult to sterilize, bottles were filled with the same bouillon heated in the Arnold steamer on three successive days, for from 30 to 45 minutes and incubated. Out of twenty bottles so run, four developed growth. Another autoclave (B) was closed up cold and run for 20 minutes at 15 lbs. and failed to sterilize any of the twelve bottles so heated.

It would thus seem that the effectiveness of different autoclaves varies when run in htis manner and that considerable work would have to be done with a particular autoclave to determine whether or not a single exposure is effective and, if so, the time and pressure required. It seems certain, however, that two exposures on consecutive days would always be effective, especially if the bottles were put in the incubator between heattings. Whatever the method of sterilization employed, it seems desirable to use bouillon or peptone water instead of the water in these "water blanks," especially if they are to be carried about in portable outfits, in order that the danger from contamination by growth in them may be readily detected.

VI. Loss Due to Evaporation on Standing.

It is a matter of considerable convenience, especially in the smaller laboratories, to sterilize a number of these "water blanks" at once and store them ready for use at any time. If this is done it is important to know the rapidity with which evaporation will take place on standing. The rate will depend upon a number of factors, such as the size and shape of the bottle, the size of the mouth, the temperature of the room and the humidity of the air. In regard to the size of the bottle, it is probably only necessary to consider the area of the exposed surface compared with the volume of the fluid. On this account a tall narrow bottle is better than a broad one. Likewise, it is apparent that a narrow bottle is more desirable than a wide-mouthed bottle. The amount of evaporation from one hundred cubic centimeters in an ordinary eight-ounce narrow-mouthed Blake bottle is shown in the following table:

TABLE d.
Loss due to Evaporation.

Number of bottles.	Loss due to sterilization.	Time of standing.	Loss due to standing.	Total loss.	
10	4.1 grams	8 weeks	4.9 grams	9%	Without caps
10	4.3 "	8 "	4.8 "	9.1%	With caps

This evaporation might be prevented by the use of glass stoppered bottles. Such, however, are not satisfactory for other reasons. The same end can be attained by the use of cotton

stoppers and a paper cap. It should be noted, however, that there was practically no checking of evaporation by the use of thin paper caps in the experiment described above. The use of waxed paper or tin foil will be found efficient. Except for the trouble in opening, a very satisfactory procedure is to dip the cotton plug in melted paraffin. My own suggestion is that the mouths of the bottles be plugged with a cork stopper covered with a thin layer of cotton such as is used by the Boston Board of Health laboratory in their blood serum tubes. This reduces the opportunity for evaporation to a minimum, while allowing for the necessary interchange of gases during sterilization. The neck of the bottle is then covered with paraffin paper, tied on with a string, this, of course, to be done before sterilization. When the bottle is to be used this paper cap is to be carefully removed and kept and then when the dilution has been made the cap is to be placed over the neck and the plug used to press the paper into the mouth of the bottle. This closes the bottle as effectively as a glass stopper and allows thorough shaking of the sample—a matter of prime importance in quantitative work. Fig. 2, Plate XCIV.

b) *Dilution Scheme.* Milks need to be diluted before they are plated. For certified or pasteurized milks a dilution of 1–100 is usually sufficient. Milks of the inspected class frequently need to be diluted 1–1,000, while raw market milks need to be diluted from 1–1,000 to 1–100,000. The scheme indicated in the following diagram (Fig. 3.) gives at a glance the proce-

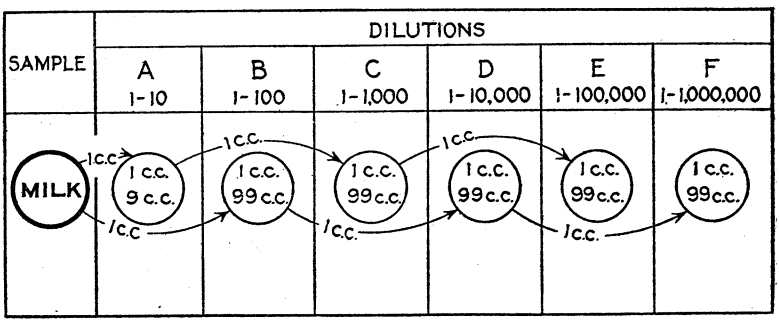


Fig. 3. Dilution scheme.

dure necessary to obtain the desired dilution. A microscopical examination of a milk by the Stewart-Slack method is sometimes of value in determining the dilution needed for a particular

sample. Unless this is done it is necessary to make more than one dilution of each sample of milk.

c) *Use of Pipettes.*

I. Different Forms. The pipettes used for milk and water work vary in length, diameter and shape. The longer and narrower, of course, the more accurate the graduations. Some of the pipettes used are graduated with one mark and deliver 1 c.c. Others have two marks the right distance apart to deliver one c.c. Frequently the graduations are in fractions of a c.c. as tenths or hundredths. Some workers also measure fractions of a c.c. by counting the drops delivered to the c.c. by a one or two mark pipette, and then take the desired number of drops. There should, perhaps, be no dogmatic statement made in regard to the size, shape, graduation, etc., of the pipette. But it has seemed worth while to make some comparisons of the different forms, and especially the influence of the point or delivery end, since some laboratories have recently introduced and used perfectly straight tubes, not at all narrowed at the end. See fig. 4.

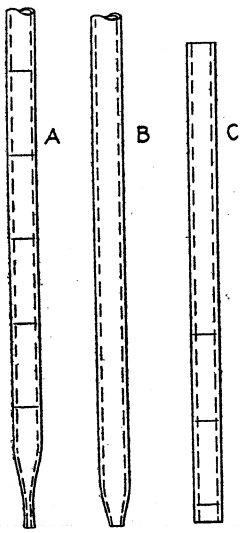


Fig. 4. Forms of pipettes. A. Ordinary form of pipette used in milk and water work. B. Form suggested for use with "Pipettometer". D. Pipette used in New York City Board of Health.

The accuracy of these was tested in the following manner:

One c.c. of a certified milk was added to 99 c.c's of sterile water, thoroughly shaken, and then 4 c.c's were taken out consecutively and plated, using first a pipette of ordinary form, and

then the "tube" pipette. The plates were grown at room temperature and counted six days later. There were only a few colonies on the plate and all were, therefore, counted.

Ordinary pipettes,	plate 1	78 colonies
	plate 2	76 colonies
	plate 3	65 colonies
	plate 4	77 colonies
Tube pipettes,	plate 1	63 colonies
	plate 2	31 colonies
	plate 3	84 colonies
	plate 4	73 colonies

The percentage of variation in the first set was 17%, in the second case it was 84%, or practically five times as great.

The shape of the pointed end and the size of the opening are matters of some importance. The smaller the opening the more accurate the pipette. If the point is drawn out fine, the less fluid is likely to be taken up by it on the outside of the pipette to run down and increase the volume of the discharge. On the other hand, such points are easily broken and furthermore, if cleaning solutions are used, there is the greater probability that the chemical may not be perfectly washed out. Again, such pipettes are slower and require considerably more time. It seems reasonable that such pipettes should have an opening of about 2 mm. and should be drawn out to a point and not merely rounded off in the flame.

II. Method of Cleaning Pipettes. The matter of cleaning pipettes is of considerable importance, not merely because they ought to be kept bright and clear, but because, especially when they are used for milk, they become greasy and do not deliver all of their contents since a part of it sticks to the sides.

It is the custom in many laboratories to clean these pipettes by immersing them for several days in a cleaning solution made from sulphuric acid and potassium bichromate, then washing them in water, or first in alcohol and then water. This requires several days. Some experiments were made for the purpose of determining whether or not it would be as satisfactory to clean the pipettes well in soap and water and then sterilize them at a high degree of heat, say 250° C., for a time in order to dry distill the organic matter. This method does not seem to succeed, at least at a reasonable temperature within a reasonable length of time.

Other pipettes were carefully cleaned with soap and water and then immersed in alcohol for a few minutes, dried, and after sterilization in the dry-air sterilizer for 1 hour at 150° C. were found to be free from grease and entirely satisfactory.

It seems, then, quite sufficient in cleaning pipettes to get them bright and clear by the use of water or soap or soap-powder, and then immerse them in alcohol for several minutes. When dry they are then ready to be sterilized.

III. A Mechanical Volumetric Pipette, or Pipettometer. The pipettes used for the purpose of diluting milk are of various types. Those carefully graduated to tenths or hundredths of a c.c., and frequently used, are expensive. With ordinary pipettes there is the danger that in using them the saliva may run down into the material being measured. This can be prevented by inserting a small plug of cotton in the end that is put in the mouth. It requires a good deal of time to put in the plug and later to take it out. Another danger, where the material worked with contains pathogenic germs. is that these may be accidentally sucked into the mouth—a catastrophe that has too often brought dire results to laboratory workers. The following simple devise obviates many of the objections raised as applying to the use of pipettes in general, and will be found useful for routine as well as special work, if not on all occasions.

It was suggested by the pipette holder described by Rosenau* and may be considered a modification of it. It can best be described by reference to the accompanying figure. Fig. 5.

A is a wooden support with a short arm on the left, and a broad arc on the right. The whole is supported by a heavy base A. On this is a bent glass tube (a, b, c, d) with a flexible joint at c, and a bulb at d. This tube is filled with mercury from e to d. When the arm (B) is moved to I, the mercury stands at 1.0, and when the arm (B) is lowered to II, the mercury stands at 0. The end of the glass tube (at a) is fitted with a rubber tube into which a pipette may be readily slipped (g). The apparatus is used by raising the arm (B) to I, a vessel containing the fluid to be drawn up into the pipette is brought up to the point of it and then the arm (B) is lowered to II. In this way the fluid is drawn into the pipette. It can then be discharged in whole or in part by raising the arm (B). The gradu-

* Hyg. Lab. Bull. 21, Gov't. Print. Office, 1905, p. 62.

ations on the tube b, c, e must be made by discharging water into the pan of a fine balance. In this way the 0.5 and 1.0 c.c. points can be determined. It will be accurate enough to measuse off the intervening points. At first thought it might be supposed that all that it would be necessary to do would be to put a carefully graduated pipette in between b and c, but in practice it does not work well because the weight of the fluid in the pipette rarifies the column of air between a and the mercury at e, so that it does not take up quite all that would be indicated.

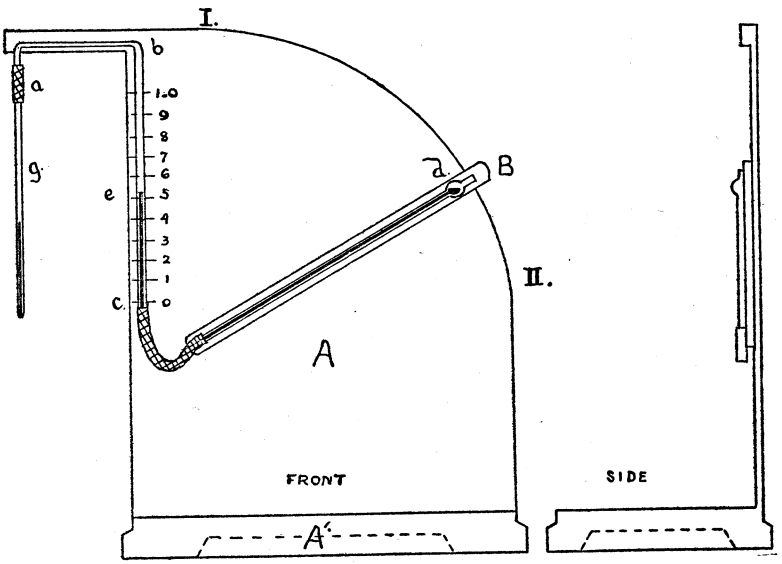


Fig. 5. Pipettometer—detail drawing.

When the graduations are once obtained it is then possible to measure any fluid very accurately that has practically the same specific gravity as the fluid used to make the graduations.

The chief value of such a piece of apparatus is that in addition to preventing the danger of saliva getting into the fluid handled, and of handling pathogenic germs, it is economical in that it makes possible the use of simple tubes instead of pipettes. These tubes can be readily made by even the unskilled in glass blowing. An additional advantage in the use of this apparatus is the fact that no error is introduced by the use of pipettes not perfectly

clean and free from grease, since a definite volume is pushed out. If some clings to the sides more will be pushed out in its stead.

d) *Ring Method* (Schroeder).

In regard to the ring method of securing small fractions of a c.c. of milk, Dr. M. C. Schroeder of the Research Laboratories, Department of Health, New York City says: "It was found after a number of experiments that a small 1/8 in. No. 20 japanned curtain ring would take up within 5% of 0.01 c.c. of milk, and by dropping this ring full of milk directly into the melted agar tube we could eliminate one or more of the dilution bottles and thus save labor and a possible source of error. The rings are dipped into the milk by means of a platinum hook and dropped directly into about 8 c. c. of nutrient agar held in the tube."—Schroeder.*

An attempt has been made to determine the accuracy of these curtain rings as volumetric devices. This was done first by determining the weight of such rings before and after being filled with milk. Sensitive chemical balances were used. Several weighings follow: Two rings were balanced, then one of the pair was dipped in milk and weighed:

1) Weight required to balance again	0.008	gms.
2) Weight required to balance again	0.008	gms.
In another series:		
3) Weight of ring and milk was found to be	.054	gms.
Weight of ring after washing and drying	.044	gms.
Weight of milk taken up	.01	gms.
4) Weight of ring with milk	.054	gms.
Weight of ring after washing and drying	.043	gms.
Weight of milk taken up	.011	gms.

Culture Tests. A Certified milk was used. After a very thorough shaking five rings were dipped into the milk and plated. Four of them were put into the Petri dish. The other one was dropped into the melted agar in the test-tube and then this tube of agar was poured. The results follow:

1) Developed	50 colonies
2) Developed	24 colonies
3) Developed	25 colonies
4) Developed	9 colonies
5) (In test-tube) developed	27 colonies

* Jour. Infect. Dis., 1912, 11, p. 3.

The average was 27 and the percentage of variations 152% One c.c. of the same milk at the same time was put with 99 c.c. of sterile water, thoroughly shaken, and from this four plates were made which gave the following results:

1)	Developed	78 colonies
2)	Developed	76 colonies
3)	Developed	65 colonies
4)	Developed	77 colonies

The average number of colonies was 74, and the percentage of variations was 17%.

Comparing the two findings it is seen that the ring method developed 27 against 74, that is, only about a third as many as the standard method, and whereas the standard method showed a variation of 17%, the plates in the ring method showed a 152% variation among themselves.

The reason why the rings take up practically .01 of a gram of milk, but deliver only one-third of this amount, judging from the bacterial count, is because the rings are hollow and hold back the milk, and also because it is difficult to wash out of them all of the bacteria.

3. INCUBATION OF CULTURES. The question of the best temperature at which milk plates should be incubated is, it seems to me, still an open one. The New York Commission, the Milk Committee of the American Public Health Association, as well as the Committee on Standards of the American Association of Medical Milk Commissions, have, nevertheless, all decided in favor of the 37° C. count. The chief reason for this is, no doubt, that the results of an analysis can, in this way, be secured some days earlier than they can at a lower temperature. It is my experience, however, that a larger number of bacteria always develop at a lower temperature, say 21° C., than at 37° C.

In the present investigation the temperature of the room (21°C.) has been employed exclusively. Any results not so obtained are definitely marked. The plates were counted after they had been grown for at least 5 days. The temperature was regulated quite closely, see chart, Fig. 12, as an example of the temperature variations. The reason for the use of this temperature was a desire to get the maximum count. A strong argument for the use of a low temperature in milk analyses, where it is important to determine the general character of the bacteria, is

developed in a later paragraph, where it is shown that a curve representing the rate of development of the colonies in a good milk is quite different from the rate of development in a poor milk. See p. 1337.

4. Counting Colonies.

a) *Methods.* The plates were all counted under a five inch reading glass, and all of the colonies were counted including the lactic acid or pin-point colonies. Where possible, the entire plate was counted. On heavily seeded plates as large a proportion was counted as possible. The plates were always run in duplicate and the average taken. A self-registering hand counter was used to minimize errors due to personal equation.

b) *A New Form of Counting Apparatus.* During the course of the work a new form of counting apparatus was constructed which may be briefly described as follows: It consists of two platforms, one below for the Petri dish, B., and one above to hold the magnifying lens R., Fig. 1, Plate XCV. The dish is supported on a screen of fine wire with one centimeter meshes instead of the usual ruled glass plate. The dish is centered by a mechanical arrangement which at the same time automatically indicates the area of the dish on a scale at the right, E. The lens is a five-inch reading glass. A metal shield prevents reflections from the surface of this. Below the lower platform is a black surface which furnishes the proper background. It is also provided with a self-registering hand counter, F.

C. Tests for Bacillus Coli in Milk.

I. Methods.

a) *Uses of Fermentation Tubes.*

1. *Lactose Peptone Bile.* This was prepared as recommended, put in Smith tubes, in which 25 c. c. were used, or in Durham tubes, where 10 c. c. were required. The inner tubes, in the latter case, were one dram vials 65 mm. long. In either case readings were made after 24 and 48 hours of incubation at 37° C. For measuring the amount of gas, a gasometer was used for the Durham tubes, as well as for the Smith tubes. Fig. 7.

II. *A New Medium—Neutral Red Milk Broth.* In this medium the milk sugar is furnished by the milk itself. It was this idea,

as well as the presence of the casein, that was thought to be a desirable innovation. It is prepared as follows:

10 grams of peptone and 3 grams of extract of beef are added to 1 liter of water. When the peptone and beef extract have gone into solution, as a result of gentle heating, 500 c. c. of separated (i. e., fat-free) milk are added, and the reaction of the whole is then so adjusted as to bring the reaction to +0.7. Fifteen cubic centimeters of a 1 % aqueous solution of neutral red is added. The medium is then ready to be put into fermentation tubes and sterilized as other sugar media.

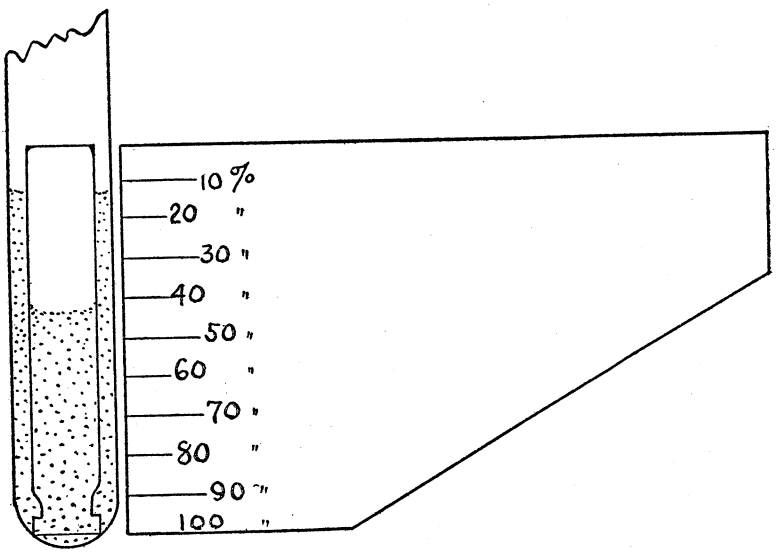


Fig. 7. Gasometer for Durham tubes.

In such a medium B. coli first coagulates the casein, then turns the medium in the closed arm yellow, forms gas, and also by its reducing action causes the whey or fluid part of the medium to become fluorescent. The amount of gas formed by B. coli in this medium is considerably less than that produced in lactose peptone bile, i. e., from 12 to 35% as contrasted with from 30 to 70%. In addition to this there are the changes in the milk part of the medium as well as the changes in the neutral red. The advantages of this medium over the lactose peptone bile are first, the ease with which it is prepared, since the materials are practically always at hand in all laboratories, and second, the large

number of changes in color or character of curd which are significant, and third, a more constant amount of gas production.

It appears to be worthy of further trial, and it is to be hoped that other workers will test its merits.

b) *Comparison of Smith and Durham Tubes.* The Smith fermentation tubes are inconvenient in several ways as compared with the Durham tubes. They are more difficult to fill; they require considerably more medium; they are difficult to store and hence are harder to handle in the sterilizer and incubator, and they are more time-consuming to clean.

If the inner tubes of the Durham apparatus are of the same length it is not difficult to measure the amount of gas formed; in fact, a gasometer can be constructed and used exactly as with the Smith tube. The tubes used for this work were heavy walled test-tubes, ½ inch by 6 inches, and a homeopathic vial of 1 dram capacity and 65 mm. long. The gasometer used is shown in Fig. 7.

The Smith tube was used exclusively in the early part of the investigation, then, for a time, the two kinds were run in duplicate, and finally the Durham tube was used instead of the Smith tube. with equal satisfaction, so far as the results obtained were concerned, and with much greater comfort. When the gas formula is desired, or a titration of the medium from the closed and open arm separately, then the Smith tubes must be used. When, however, it is sufficient to know that gas is formed, and about how much, the Durham tube is quite sufficient, and is very much more convenient, and saves medium.

c) *Use of Endo's Medium.* The use of Endo's medium for the detection of B. coli in milk has been tried by a number of workers. Kinyoun and Deiter, for example,* are very enthusiastic over its use. Ford,† however, says: "The results were, in general, not so satisfactory as those obtained from a dextrose tube." It has been tried out in the course of my work, and a column is provided in the Tables I. and VIII. for the data obtained. Towards the last its use was discontinued, not so much because it was thought useless, but because of the difficult technique it requires when compared with the use of fermentation tubes.

---

* Am. Jour. Pub. Health, 1912, 2, p. 979, and also in personal conversation.

† Johns Hopkins Hosp. Bull., 1913, 24, p. 25.

The method of preparation followed was that suggested by Kendall and Day.† Later, media made as above was neutralized biologically as suggested by Kinyoun and Deiter.* This method led to somewhat more satisfactory results due, it would seem, to the use of phenolthalein rather than litmus as an indicator, and consequently a more definite point of alkalinity. It seems, however, unnecessary to neutralize biologically each batch of medium as suggested by Kinyoun and Deiter, but when the proper reaction has been determined this point can be satisfactorily secured by the ordinary methods of titration. It would seem possible also to modify this medium and its method of use so that it would be both easily handled and extremely useful.

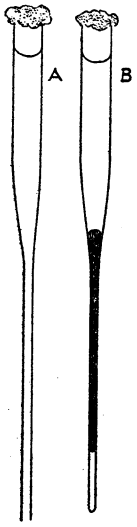


Fig. 8. Thermal Death-point Tubes.

D. Thermal Death Point of Bacillus Coli.

1. New Method of Testing. Although the thermal death point of B. coli has been frequently determined, it seemed desirable to test the particular strains used here and to do it quantitatively.

The method used is a modification and improvement on a method previously used by the writer. In its present form it is somewhat like the method suggested by Sternberg, except that by the use of the mechanical volumetric pipette, previously described, it is possible to take up measured quantities.

† Jour. Med. Research, 1911, 25, p. 95.
* Loc. cit.

The method is as follows: Glass tubes, 6 to 8 mm. in diameter, are drawn out at one end into a straw about 1 mm. in diameter. The form and size are given in Fig. 8. These tubes are then plugged with cotton and sterilized. The fine pointed end may either be sealed, or it can be flamed just before use. One of these tubes is then placed in the pipettometer and 0.1 of a c. c. of the suspension is drawn into the tube. This amount is then drawn up the tube about an inch, and the end of the straw is sealed in the flame. This tube can then be removed from the pipettometer. It is now ready to be put into the water-bath. A series of tubes are prepared in this way. One is plated directly and the others are heated at various temperatures for the same length of time, or at the same temperature for varying lengths of time, as the case may require. When the tubes are in the water-bath special care must be taken to keep the thin straws below the surface of the water so as to be sure that all of the bacteria are sufficiently heated. After the proper exposure the tubes should be removed from the water-bath and immersed in ice water. In plating, the sealed end is broken off with sterile forceps and the contents blown into a Petri dish, and covered with agar. The tube plated directly serves as a control. By this means it is possible to determine what Gage calls the "normal thermal death-point," as well as the "absolute thermal death-point."

E. Inhibiting Action of Milk in the Gas Production, by Bacillus Coli, in the Fermentation Tube.

Dr. Theobald Smith called my attention to the fact that B. coli is not capable of producing gas in milk when it is in the fermentation tube, as it does under similar conditions with other sugar media. The facts are shown in the following series:

Six fermentation tubes of milk, inoculated with one loop of a 24 hr. culture of B. coli.. 0, 15%, 5%, 5%, 0, 20%
Average = 7%

Six fermentation tubes of lactose peptone bile, inoculated as above.... 60%, 55%, 45%, 50%, 50%, 50%
Average = 52%

In view of these results, which are taken as representative, it was natural to ask: Does the addition of milk in small quantities, i. e., 1, 2, or 3 c. c., inhibit the characteristic reaction of any colon bacilli that might be present?

Six fermentation tubes of lactose peptone bile, inoculated with B. coli as above	60%, 55%, 45%, 50%, 50%, 50% Average = 52%
Six fermentation tubes inoculated as above, plus 1 c. c. of sterile milk	50%, 55%, 50%, 52%, 55%, 50% Average = 52%
Six fermentation tubes, inoculated as above, plus 1 c. c. of raw milk	65%, 55%, 43%, 58%, 55%, 50% Average = 54%

From these experiments it seems fair to conclude that the addition of a small amount of milk to culture media, will not perceptibly inhibit the gas production of any B coli contained therein.

F. Tests for Streptococci.

Methods for determining the presence of streptococci in milk are not satisfactory. A number of laboratories depend upon the direct microscopical method. In others the milk is introduced into sugar broth, and after incubation the surface layers are examined microscopically for long chains. If it were possible to readily and satisfactorily differentiate pyogenic streptococci from the lactic acid streptococcus, it would seem likely that a method of detection that would be useful would need the following essentials. The culture medium should be selective in the sense of favoring the growth of the streptococcus at least equally with any other form likely to be present. The resulting growth ought to be easily examined microscopically in rather large quantities. Following out these ideas milk was infected with the streptococcus and then added, in 1 c. c. lots, to a tube of dextrose broth. This culture was grown for 24 hours, and then centrifuged, and the sediment examined in a stained microscopical preparation. The large amount of curd makes this method useless. It was modified by straining out the curd and centrifugating the cleared fluid. This was more satisfactory than the first method tried, but since it amounted practically to filtering the medium through the casein, which would be most likely to hold back the long chains, the very elements most sought, this method would be of little value. A third step was taken by growing milk in dextrose broth as above, and then taking up in a capillary pipette about 2 c. c. of the upper part of the culture, and centrifugating this and examining the sediment.

In order to thrown down the sediment the milk centrifuge tubes of the Stewart–Slack method were used. This method has

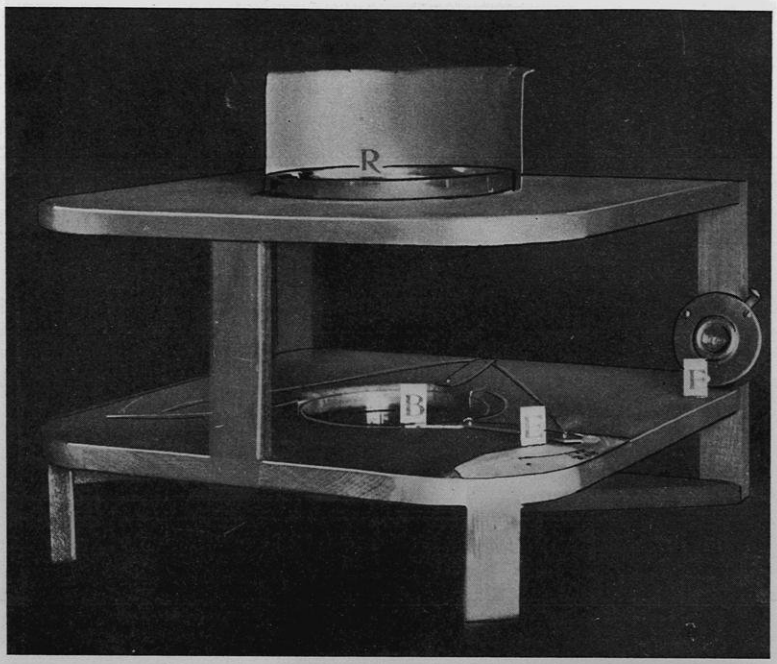


FIGURE 1

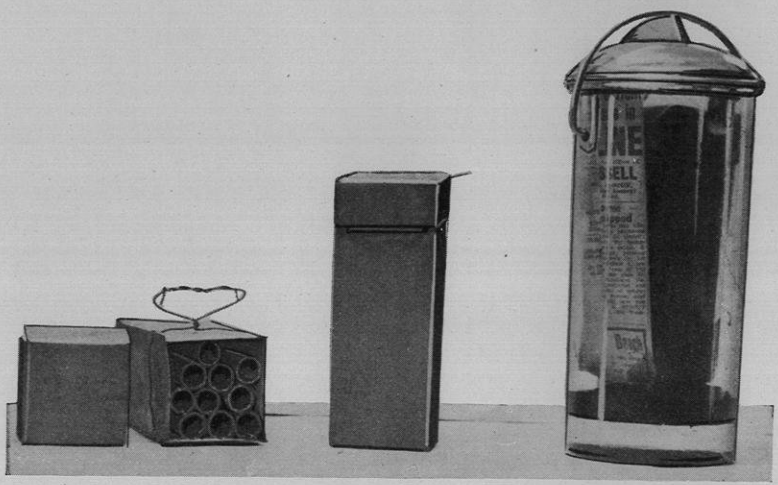


FIGURE 2

FROST:—MILK SUPPLIES

COCKAYNE—BOSTON

been used only to a limited degree in this investigation but more extensively in a subsidiary series, and is believed to be a promising procedure.

G. Tests for Bacterium Welchii.

1. A New Outfit for Quantitative Work. Savage suggests a quantitative test for Bacterium Welchii (B. enteritidis sporogenes) in milk which is as follows: "Quite small, narrow (4x¼ inch), sterile empty test-tubes are used in batches of ten for each estimation. 20 c. c. of milk are employed for each test, 2 c. c being added by a sterile pipette to each tube. The ten tubes are heated for 10 minutes at 80° C., rapidly cooled, and incubated anaërobically in specimen jars with ground-glass stoppers, just large enough to take the ten tubes, the oxygen being absorbed by the usual potash and pyrogallic acid mixture."—Savage.*

This method has been modified and improved in several details. The test-tubes used are 100 by 8 mm. Ten of them are placed in a zinc or copper box made out of sheet metal, as seen in Fig. 2, Plate XCV. This box makes it unnecessary to plug or handle the separate tubes. The box and contents are sterilized in the hot air oven. This sterilization is a matter of considerable importance since when the tubes are used over and over, the possibility of spores being carried from one test to another must be carefully guarded against. This is easily done by putting a piece of fresh cotton under the cover, and continuing the sterilization until this cotton is well browned. By means of a graduated 10 or 20 c. c. pipette, 2 c. c. of milk is run into each tube. The cover is replaced which is easily given a distinctive mark with a grease pencil. The tubes are now heated. To do this it is only necessary to place the tubes, box and all, in a water-bath so arranged that the water will come well toward the top of the tubes. They are then cooled and placed in jars from which the oxygen can be absorbed. Jars particularly adapted to this use are the specimen jars with straight sides, with tops clamping on. In order to hold the box up from the bottom, and allow room for the pyrogallate, a strip of zinc about ½ an inch wide is coiled up and laid in the bottom of the jar. The required amount of pyrogallic acid is placed in the bottom of the jar, the box with the milk

* Milk and the Public Health, 1912, p. 189, The Macmillan Co.

tubes is put in place, and then a paper bag is put in one side and a small tube of gelatin containing a little methylene blue, which has just been boiled until it is colorless, is put in on the other side for the purpose of determining whether or not anaërobic conditions are secured and maintained. The gelatin tube should, of course, remain free from a blue color; i. e., the methylene blue, should remain reduced. The paper sack is made from newspaper (1x3 inches) pasted together, and is used to hold the alkali. It requires a short time for the alkali to eat through the bag during which time it is possible to close and seal the jar. The outfit is incubated for 48 hours at 37° C. In examining them the box is removed from the jar, the cover taken off, and the tubes lifted out two at a time with a small pair of forceps. The following is regarded as a typical reaction: Abundant gas formation, cream layer may be forced to top, or even out of tube, otherwise torn into shreds; beneath is a flocculent or floating curd. The amount of coagulated casein is small in comparison with the amount of whey, which is colorless, clear, or slightly turbid. The reaction is strongly acid and has the odor of butyric acid. A similar change is sometimes seen in which there is lacking, however, evidence of gas and flocculent curd, and in which the curd remains at the bottom. In doubtful cases, as for example, where this last change occurs with milk very good in every other way, it would be desirable to test out the tubes by sub-cultures. For this purpose a milk fermentation tube is excellent. A new form of fermentation tube, not previously described, useful in this connection may properly be considered here.

2. New Form of Fermentation Tube Used for Testing out Doubtful Reactions in Bacterium Welchii Determinations. This form of the fermentation tube was devised some years ago for some special problems still under way, and is especially useful for the study of anaërobes and the amount and rate of gas formation from a constant volume of the medium.

Its special features are best understood by reference to the accompanying figure. Fig. 10. (A) lower arm A is the essential modification of the ordinary form. This is made of such size that it will contain a measured amount of culture medium, say 10 c. c. On top of this is put an oil (white paraffin or other neutral oil) filling the closed arm B, and some in the bulb. The medium is inoculated by means of a capillary pipette. The gas, as it is

formed, rises through the oil and collects at C. It is possible of course, to obtain and maintain absolute anaërobic conditions in the medium situated as it is under oil.

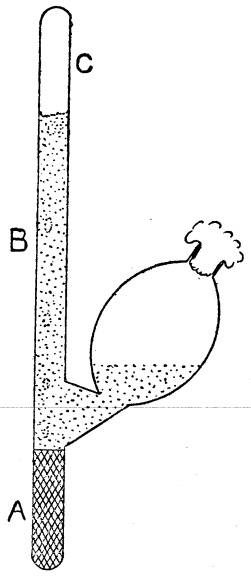


Fig. 10. New form of fermentation tube.

III. DETAILED ANALYSES OF VARIOUS GRADES OF MILK STUDIED.

A. Classification of Milks.

1. Schemes Proposed. The Commission on Milk Standards appointed by the New York Milk Committee† suggested that milks should be classified into the following grades:—

Class A Certified milk or its equivalent

Class B Inspected milk

Class C Pasteurized milk

Class D Milk not suitable for drinking purposes.

This is practically the same classification suggested by Melvin.* The Department of Health of New York City‡ has adopted a classification somewhat more elaborate.

† Public Health Reports, 1912, 27, p. 673.

* Milk and Its Relation to the Public Health. Hyg. Lab. Bull. 56, 1909, p. 607.

‡ Milk Supply of New York City, 1912. Dep't of Health Monograph Series, 5, p. 13.

Grade A. For infants and children
1. Certified
2. Guaranteed
3. Inspected
4. Selected pasteurized

Grade B. For adults
1. Selected raw
2. Pasteurized

Grade C. For cooking and manufacturing purposes only.

A comparison of the two schemes is shown here.

Report of Commission		New York City Board of Health
		Grade A
Class A Certified (or its equivalent)	.....	1. Certified 2. Guaranteed
Class B Inspected	.....	3. Inspected raw
	.....	4. Selected pasteurized
		Grade B
[Not provided for]	.....	1. Selected, raw
Class C Pasteurized	.....	2. Pasteurized
		Grade C
Class D Raw	.....	Raw

2. Plan Adopted. The plan adopted as most generally applicable was that proposed by the Milk Commission.

B. Milks Examined.

1. List and Description of Milks. An attempt was made to secure representative grades of the various classes. Those studied are as follows:

	(Grade A)
a) *Certified.*	
B_5	9 samples
B_6	3 samples
H_1	3 samples
H_2	3 samples
H_3	3 samples
I	3 samples
J_1	3 samples
J_2	3 samples

b) *Inspected.*	(Grade B)
A_5	5 samples
A_6	1 sample
B_3	7 samples
B_4	6 samples
C_3	3 samples
D	3 samples
G	7 samples
c) *Pasteurized.*	(Grade C)
Holding process	
A_2	6 samples
B_2	6 samples
C_2	7 samples
In bottle	
A_3	5 samples
A_4	9 samples
M_2	4 samples
d) *Raw Milk.*	(Grade D)
A_1	6 samples
B_1	7 samples
C_1	8 samples
E	2 samples
F_1	3 samples
F_2 and $_4$	3 samples
F_5	4 samples
K	3 samples
L	3 samples
M	4 samples

C. Scope of the Analyses.

Most of the analyses were made during the months of January, February, March, and April. The results represent winter conditions. These, it seems fair to assume, are the most favorable for the producers as well as the consumers of milk. On practically all samples the following determinations were made:

In all cases:

1. Total number of bacteria growing at 21° C.
2. Gas production in lactose media, either lactose peptone bile, a special medium (neutral red milk broth), or Endo's medium.
3. Bacterium Welchii, by a quantitative method modified from Savage.
4. Spores or forms resisting 80° C. for 10 minutes.

In part of the samples:

5. Streptococci were examined for.
6. The character of the curd at 37° C. studied.
7. The time required to reduce methylene blue determined.
8. The number of bacteria determined directly by the Stewart-Slack method.

The method used for collection, as well as the technique of the various steps, has already been given.

The results obtained are shown in the following Tables, I.–IV. inclusive.

TABLE I.—CERTIFIED MILKS (Class A).

Source.	Page No.	Date.	No. of bacteria.	Fermentation in: Bile. 1 c.c.	Bile. 1/10	Bile. 1/100	Special. 1 c.c.	Special. 1/10	Special. 1/100	Endo medium.	Bact. Welchii in or 20 cc.	Spores.
				%	%	%	%					
B_5	102	2- 4	3,000	0	.....	0	0	.....	0	.....	0	.....
B_5	162	2-26	2,500	0	.....	0	0	.....	.....	.....	.....	.....
B_5	171	3- 4	2,050	0	0	.....	.....	.....	.....	.....	0	0
B_5	176	3- 7	2,750	0	0	.....	.....	.....	.....	.....	0	300
B_5	179	3- 7	2,200	0	0	.....	0	.....	.....	0	0	100
B_5	194	3-14	1,500	0	0	.....	0	.....	.....	0	0	0
H_1	197	3-18	18,000	65	60	.....	18	.....	.....	0	0	1,200
H_2	198	3-18	22,600	50	60	.....	?	.....	.....	0	1	2,700
H_3	199	3-18	24,500	60	60	.....	?	.....	.....	0	0	1,400
1	200	3-18	4,000	0	0	.....	0	.....	.....	0	0	100
J_1	201	3-18	81,000	0	0	.....	0	.....	.....	0	0	0
J_2	202	3-18	3,600	0	0	.....	0	.....	.....	0	0	0
B_5	203	3-18	3,900	0	0	.....	0	.....	.....	0	0	50
B_6	204	3-18	58,000	0	0	.....	0	.....	.....	0	0	17,800
B_5	206	3-18	6,000	0	0	.....	0	.....	.....	0	0	50
H_1	312	7- 2	152,000	60	60	0	.....	.....	.....	.....	0	100
H_2	313	7- 2	8,650	0	0	0	.....	.....	.....	.....	0	50
I	314	7- 2	4,350	80	90	0	.....	.....	.....	.....	0	150
J_1	315	7- 2	1,350	0	0	0	.....	.....	.....	.....	0	100
J_2	316	7- 2	50,100	0	0	0	.....	.....	.....	.....	0	250
B_6	318	7- 2	4,900	95	90	95	.....	.....	.....	.....	0	1,600
H_1	319	7- 8	18,500	0	0	0	.....	.....	.....	.....	0	1,400
H_2	320	7- 8	2,460	68	0	0	.....	.....	.....	.....	0	200
L	321	7- 8	1,800	70	0	0	.....	.....	.....	.....	0	300
J_1	322	7- 8	2,600	50	45	0	.....	.....	.....	.....	0	300
J_2	323	7- 8	19,000	0	0	0	.....	.....	.....	.....	0	100

TABLE II.—INSPECTED MILKS (Class B).

Source.	Sample No.	Date.	No of Bacteria.	Fermentation in:						Endo medium.	Bact. Welchii in 10 or 20 cc.	Spores.
				Bile.			Special.					
				1 c.c.	1/100	1/1000	1 c.c.	1/100	1/000			
				%	%	%	%	%	%			
G	81	1-19	9,800	0	.....	.....	0	.....	0	.....	0	100
A_5	83	1-21	215,000	.....	30	.....	.....	.....	0	.....	0/10	3,080
G^5	88	1-21	7,200	0	0	.....	.....	0	.....	.....	0/10	96
A_5	90	1-24	1,700,000	.....	(1/10) 70	50	25	.....	20	red colonies	1/10	23,400
A_6	92	1-24	565,000	.....	(1/10) 60	73	.....	1/10 20	5	60 " "	1/10	40,320
A_5	96	2-3	132,000	.....	0	0	.....	0	0	Few " "	1/10	.....
B_3	103	2-4	10,000	50	0	.....	0	0	.....	.....	0	.....
G^5	106	2-10	5,250	0	0	.....	0	0	.....	.....	?	.....
A^5	120	2-11	425,000	.....	(1/100)	0	.....	1/10 0	0	.....	0	36,000
G	123	2-11	5,400	0	0	.....	50% pink	0	.....	.....	0	120
W	124	2-12	16,500	0	0	.....	0	0	.....	0	1/10?	5,450
A_5	128	2-12	25,000	0	0	.....	0	0	.....	0	8/10?	2,400
G^5	138	2-18	20,500	0	.....	.....	0	0	.....	Few red colonies	1/10	0
G	139	2-18	7,850	0	.....	.....	0	0	.....	0	0/10	400
G	147	2-20	33,200	0	0	.....	0	0	.....	0	0/10	.....
C_3	156	2-24	60,000	0	0	.....	0	0	.....	0	0/10	.....
C^3	157	2-24	24hr 127,500	0	0	.....	0	0	.....	0	0/10	.....
B^3	161	2-26	220,000	60	60	.....	0	.....	.....	26 red colonies	3/10	.....
B^4	163	2-26	51,500	60	0	.....	10	.....	.....	26 " "	9/10	5,250
B_3	169	3-4	25,000	.....	0	0	.....	.....	.....	.....	0/10	600
B^4	170	3-4	768,000	58	0	.....	.....	.....	.....	.....	4/10	26,500
B^4	180	3-7	29,000	.....	0	0	.....	0	.....	.....	0/10	800
B^4	181	3-7	37,500	60	0	.....	.....	.....	.....	Few red colonies	0/10	7,000
C^4	186	3-10	207,000	1/100	0	.....	1/10 0	0	.....	20 " "	.....	39,050
B^3	195	3-14	38,000	65	0	.....	0	.....	.....	Several red col.	10/10	1,200
B^3	196	3-14	108,000	75	0	.....	.....	.....	.....	" " "	10/10	24,500
B^4	207	3-18	74,000	70	0	.....	.....	.....	.....	" " "	0/10	8,400
B_3	209	3-18	54,000	0	0	.....	.....	.....	.....	Doubtful	0/10	2,700
D^3	214	3-21	6,000	55	(1/10) 22	.....	.....	.....	.....	.....	3/10	400
D	215	3-21	6,000	0	(1/10) 20	.....	.....	.....	.....	.....	2/10	800
B_4	220	3-21	138,000	70	22	0	.....	.....	.....	.....	2/10	800
B^4	221	3-21	28,000	70	0	0	.....	.....	.....	.....	2/10	300
D^3	230	3-28	8,100	60	60	.....	.....	.....	.....	.....	1/10	250

TABLE III.—PASTEURIZED MILK (CLASS C).

Source.	Sample No.	Date.	No. of Bacteria.	Fermentation in: Bile. 1 c.c.	Bile. 1/10	Bile. 1/100	Special. 1 c.c.	Special. 1/10	Special. 1/100	Endo medium.	Bact. Welchii.	Spores.
				%	%	%	%	%	%			
A_4	78	1-19-13	46,750	0	.....	0	0	.....	0	.....	Absent...	2,500
A_2^4	79	1-19-13	60,500	70	.....	.....	20	.....	0	.....	"	4,300
A_2^3	80	1-19-13	36,250	0	.....	.....	0	.....	0	.....	"	500
A_3^2	85	1-21-13	76,500	0	.....	0	.....	.....	0	.....	"	1,900
A_4^2	86	1-21-13	19,250	0	.....	0	.....	.....	0	.....	"	2,100
A_3	87	1-21-13	27,400	0	.....	0	.....	.....	0	.....	"	2,700
A_4^3	91	1-24-13	74,500	0	.....	0	0	.....	0	0	1/10	9,800
A_4^4	93	1-24-13	38,000	0	.....	0	0	.....	0	0	Absent...	15,120
A_3^3	95	1-24-13	50,000	0	.....	0	0	.....	0	0	"	11,200
A_4^2	98	2- 3-13	5,000	0	.....	0	0	.....	0	0	2/10 ?	4,800
A_2	99	2- 3-13	42,300	0	.....	0	0	.....	0	.....	1/10	4,800
A_3^2	100	2- 3-13	18,000	0	.....	0	0	.....	0	.....	.....	4,000
G_2^2	101	2- 3-13	94,000	40	.....	45	.....	.....	28	.....	.....	4,000
B_2^2	104	2- 3-13	45,500	95	.....	0	0	.....	0	.....	.....	.....
A_2^2	119	2-11-13	48,250	50	.....	0	0	0	.....	.....	.....	16,000
A_4	121	2-11-13	22,250	0	0	.....	0	0	.....	.....	.....	15,450
A_4^4	122	2-11-13	26,500	0	0	.....	0	0	.....	.....	.....	10,800
A_3^3	125	2-12-13	21,250	0	0	.....	0	0	.....	0	2/10 ?	15,350
A_4^3	126	2-12-13	24,500	0	0	.....	0	0	.....	0	3/10 ?	9,100
A_2^4	127	2-12-13	102,250	25	0	.....	0	0	.....	Numer's red colonies	10/10 ?	33,000
C_2	136	2-18-13	16,900	50	.....	.....	.....	.....	.....	..... " " "	8/10 ?	2,800
G_2^2	137	2-18-13	34,450	40	.....	.....	5	.....	5	" " "	8/10 ?	74,800
W^2	146	2-20-13	35,000	0	.....	0	0	.....	0	0	0/10 ?	.....
C_2	154	2-24-13	40,000	60	0	.....	20	12	.....	20 red colonies	2/10 ?	.....
B_2^2	160	2-26-13	100,000	45	0	.....	0	.....	.....	Numer's " "	1/10 ?	4,300

TABLE III. — PASTEURIZED MILK (CLASS C).

Source.	Sample No.	Date.	No. of Bacteria.	Fermentation in:						Endo medium.	Bact. Welchii.	Spores.
				Bile.			Special.					
				1 c.c.	1/10	1/100	1 c.c.	1/10	1/100			
				%	%	%	%	%	%			
B_2	168	3- 4-13	192,500	68	.....	bubble	.....	.....	.....	.....	0/10	21,500
B_2	178	3- 4-13	83,000	48	.....	0	0	.....	.....	Several " "	6/10	21,000
C_2	184	3-10-13	858,500	70	.....	60	30	.....	35	Numer's " "	8/10	49,000
C_2	185	3-10-13	462,500	60	.....	65	35	0	.....	" " "	8/10	126.000
C_2	190	3-13-13	608,000	50	.....	55	12	.....	.....	" " "	6/10	47,200
C_2	191	3-13-13	308,000	.....	.....	50	50	.....	.....	" " "	6/10	78,000
B_2	193	3-14-13	225,500	60	.....	0	?	.....	0	Several " "	4/10	10,100
B_2	208	3-18-13	104,000	40	.....	0	.....	.....	.....	" " "	6/10	64,000
H_2	219	3-21-13	174,500	50	60	60	.....	.....	.....	.....	10/10	8,700
W	232	3-31-13	22,500	0	.....	0	.....	.....	.....	.....	0/10	13,000
M_2	251	4-11-13	5,500	0	0	.....	.....	.....	.....	.....	1/10	1,300
M_2	255	4-13-13	4,300	0	0	0	.....	.....	.....	.....	0/10	800
M_2	260	4-14-13	6,700	0	0	0	.....	.....	.....	.....	2/10	2,600
M_2	261	4-15-13	7,150	0	0	0	.....	.....	.....	.....	2/10	4,000

TABLE IV.—RAW MILKS (CLASS D).

Source.	No. of samples.	Date.	No. of bacteria.	Fermentation in: Bile. 1 c.c.	Bile. 1/100	Bile. 1/1000	Special. 1 c.c.	Special. 1/100	Special. 1/1000	Endo medium.	Bact. Welchii.	Spores.
				%	%	%	%	%	%			
A_1	77	1-19	1,095,000	55	.....	.....	25	30	.....	.....	Negative	3,000
A_1	84	1-21	1,490,000	.....	50	24	.....	.....	24	.....	2/10	1,900
A_1	94	1-24	3,500,000	.....	70	23	.....	25	20	Several red colonies	Negative	14,000
A_1	97	2-3	1,645,000	.....	50	55	.....	20	25	Numerous " "	3/10	6,400
B_1	105	2-4	860,000	.....	50	bubble	.....	30	15	.....	Present	.....
F_1	109	2-6	100,000	.....	0	0	.....	0	0	Numerous red colonies	Absent	325
F_3	110	2-6	1,520,000	.....	0	0	.....	0	0	Few " "	1/10?	6,500
F_3	111	2-6	31,000	.....	50	0	.....	0	25	Few " "	Absent	.....
F_3	112	2-6	532,000	.....	35	0	.....	5	.....	Few " "	7/10	1,050
F_1	113	2-6	30,000	.....	20	0	.....	32	.....	Few " "	Absent	1,000
F_2	114	2-6	66,500	.....	0	0	.....	0	0	Few " "	Absent	15,750
A_1	118	2-11	1,250,000	.....	0	0	.....	12	.....	.....	Absent	5,000
A_1	129	2-12	1,467,500	.....	.....	.....	5	0	.....	Several " "	10/10?	48,900
C_1	134	2-18	1,770,000	.....	.....	55	(1/10) 20	25	.....	Several " "	10/10	2,700
C_1	135	2-18	1,095,000	.....	.....	48	(1/10) 20	20	.....	Several " "	8/10	1,800
F_1	142	2-20	443,000	60	.....	.....	?	?	.....	Few " "	1/10	0
F_2	143	2-20	110,000	60	.....	0	0	.....	0	0	0/10	600
F_3	144	2-20	210,000	40	.....	0	?	.....	?	Few red colonies	1/10	0
F_2	145	2-20	36,000	33	.....	0	15	.....	0	Few " "	0/0	400
C_1	152	2-24	1,777,500	.....	60	20	30	15	.....	Several " "	3/10	2,300
C_1	153	2-24	2,200,000	.....	20	10	0	0	.....	Several " "	1/10	27,000
B_1	159	2-26	2,120,000	.....	60	58	.....	32	.....	Numerous " "	0/10	13,400
B_1	167	3-4	980,000	.....	64	60	.....	.....	.....	.....	0/10	4,750
B_1	177	3-7	125,000	.....	0	1/10000 0	.....	0	.....	0	5/10	0
C_1	182	3-10	50,000	.....	0	0	.....	0	0	0	3/10	5,000

TABLE IV.—RAW MILKS (CLASS D).

Source.	No. of samples.	Date.	No. of bacteria.	Fermentation in:						Endo medium.	Bact. Welchii.	Spores.
				Bile.			Special.					
				1 c.c.	1/100	1/1000	1 c.c.	1/100	1/1000			
C_1	183	3-10	8,035,000	.....	65	0	.....	20	.....	Numerous red colonies	10/10	26,300
C_1	188	3-13	1,550,000	.....	60	70	.....	5	.....	Several " "	10/10	21,400
C_1	189	3-13	1,250,000	.....	55	43	.....	5	.....	Several " "	10/10	27,700
B_1	192	3-14	1,400,000	.....	70	45	.....	30	.....	Numerous " "	7/10	10,100
B_1	210	3-18	1,070,000	100	50	0	.....	12	.....	Numerous " "	0/10	3,000
E	216	3-21	250,000	.....	0	0	.....	.....	.....	.....	0/10	27,000
E	217	3-21	110,000	.....	0	0	.....	.....	.....	.....	0/10	2,500
B_1	218	3-21	6,750,000	.....	70	1/10000 0	55	.....	.....	.....	10/10	3,400
K	231	4-1	1,250,000	80	0	0	.....	.....	.....	.....	1/10	2,250
L	244	4-3	6,450,000	0	0	0	.....	.....	.....	.....	7/10	200
K	252	4-11	500,000	65	30	.....	.....	.....	.....	.....	1/10	1,500
K	256	4-14	4,600,000	.....	45	70	.....	.....	.....	.....	.....	1,400
L	264	4-14	1,950,000	.....	60	35	.....	.....	.....	.....	2/10	6,200

D. General Consideration of Results Obtained.

When the results obtained from each grade and source are grouped and studied, certain interesting, and, it is believed, very important points are brought to light, so that it seems worth while to consider the points raised somewhat in detail.

1. Raw Milks. The analyses of *raw milks* are grouped and shown in Table IV. It is to be noted here that the first three milks, A_1, B_1, and C_1, which are to be pasteurized before marketing, are much similar. The bacterial count is high, about 2,000,000. B. coli, or its allies, are practically always present in quantities of 100 per c. c. Usually there are 1000 per c. c. and occasionally, at least, there are 10,000 per c. c. Spores of Bact. Welchii are generally present; frequently there is one such spore for each 2 c. c. of the milk, but on the average there are 4.2 to each 20 c. c. of the milk. Spores of organisms growing under aërobic conditions are also present in considerable numbers. K and L. were raw milks to be sold as produced and the samples studied were from stores. They were apparently somewhat better milks. The high bacterial count comes, no doubt, from recent multiplication since, aside from the rather high Bact. Welchii content, there is no evidence that these milks are badly contaminated.

The milks marked F_1, F_2, and F_3 are from a small town (15,000) and are very much cleaner than the city milks. It is worthy of special note that F_1 and F_2 came directly from the producer, while F_3 is a similar and sometimes the same milk which has gone through the bottling works with considerable detriment to the quality of the milk.

E is a relatively small producer who is apparently producing quite a good quality of milk.

2. Pasteurized Milks. The pasteurized milks (Table III.) are of two classes, those pasteurized in bulk and from milk produced without any special care, and those from milks belonging to the inspected grade and pasteurized in bottles. The first class, A_2, B_2 and C_2, all contain more bacteria than would be allowed by the Commission's standard. Practically all of the samples contain B. coli in 1 c. c. lots, and some even show 100 per c. c. The number of resistant forms is high, showing, I believe, inefficient sterilization and cleanliness of the pasteurizing and bottling apparatus and utensils. The high content of Bact. Welchii is, of course, to be attributed to the contaminated condition of the raw milk.

The milks pasteurized in the bottle are very much better than those pasteurized in bulk. The count is low, especially in M_2, since A_3 and A_4 were taken from the plant and usually soon after pasteurization, while M_2 was delivered in the early morning and remained on a doorstep for some hours before it was taken to the laboratory. B. coli was practically never found in 1 c. c. lots. The number of Bact. Welchii is low as well as the number of resistant aërobic forms.

3. INSPECTED MILKS. The inspected milks (Table II.) are most of them of only a fair grade. Certain ones, however, are uniformly excellent, such as B_3 and G. The latter belongs practically in the certified class. B. coli is usually present in 1 cc. amounts, except in the very best of them. Bact. Welchii is frequently present and occasionally in large numbers. The best of these milks have a very small number of resistant forms or spores, but the poorer grades frequently have large numbers.

4. CERTIFIED MILKS. The certified milks (Table I.) have usually been found to be excellent.

E. DISCUSSION OF THE VARIOUS FACTORS STUDIED AND THEIR SIGNIFICANCE.

1. TOTAL NUMBER OF BACTERIA. (Table V.)

a) *Raw Milks*—Grade D.

The raw milks studied belong to two different classes,—those that are to be sold raw, and those that are to be pasteurized in bulk before being put on the market. The milks of the latter class are A_1, B_1 and C_1. It will be seen from Table V. that of these, even in midwinter, very few samples came within the prescribed limit. The average of six samples of A_1 was 1,741,400, of seven samples for B_1 was 1,786,000, of eight samples for C_1 was 2,211,600, which is from 70% to 100% above the standard of 1,000,000 set by the Commission.

The other class, namely, those to be sold in a raw condition, are represented by E, K, and L, which give the following averages respectively: 180,000, 6,916,500 and 3,970,000 bacteria per c. c.

Milks F_1, F_2, F_3, and F_4 are from a small town of about 15,000 inhabitants, some sixty miles from Boston. So far as can be judged by the total number of bacteria, it is seen that these milks are considerably better than those of a large city. One

TABLE V.—TOTAL NUMBER OF BACTERIA PER C.C. IN VARIOUS GRADES OF MILK.

RAW.				PASTEURIZED.				INSPECTED.				CERTIFIED.			
Source	Sample No.	Age.	Total number of bacteria.	Source	Sample No.	Age.	Total number of bacteria.	Source	Sample No.	Age.	Total number of bacteria.	Source	Sample No.	Age.	Total number of bacteria per c.c.
A_1^1	77	Fresh ...	1,095,000	A_2^2	79	Fresh....	60,500	A_5^5	83	Fresh ...	215,000	B_5^5	102	Fresh ...	3,000
A_1^1	84	" ...	1,490,000	A_2^2	85	"	76,500	A_5^5	90	" ...	1,700,000	B_5^5	162	" ...	2,500
A_1^1	94	" ...	3,500,000	A_2^2	95	"	50,000	A_5^5	96	" ...	132,000	B_5^5	171	" ...	2,050
A_1^1	97	" ...	1,645,000	A_2^2	99	"	42,300	A_5^5	120	" ...	425,000	B_5^5	179	" ...	2,200
A_1^1	118	" ...	1,250,000	A_2^2	119	"	48,250	A_5^5	128	" ...	25,000	B_5^5	194	" ...	1,500
A_1^1	129	" ...	1,467,500	A_2^2	127	"	101,250					B_5^5	203	" ...	2,900
												B_5^5	206	" ...	6,000
Ave..	.....	.....	1,741,400	Ave.	.....	.....	63,000	Ave.	.....	.....	499,400				
								B_6^6	92	Fresh ...	565,000	Ave.	.....	.....	2,880
B_1^1	105	" ...	860,000	B_2^2	104	Fresh....	45,500	B_3^3	103	" ...	10,000				
B_1^1	159	" ...	2,120,000	B_2^2	160	"	100,000	B_3^3	163	" ...	51,500	B_6^6	204	24 hrs...	58,000
B_1^1	167	" ...	980,000	B_2^2	168	"	198,000	B_3^3	169	" ...	25,000	B_6^6	318	24 hrs...	4,900
B_1^1	177	" ...	125,000	B_2^2	178	"	83,500	B_3^3	180	" ...	29,000	B_6^6	325	24 hrs...	4,400
B_1^1	192	" ...	1,400,000	B_2^2	193	"	225,500	B_3^3	195	" ...	38,000				
B_1^1	210	" ...	1,070,000	B_2^2	208	"	104,000	B_3^3	209	" ...	54,000				
B_1^1	218	" ...	6,750,000					B_3^3	221	" ...	28,000	Ave.	.....	.....	23,400
				Ave.	....	.....	126,000								
Ave..	.....	.....	1,786,000					Ave.	.....	.....	33,640	H_1^1	197	24 hrs...	18,000
				C_2^2	101	Fresh....	94,000					H_1^1	312	24 hrs...	152,000
C_1^1	134	Fresh ...	1,770,000	C_2^2	136	" ...	16,900	B_4^4	161	Fresh ...	220,000	H_1^1	319	24 hrs...	18,500
C_1^1	135	" ...	1,095,000	C_2^2	137	24 hrs....	34,450	B_4^4	170	" ...	168,000				
C_1^1	152	" ...	1,777,500	C_2^2	154	Fresh ...	40,000	B_4^4	181	" ...	37,500	Ave.	.....	.....	62,800
C_1^1	153	" ...	2,200,000	C_2^2	184	" ...	858,500	B_4^4	196	" ...	108,000				
C_1^1	182	" ...	50,000	C_2^2	185	24 hrs ...	462,500	B_4^4	207	" ...	74,000	H_2^2	198	24 hrs...	22,600
C_1^1	183	" ...	8,000,000	C_2^2	190	Fresh ...	608,000	B_4^4	220	" ...	138,000	H_2^2	313	24 hrs...	8,650
C_1^1	188	" ...	1,550,000	C_2^2	191	" ...	308,500					H_2^2	320	24 hrs...	2,400
C_1^1	189	" ...	1,250,000					Ave.	.....	.....	124,250				
				Ave.	.....	.....	302,800					Ave.	.....	.....	11,200
Ave..	.....	... .	2,211,600												

TABLE V.—TOTAL NUMBER OF BACTERIA PER C.C. IN VARIOUS GRADES OF MILK.

RAW.				PASTEURIZED.				INSPECTED.				CERTIFIED.			
Source	Sample No.	Age.	Total number of bacteria.	Source	Sample No.	Age.	Total number of bacteria.	Source	Sample No.	Age.	Total number of bacteria.	Source	Sample No.	Age.	Total number of bacteria per c.c.
E	216	Fresh ...	250,000	A_3	80	Fresh....	36,250	C_3	156	Fresh ...	60,000	I	200	24 hrs...	4,000
E	217	" ...	110,000	A_3	87	"	27,400	C_3	157	24 hrs...	127,500	I	314	24 hrs...	4,350
Ave..	.....	.....	180,000	A_3	93	"	38,000	C_3	186	Fresh ...	207,000	I	321	24 hrs...	1,800
F_1	109	24 hrs....	100,000	A_3	100	"	18,000	Ave .	.....	.....	131,500	Ave .	.....	.....	2,700
F_1	113	Fresh ...	30,000	A_3	125	"	21,250								
F_1	142	" ...	443,000	Ave .	.....	.....	28,180	D	214	Fresh ...	6,000	J_1	201	24 hrs...	81,000
Ave .	.....	.....	191,000	A_4	78	Fresh ...	46,750	D	215	" ...	6,000	J_1	315	24 hrs...	1,350
F_2	114	Fresh ...	66,500	A_4	86	24 hrs...	19,250	D	230	" ...	8,100	J_1	322	24 hrs...	2,600
F_2	143	" ...	110,000	A_4	91	Fresh ...	74,500	Ave .	.....	.....	6,700	Ave .	.....	.....	28,000
F_4	145	" ...	36,000	A_4	98	" ...	5,000	G	81	24 hrs...	9,800	J_2	202	24 hrs...	3,600
Ave .	.....	.....	70,800	A_4	121	" ...	22,250	G	88	24 hrs...	7,200	J_2	316	24 hrs...	50,100
F_3	111	" ...	31,500	A_4	122	24 hrs...	26,500	G	106	24 hrs...	5,250	J_2	323	24 hrs...	19,000
F_3	112	" ...	532,500	A_4	126	Fresh ...	24,500	G	123	24 hrs...	5,400	Ave .	.....	... .	24,200
F_3	144	" ...	211,000	A_4	146	24 hrs...	35,000	G	138	4 days ..	20,500				
F_3	110	" ...	1,520,000	A_4	232	24 hrs...	22,500	G	139	24 hrs...	7,850				
Ave .	.....	.....	573,750	Ave .	.....	.....	30,640	G	147	24 hrs...	3,200				
K	231	24 hrs....	1,250,000	M_2	251	24 hrs...	5,500	Ave .	.....	.....	8,460				
K	252	24 hrs....	500,000	M_2	255	24 hrs...	4,300								
K	256	24 hrs....	4,600,000	M_2	260	24 hrs...	6,700								
K	258	24 hrs....	14,400,000	M_2	262	24 hrs...	7,150								
Ave .	.....	.....	6,916,500	Ave .	.....	.....	5,910								
L	244	Fresh ...	6,450,000												
L	264	24 hrs....	1,950,000												
L	272	24 hrs....	3,525,000												
Ave .	.....	.....	3,970,000												

point of interest appears, and that is, that milks prepared for immediate sale by the producer, even in a small place, are frequently, if not usually, better than those worked over by a pasteurizing or bottling plant. Compare the bacterial content of F_1 with 191,000 per c. c. and F^2 with 70,500 per c. c. contrasted with F_3 with 573,750 bacteria per c. c.

b) *Pasteurized Milk*—Class C.

The Commission states that pasteurized milks should not contain over 50,000 bacteria per c. c.

The analyses reported here were of several kinds of pasteurized milk, and these should be considered separately. We have first of all milks pasteurized in bulk in which a holding device was used. Others were pasteurized in the bottle. Milks A_2, B_2, and C_2 represent those pasteurized in bulk. The analyses showed the following averages:—63,000, 126,000, and 302,800 bacteria per c. c. In practically all these cases the milks were brought directly from the machine to the laboratory and were therefore 24 hours fresher than samples taken from the bottles of milk delivered to the consumers. It seems fair to assume that the conditions under which these milks were received were better than the conditions of the same milk would be when delivered to the consumer.

It is apparent that the bacterial content found is far above that prescribed as the limit by the Commission, and this at a time of year when it is easily possible to turn out the best product. If the 50,000 limit had been enforced at the time these experiments were made, less than one-third, or, precisely, only six out of twenty would have been within the limit. Most of them were considerably higher, several, two, three and four times too high, and one sample seventeen times above the prescribed limit. The reason for this high count is usually, if not always, to be laid at the door of the pasteurizing concern because of improperly sterilized apparatus with which the milk comes in contact before it reaches the final container, a too low pasteurizing temperature, or a too highly contaminated raw milk.

Milk pasteurized in the bottle or final container, was examined from three plants, A_3, A_4, and M_2. These milks are very different from those pasteurized in bulk. The low count, however, is not of necessity due to the higher efficiency of this method of pasteurization, because this method of pasteurization is used only

on the better grades of milk. The milks pasteurized by this method all belong, theoretically, to the inspected class, and are much better milks than those used for pasteurization in bulk. Compare counts of A_5 A_6, and M_1, in this connection.

c) *Inspected Milks*—Class B.

Inspected milks should contain less than 100,000 bacteria per c. c. according to the Milk Commission.

Eight different milks of this grade have been examined. A_5 and A_6 run high; both of these, however, are afterwards pasteurized in the bottle. See A_3 and A_4, B_3, D, G, and M were very good milks and were always well under the above limit. B_4 and C_3 were not nearly as good, but satisfactory from this standpoint in practically one-half of the samples examined.

d) *Certified Milks*—Class A.

The certified milks have a limit of 10,000 fixed by contract, and it is quite certain that any excessive count would be only temporary. Table V. gives the results obtained.

e) *General Considerations.*

The technique used for determining the bacterial content was the Committee's, except that the temperature of incubation was that of the room (21° C.) instead of 37° C., as recommended by them. My object in making this change is a feeling gained from a rather long experience that the number of bacteria growing into colonies at this lower temperature much more nearly corresponds to the total number present than when the incubation is at the body temperature. What I wanted in this particular study was to get the total number of bacteria present, as nearly as possible, since I hoped to detect and estimate quantitatively the fecal forms by other methods. Hence the numbers representing the total number of bacteria per c. c. is somewhat higher than that likely to be obtained by one who follows exactly the standard methods.

In this connection a phenomenon of much importance was observed which needs consideration here. It relates to the rate of growth of colonies of bacteria on plate cultures made from milks of varying degrees of purity. This is especially noticeable when the rate at which colonies develop from raw milks on agar plates is compared with the rate at which colonies develop on agar plates when seeded with pasteurized or certified milks.

It has no doubt been recognized before that the colonies on plates from highly contaminated milks appear before those on plates from the better grades of milk, but no cognizance of it seems to have been taken of the possibility of using this as a means of judging the quality of a milk. The following data illustrate the facts in the case:

TABLE VI.—RATE OF GROWTH OF MILK COLONIES ON AGAR AT 21° C.

Number and character of milk.	Upper figures give number of bacteria per c.c. Lower figures give percentage of total bacteria per c.c.				
	1st day	2nd day	4th day	5th day	6th day
143 Raw milk	4,000 3½%	89,000 74%	.....	113,000 94%	120,000 100%
144 Raw milk	175,000 83%	189,000 90%	.....	204,000 97%	210,000 100%
146 Pasteurized	0 0%	0 0%	14,000 40%	18,000 51%	35,000 100%
147 Inspected (very good milk)	0 0%	10,000 31%	21,000 65%	24,000 75%	32,000 100%

If these figures are plotted the following graph is obtained. Fig. 11. A similar set is shown in a graphical form in Fig. 12.

Since it would be too much of a burden to make daily counts over the greater part of a week, it seemed worth while to determine whether two counts would not be sufficient. Forty-eight hours seems to be the crucial time, and the following graph, constructed on counts made at the end of 48 hours and four days, gives the necessary data. (See Fig. 12.)

From these results presented in Table VI. and graphs, Figs. 11 and 12, it appears that it is possible to predicate the general characteristics of a milk by determining the rate of growth of its colonies on agar plates at 21° C. This phenomenon can be well brought out then by the following procedure:

Agar plates are inoculated with a suitable dilution of a milk of unknown character and incubated at room temperature, about 21° C. They should be counted daily, or at least after two and five days. The figures representing the percentage of colonies found on the second and other intermediate days are then determined by considering the fifth day as giving the total. In this way it is ascertained whether or not the percentage on the second or other intermediate days is greater or less than 50 %.

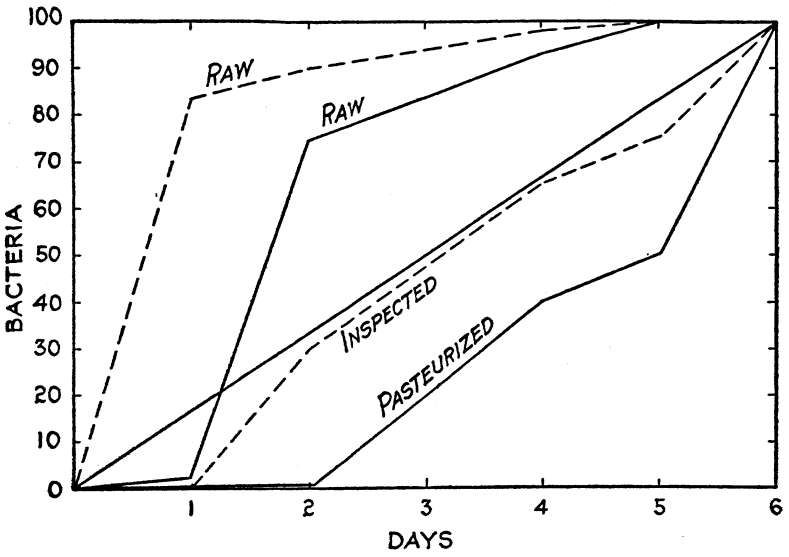


Fig. 11. Graph of rate of development of colonies in poor milk compared with good. Pasteurized milk heated at 145° F. for 30 min.

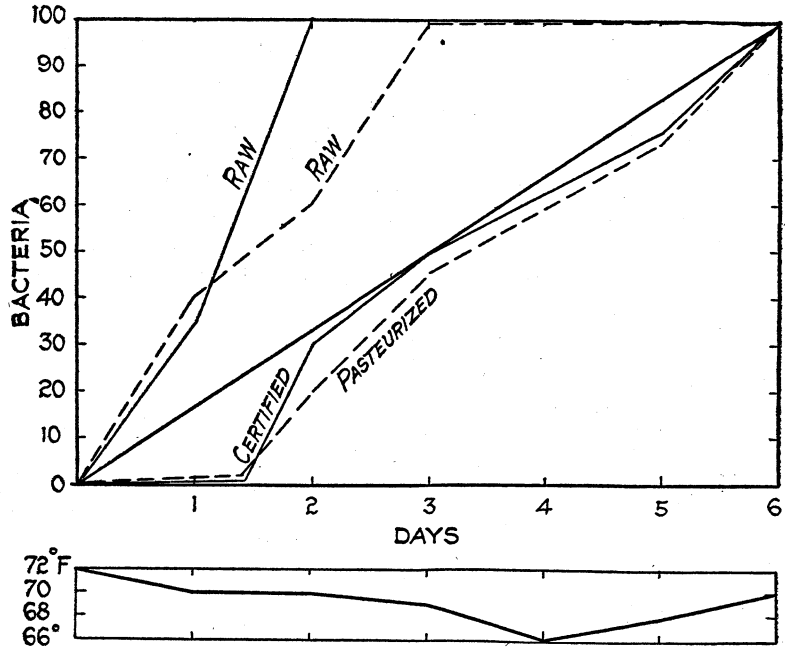


Fig. 12. Same as Fig. 11 except temperature chart is added.

The percentages obtained are plotted as ordinates, and the days as abscissae. In this way it will be found that the curves formed will fall below the diagonal, formed by drawing a line from 0 to 100%, on the last day in the case of pasteurized or certified milks, and that the curve will rise well above this diagonal in the case of raw or highly contaminated milks. It has not been possible so far to obtain similar results using a 37° C. temperature.

2. Gas Production in Lactose Media. (Table VII.) The Milk Commission,* states "pasteurized milk should not contain colon bacilli in 1 c. c. as determined by cultural methods." In some cities this criterion is being applied, as for example, in Washington, D. C. This organism has served a most useful purpose in water analysis, and there seems every reason to believe that tests for it may be of great service in milk work. Clean milk, as it exists in the udder of the cow, does not contain B. coli or other bacteria capable of fermenting lactose with gas production. Ayres and Johnson† find anaërobic bacteria in pasteurized milk which produce gas and which might be mistaken for B. coli in preliminary tests. If they are found in the milk after it is drawn, they must come from outside sources, and these must be the manure, the persons handling the milk, or the utensils with which the milk comes in contact.

The cleanliness of a milk could, in reality, be measured by the relative abundance of bacteria capable of producing gas in a lactose medium, or in other words, by the relative abundance of B. coli and its allies.

As to the cultural methods it seems likely that those employed for water will be found equally satisfactory for milk. Lactose peptone bile in fermentation tubes has been uniformly used in all analyses reported here. In a considerable number of instances a special medium neutral red milk broth, has also been used. An attempt too has been made to use Endo's medium. The methods or preparation of these media has already been considered, and the results obtained by their use are alone to be discussed here.

Some attempt was made to identify the organisms producing gas in the lactose media as B. coli by isolating in pure culture in lactose litmus agar, and then running through the fermentation

* Loc. cit.

† U. S. Dep't of Agr. Bu. An. Ind., Bull. 161, 1913, p. 60.

tube, determining the amount and the formula of the gas produced, by the action on milk and gelatin, and the production of indol. This work was not carried far, however, because of the time required and the fact that, to a considerable extent, it seemed unnecessary and of less value than other phases of the work. This supposition is based on the assumption that bacteria producing gas in lactose media are foreign to the best milk, and especially unnecessary in pasteurized milk.

In the poorer grades, belonging to the class "Raw milks," A_1, B_1 and C_1 (referring to Table VII.), gas was produced in 91% of the samples in 0.01 of a c. c. In the remaining cases the bacterial count was very low and such did not properly belong to this class. In 75% of the samples gas was produced in 0.001 of a c. c. Two of the non-fermenting samples, in this case also, were very low in bacteria. Hence it would seem fair to conclude that milks of the grade examined above; i. e., milks which are delivered to large pasteurizing plants, are likely to contain these lactose fermenters in 0.01 of a c. c., and in the majority of instances contain such organisms in 0.001 of a c.c. or, in other words, such milks may contain hundreds or even thousands of such organisms per c. c.

Milk belonging to this class, but of a better grade, as represented by E, F_1, $_2$, and $_3$, contain a fewer number of these bacteria. K and L are more like the first firoup, namely, A_1, B_1 and C_1, but are sold raw. Judged from the standpoint of the number of gas bacteria, however, they are better milks.

If we turn now to the better grades of raw milks we see that the gas-producing bacteria, in inspected milks, are less numerous, occurring in 1 c. c. portions in 100% of the samples in A_5, A_6, and B_4, and in 27% of the cases in 0.01 of a c. c. portion.

In the remaining groups of Table VII. the total bacterial content indicates them to be of better quality. B_2, C_3, D, G, and M_1 have a much lower percentage of gas-producing bacteria.

Turning again to the certified milks we see that colon-like bacilli are rarely present in 1 c. c. lots, and are never present in a fraction of a c. c.

It appears, then, that the raw milk of Boston contains large numbers of bacteria capable of producing gas in lactose media, i. e., bacteria belonging to the colon group, in considerable numbers in ordinary raw milk (Grade D), fewer numbers in the in-

TABLE VII. GAS FORMATION IN LACTOSE PEPTONE BILE AND COLI-LIKE ORGANISMS ON ENDO'S MEDIUM.

Source.	Raw. Gas in lact. pep. bile. 1/100	1/1000	1/10000	Coli-like colonies on Endo medium.
A_1	+	−	−	−
A_1	+	+	−	−
A_1	+	+	−	Several
A_1	+	+	−	Numerous
A_1	+	0	−	−
A_1	+	+	−	Several
	100%	80%		
B_1	+	+	−	
B_1	+	+	−	Numerous
B_1	+	+	−	−
B_1	0	0	0	−
B_1	+	+	−	Numerous
B_1	+	+	0	Numerous
B_1	+	0	+	−
	86%	71%		
C_1	+	+	−	Several
C_1	+	+	−	Several
C_1	+	+	−	Several
C_1	+	+	−	Several
C_1	0	0	−	0
C_1	+	0	−	Numerous
C_1	+	+	−	Numerous
C_1	+	+	−	Numerous
	87%	75%		

Source.	Pasteurized. Gas in lact. pep. bile. 1 c. c.	1/10	1/100	Coli-like colonies on Endo medium.
A_2	+	−	0	−
A_2	0	−	0	−
A_2	0	−	0	0
A_2	0	−	0	−
A_2	+	−	0	−
A_2	+	−	0	Several
	50%	−	0%	
B_2	+	−	0	−
B_2	+	0	−	Several
B_2	+	−	0	Several
B_2	+	−	0	Several
B_2	+	−	0	Several
B_2	+	+	0	Several
	100%	50%	0%	
C_2	+	−	+	−
C_2	+	−	−	Num'r'us
C_2	+	−	+	Num'r'us
C_2	+	+	−	Several
C_2	+	+	+	Num'r'us
C_2	+	+	+	Num'r'us
C_2	+	+	+	Num'r'us
C_2	+	−	+	Num'r'us
	100%	100%	100%	

Source.	Inspected. Gas in lact. pep. bile. 1 c. c.	1/100	1/1000	Coli-like colonies on Endo medium.
A_5	+	+	0	−
A_5	+	+	+	Num'r'us
A_5	+	0	0	A few
A_5	−	0	0	−
A_5	−	0	0	0
	60%	40%	20%	
A_6	−	+	+	Several
B_3	+	0	−	−
B_3	+	0	−	Few
B_3	0	0	−	−
B_3	0	0	−	−
B_3	+	0	−	Several
B_3	0	−	−	Doubtful
B_3	+	0	0	−
	57%	0	0	
B_4	+	−	−	Several
B_4	+	0	−	−
B_4	+	0	−	Few
B_4	+	0	−	Several
B_4	(1/10)+	−	−	Several
B_4	+	−	0	−
	100%	40%	0	

Source.	Certified. Gas in lact. pep. bile 1 c. c.	1/10	1/100	Coli-like colonies on Endo-medium.
B_5	0		0	
B_5	0	−	0	Sterile
B_5	0	−	0	
B_5	0	0	−	0
B_5	0	−	0	0
B_5	0	0	−	
B_5	0	0	−	0
	0%	0%	0%	
B_6	0	0	0	−
B_6	?	?	?	−
B_6	+	0	0	−
	33%	?	?	
H_1	+	+	−	−
H_1	+	+	0	−
H_1	0	0	0	
	66%	66%	0%	
H_2	+	+	0	−
H_2	0	0	0	−
H_2	0	0	0	
J	33%	33%	0	

TABLE VII. GAS FORMATION IN LACTOSE PEPTONE BILE AND COLI-LIKE ORGANISMS ON ENDO'S MEDIUM.

Source.	Raw. Gas in lact. pep. bile. 1/100	1/1000	1/10000	Coli-like colonies on Endo medium.
E	—	0	0	
	0(1/10)	0	—	
	0%	0%		
F_1	0(1/10)	0	—	Few
F_1	+(1/10)	0	—	Few
F_1	+(1 c.c)	0	—	Few
F_2	0(1/10)	0	—	Few
F_2	+(1 c.c)	0	—	0
F_2	+(1 c.c)	0	—	Few
F_3	+(1/10)	0	—	Few
F_3	+(1/10)	0	—	Few
F_3	+(1 c.c)	0	—	Few
	0%	0%	—	Few
K	+(1 c.c)	0	—	—
K	0+	—	+	—
K	+	+	—	—
K	+	+	—	—
	75%	66%		
L	0	0	0	—
L	+	+	0	—
L	+	+	0	—
	66%	66%		

Source.	Pasteurized. Gas in lact. pep. bile. 1 c. c.	1/10	1/100	Coli-like colonies on Endo medium.
A_3	0	—	0	
A_3	0	—	0	
A_3	0	—	0	0
A_3	0	—	0	0
A_3	0	—	0	0
	0%	—	0%	
A_4	0	—	0	—
A_4	0	—	0	—
A_4	0	—	0	0
A_4	0	—	0	0
A_4	+	—	0	—
A_4	0	—	0	—
A_4	0	—	0	0
A_4	0	—	0	0
A_4	0	—	0	—
	11%	—	0%	
M_2	0	0	—	—
M_2	0	0	—	—
M_2	0	0	—	
M_2	0	0	—	
	0%	0%	0%	

Source.	Inspected. Gas in lact. pep. bile. 1 c. c.	1/100	1/1000	Coli-like colonies on Endo medium.
C_3	0	0	—	0
C_3	0	0	—	0
C_3	0	0	—	Few
	0	0		
D_3	(1/10) +	—	—	—
D_3	(1/10) 0	—	—	—
D_3	+	+	—	—
	66%	33%		
G	0	—	0	—
G	0	0	—	—
G	0	0	—	—
G	0	0	—	—
G	0	0	—	—
G	0	0	—	—
	0%	0%	0%	

Source	Certified. Gas in lact. pep. bile 1 c. c.	1/10	1/100	Coli-like colonies on Endo medium.
J	0	0	—	—
J	?	?	0	—
J	?	0	0	—
	?	?	0	
J_1	0	0	—	—
J_1	0	0	0	—
J_1	+	+	·	
	33%	33%	0%	
J_2	0	0	—	—
J_2	0	0	0	—
J_2	0	0	0	
	0%	0%	0%	

spected grade (B), and that the certified milks are practically free from such organisms in 1 c. c. lots.

The pasteurized milks, A_2, B_2 and C_2 (Table VII.), produced gas, when 1 c. c. of the milk was added to the lactose medium, in 83% of the cases, and in 25% of the cases in 0.01 c. c. portions In certain supplies, as C_2, it is unfortunate that greater dilutions were not planted, since it is quite likely that there might have been quite as many lactose fermenters in the pasteurized as in the raw milk. (C_1).

In milks pasteurized in the bottle, A_3, A_4, M_2, these bacteria are practically absent in 1 c. c. portions.

3. The Value of Endo's Medium in Milk Work. Endo plates were made in a majority of the analyses considered in this investigation. The methods employed have already been discussed and it is necessary here to consider the findings only. It was difficult at times to correlate these findings with the data obtained from the fermentation tubes. The greatest difficulty and indefiniteness come in the better grades of milk, where it was necessary to introduce 1 c. c. of the milk into a Petri dish In these cases the opacity produced by the milk made the resulting growth less characteristic. In recording results no attempt was made to give actual counts, because of the frequent appearance of red colonies (not B. coli) in certain of the samples. The terms "few" "several," and "numerous," have been used instead. (See Tables I.-IV. and VII.) It will be noticed that in the raw milk (Table VII.), where there are many gas producers, there are always several or numerous coli-like colonies on the Endo plates, as for example, in A_1, B_1, and C_1. In those samples where fermentation occurs in large quantities of the milk (1 c. c.) only, as F_4, $_2$, and $_3$, there are also few coli-like colonies on the Endo plates. In the inspected milks (Table VII.) there is a rather close correspondence between the abundance of gas-producers in lactose peptone bile, and the red colonies on the Endo medium.

In the certified milks the tests were the same as those obtained by the use of lactose peptone bile or in the fermentation-tube method. Table VI. of pasteurized milks also shows that similar results were obtained by both methods. In milks pasteurized in bulk, A_2, B_2, and C_2, coli-like organisms appear in each

method. In milks pasteurized in the bottle, A_3 and A_4, all the plates made remained sterile, which was in correspondence with the fermentation-tube tests.

It seems that there is quite a close resemblance between the results obtained in test for B. coli by the Endo plate method, and the lactose petoone bile. Ayres and Johnson* find that there are anaërobic bacteria in milk, which resists pasteurization that give gas in the bile fermentation tests which might be confused with B. coli, and suggest that where B. coli tests are used to control pasteurization that complete cultural determinations be made of suspected colon forms.

The simultaneous use of lactose bile and Endo's medium would be strong evidence of B. coli in case a positive result was obtained in each, and would enable one to arrive at a definite opinion considerably sooner than would be possible if it were necessary to test out all gas formers found in lactose bile. The particular difficulties come in the use of this medium due to the troublesomeness of its preparation, and difficulty of using relatively large amounts of milk (1 c. c.).

4. BACT. WELCHII. Savage† has suggested that Bact. Welchii (*B. enteritidis sporogenes*) is of importance in that it is a valuable means of measuring the manurial pollution of milk, since the spores of this organism are prevalent in manure and in dust, while they are absent from milk collected under conditions of great cleanliness. Accepting this as a statement of fact, it seemed that this organism might be a measure not only of the cleanliness of raw milks, but it may also be used in the case of pasteurized milks to indicate the original character of the milk before being heated. In other words, it seemed as if we might have in this organism a means of judging the original character of the raw milk by examining the pasteurized milk. Savage‡ has also suggested a quantitative method of estimation. A modification of Savage's outfit has been described above (see p. 1320), and was used throughout this investigation.

The method used of recording results is that suggested by Savage, and is as follows: Twenty c. c. of the milk, having been

* Ayers and Johnson: A Study of the Bacteria Which Survive Pasteurization". Gov't. Printing Office, Wash., 1913, p. 60.
† Savage: Milk and the Public Health. The Macmillan Co., 1912.
‡ Ibid., p. 189.

TABLE VIII. BACTERIUM WELCHII IN VARIOUS GRADES OF MILK.

Raw.		Pasteurized.		Inspected.		Certified.	
Source.	Bact. Welchii.	Source.	Bact. Welchii.	Source.	Bact. Welchii.	Source.	Bact. Welchii.
A_1	0	A_2	0	A_5	0	B_5	0
A_1	2	A_2	0	A_5	1	B_5	0
A_1	0	A_2	0	A_5	1	B_5	0
A_1	3	A_2	1	A_5	0	B_5	0
A_1	0	A_2	0	A_5	8 ?	B_5	0
A_1	10	A_2	10	A_5	2	B_5	0
	2.5		2	A_5	1	B_5	0
B_1	+	B_2	?		1.8		0
B_1	0	B_2	1	B_3	0	B_6	0
B_1	0	B_2	0	B_3	0	B_6	0
B_1	5	B_2	6	B_3	0	B_6	0
B_1	7	B_2	4	B_3	0	B_6	0
B_1	0	B_2	6	B_3	10		
B_1	10			B_3	0		0
	3.1		3	B_3	2		
C_1	10	C_2	4		1.7	H_1	0
C_1	8	C_2	8			H_1	0
C_1	3	C_2	8	B_4	3	H_1	0
C_1	1	C_2	2	B_4	4		0
C_1	3	C_2	8	B_4	0		
C_1	10	C_2	8	B_4	10	H_2	1
C_1	10	C_2	6	B_4	0	H_2	0
C_1	10	C_2	6	B_4	—	H_2	0
	7		6.2		3.4		½
E	0	A_3	0	C_3	0	I	0
E	0	A_3	0	C_3	0	I	0
		A_3	0	C_3	0	I	0
F_1	0	A_3	1				
F_1	0	A_3	2		0		0
	0		0.6	D	3	J_1	0
				D	2	J_1	0
F_2	0	A_4	0	D	1	J_1	0
F_2	0	A_4	0				
F_2	0	A_4	1		2		0
		A_4	2				
	0	A_4	0	G	0	J_2	0
		A_4	0	G	0	J_2	0
F_3	0	A_4	3	G	0	J_2	0
F_3	7	A_4	—	G	0		
F_3	1	A_4	0	G	1		0
F_3	1			G	0		
			0.7	G	0		
	2.2				0.14		
		M_2	1				
K	1	M_2	0				
K	1	M_2	2				
K	0	M_2	2				
K	2						
			1.2				
	1						
L	7						
L	2						
L	10						
	6.3						

equally divided among the ten small test-tubes, is put under anaërobic conditions, and incubated for 48 hours. The tubes showing the characteristic reaction are counted. If all of the tubes are positive, the result is recorded as 10. All gradations between 0 and 10 will be encountered.

Turning now to the results obtained in this investigation (see Table VIII,) the raw milks used for pasteurization in the bulk nearly always contained the organism under discussion, the number ranging from 0 to 10. The average for the three supplies were 2.5, 3.1, and 7, respectively. Raw milks produced for direct consumption were much less frequently and less heavily infected. The milks supplied to a small town, F_1 and F_2, proved to be free from this germ, but F_3, which is a bottling concern is infected in three out of five samples. Milks K and L, which had a high count, likewise have Bact. Welchii present.

Inspected milks, are especially free, but occasionally, and especially the poorer grades, do contain these germs. The number varies from 1.7 to 3.4. The better grades of this class, and all of the certified milks are free from Bact. Welchii.

In pasteurized milks the germ under discussion appears in practically the same frequency with which it occurs in the raw milk which has been treated. A_2, B_2, C_2, show averages of 2, 3 and 6.2, while 2.5, 3.1 and 7 are the averages of the raw milks (A_1, B_1 and C_1). The milks pasteurized in the bottle (A_3, and A_4,) have averages of 0.6 and 0.7, while these same milks in the raw condition (A_5) contain 1.8.

There seems to be quite a striking correspondence between the distribution of Bact. Welchii and the lactose fermenters (coli-aërogenes group.) This organism is rarely found, and apparently never in any quantity in raw milks unless the coli-like organisms are also present in considerable quantities. Positive tests for both of these organisms is quite conclusive proof of manurial contamination. If only a single test could be made on a milk a positive reaction of this organism would indicate more serious contamination than the presence of B. coli.

In pasteurized milk this organism may be present in considerable quantity and B. coli may be absent. This would mean that the original milk was badly contaminated, but that the pasteurizing process had been well carried out.

It seems then that this test is capable of being used to a very

good purpose in the control of pasteurization, and merits further study.

This work seems to confirm the good opinion which Savage expresses of it.

5. Spores or Heat-Resistant Forms. The various grades of milk probably contain different proportions of spores. One would suppose that the best grades would contain very few spores—that the more careless the operation of milking and handling, the greater the number of spores it would contain. These would come largely from dust and manure. Providing all milk was immediately cooled and kept cool, the care in milking could be quite accurately judged by the proportion of spores present.

If milk stands for some time, and especially at temperatures at which bacteria can grow rapidly, spores originally present would germinate and others would probably be formed so that no general law could be formulated, and their estimation would be of little value. Whatever their genesis, however, spores of bacteria in milk would not be found in any quantity in the very good milks properly kept. While milks with a high initial contamination, or milks which are not properly kept, would contain very many spores.

Furthermore, it is quite evident that if milks used for pasteurization contain a large number of spores it would be impossible to produce a pasteurized product from such milks with a low bacterial content.

The efficiency of pasteurization is now determined by ascertaining the percentage of original bacteria which are killed during the process. This method is, however, unsatisfactory, since it places a premium on highly contaminated raw milks, as it is easier to get a higher percentage of efficiency with them than with good milks. Bearing on this point, the following quotation from Ayres and Johnson* is made: "Percentage bacterial reduction is of no value in determining the efficiency of the process of pasteurization. As a general rule when the bacterial content of raw milk is high there will be a high percentage reduction. When the bacterial content is low, then the percentage reduction is often low. The percentage reduction may be 99.9 per cent and

* Ayers and Johnson: A Study of the Bacteria Which Survive Pasteurization. Gov't. Printing Office, Wash., p. 58.

TABLE IX.—SPORES OR RESISTANT FORMS IN VARIOUS GRADES OF MILK.

Raw.		Pasteurized.		Inspected.		Certified.	
Source	Spores	Source	Spores	Source	Spores	Source	Spores
A_1	3,000	A_2	2,500	A_5	3.080	B_5	.....
A_1	1,900	A_2	4,300	A_5	23.400	B_5	0
A_1	14,000	A_2	11,200	A_5	.....	B_5	0
A_1	6,000	A_2	4,800	A_5	36,000	B_5	100
A_1	5,000	A_2	16,000	A_5	2,400	B_5	0
A_1	43,900	A_2	33,000			B_5	50
	13,100		11,700		16,200	B_5	50
				A_6	40,000	B_5	0
						B_5	30
B_1	.....	B_2	.....			B_5	17,800
B_1	13,400	B_2	4,300			B_6	1,600
B_1	4,750	B_2	21,000			B_6	11,000
B_1	0	B_2	21,000				
B_1	1,600	B_2	10,100				10,700
B_1	3,000	B_2	64,000				
B_1	3,300				0	H_1	1,200
			20,000	B_3	5,250	H_1	100
	4,340			B_3	600	H_1	1,400
		C_2	4,000	B_3	800		
C_1	2,700	C_2	2,800	B_3	1,200		960
C_1	1,800	C_2	4,800	B_3	2,700		
C_1	2,300	C_2	10,000	B_3	300	H_2	27,000
C_1	27,000	C_2	49,000			H_2	50
C_1	5,000	C_2	126,000		1,550	H_2	200
C_1	26,300	C_2	47,200				
C_1	21,400	C_2	78,000	B_4	47,000		920
C_1	27,700			B_4	26,500		
			40,200	B_4	7.000		
	14,270			B_4	24,500		
		A_3	500	B_4	8,400		
E	27,000	A_3	2,730	B_4	8,500		
E	2,500	A_3	15,120				
		A_3	4,000		20,600		
	14,750	A_3	15,350				
			7,540	C_3	28,600		
F_1	.....			C_3	7,000		
F_1	1,000	A_4	2,500	C_3	39,000		
F_1	100	A_4	2,100			I	0
F_1	550	A_4	9,800		24,800	I	150
F_1	15,750	A_4	4,800	D	400	I	300
F_2	600	A_4	16,000	D	800		
F_2	400	A_4	10,800	D	250		150
		A_4	9,100				
	5,600	A_4	3,000		480	J_1	0
			13,000			J_1	100
F_3	6,500			G	100	J_1	300
F_3	1,050		7,900	G	96		
F_3	100			G	.....		130
F_3	350	M_2	1,300	G	120		
	2,000	M_2	800	G	0	J_2	0
		M_2	2,600	G	400	J_2	250
K	2,250	M_2	2,600	G	.....	J_2	100
K	1,500						
K	1,400		1,675		144		115
K	200						
	1,337						
L	200						
L	6,200						
	3,200						

yet the pasteurized milk may show a count of 100,000 per cubic centimeter. When pasteurized milk contains only 10,000 bacteria per cubic centimeter the percentage reduction may only have been 95 per cent. It is often impossible to obtain a 99 per cent. reduction when a good quality of milk is pasteurized, therefore, regulations which require a 99 per cent. reduction of bacteria during pasteurization are of no value." Following these theoretical considerations it will be of interest to notice the results which were obtained in this study. Before doing so, however, it will be desirable to explain that while the forms under discussion are headed spores, that some and perhaps at times many of the forms thus grouped are not spore-forming. A better term than "spores", to use in this connection, would be "heat-resisting forms." Occasional attempts to determine the presence of spores in cultures from plates obtained directly from the milk have showed that some ten of the twelve or more forms examined were, however, spore-bearing. At first it was considered necessary only to heat a few c. c. of the milk in test tubes to 80° C. for 10 minutes. Lest, however, a scum should be formed, which Theobald Smith, and Russell and Hastings, and others have shown will protect the contained bacteria from the usual effects of the heat, dilutions of the milk, 1–100, were used. One cc. of this heated dilution was then plated in duplicate and allowed to grow from 6 to 8 days at room temperature. This long period of incubation having been found necessary.

Turning now to Table IX. it is seen that the raw material milks contain a considerable number of heat-resisting forms. In a general way the higher the bacterial content the higher the average spore count, and vice versa. If there is a low bacterial count comparatively few highly resistant forms will be formed. There are, however, some glaring exceptions for which there is no data to furnish an explanation.

The inspected milks have a comparatively large number of heat-resisting forms, larger even on the average than the raw market milks, the only explanation of which seems to be that these milks have in all probability been kept cooler, and that the figures obtained represent the original spore content more nearly than those of the market milk do, where there has presumably been more opportunity for the spores to germinate.

The certified milks invariably have a very low spore content.

Turning now to the pasteurized milks, it will be noted that they all have a higher spore content than any of the raw milks. They have, in other words, not only the resistant forms of the original milk, but in addition the forms that they have picked up on the way through the plant. The less perfect the sterilization process, the more of these resistant forms there are likely to be.

The estimation of spores would apparently give data which would indicate two things, namely, that there are in all milks a certain number of spores, or high heat-resistant forms, which serve as the lower limit of purification by pasteurization, as a goal towards which the dealer must strive, but which he may never hope to reach with the prevailing low temperature, and quite likely it is best that he should not. Secondly, they may be a good indication of the sterility and cleanliness of the plant. It seems quite possible that the bacterial content of commercially pasteurized milks may be raised a considerable amount by the presence of large numbers of these heat-resistant forms in the poorly sterilized tanks, pipes, and other utensils of the plant.

6. THE CHARACTER OF THE CURD AT 37° C. During the course of this investigation my attention was called to the work of Klein and Campbell* on, "The Use of the Fermentation Test in Dairy Inspection." Following the work of Walter, Peter and others, they suggest a classification of curds which may be briefly summarized thus:

1. Jelly-like curd. Solid jelly-like curd. Solid, smooth and white. Lactic acid curd.
   - J 1. With no fluid.
   - J 2. Showing very few furrows or gas holes.
   - J 3. Furrows, gas holes or cracks with some fluid.

2. Peptonized curd. May be hard, contracted, and in one or several pieces, or soft, flocculent and mushy, with more or less fluid that is entirely clear, but may have a greenish or whitish tinge.
   - P 1. Amount of fluid is small in proportion to size of curd.
   - P 2. Increased amount of fluid.
   - P 3. Amount of fluid large in proportion to curd.

3. Gaseous curd. White, jelly-like curd, showing small holes due to gas formation and in the higher degree presenting a sponge-like appearance; more or less fluid present, which may also show collection of gas bubbles.
   - G 1. Gas holes in the cream layer or in the curd.
   - G 2. Gas holes, numerous in cream and curd, and may be in fluid.
   - G 3. Curd, sponge-like, containing many gas holes, and may be split, and a portion driven to the top, gas bubbles in the fluid.

---

* Am. Vet. Rev., 1912, Oct., p. 25.

4. Flaky or Flocculent Curd. Curd in flakes associated with a turbid fluid which may be whitish, yellowish or otherwise discolored.

F 1. Curd in fine flakes or partially homogeneous.
F 2. Large flakes and considerable fluid.
F 3. Large flakes, torn and white or discolored fluid.

A considerable number of the milks were put in large test-tubes or oil-somple bottles, containing about 50 c. c. put at 37° C. and examined at from 12 to 16 hours later, and finally after two or three days.

The following records were made:—

TABLE XI — CHARACTER OF CURDS FORMED BY DIFFERENT GRADES OF MILK AT 37° C.

No.	Grade D. Raw.	Grade C. Pasteurized.	Grade B. Inspected.	Grade A. Certified.
159	J3–J3			
160		P2–P3		
161			P3-P3	
162				O-J1
163			O-G1	
167	J1-J1	P -P		
168		P2-P2		
169			J2-G1	
170			P2-P2	
171				O-J2
177	J1–J2			
178		J1-J2		
179				O-J1
180			P–J1	
181			P1-G2	
182	P2–F2			
183	J1–J2			
184		J1-J3		
185		J1-J3		
186			P1-F1	
188	J1–J2			
189	J2-J2			
190		J2-J2		
191		J2-J2		
192	P2			
193		J1		
194				O-J2
195			G1	
196			J1	
197				O-G1
198				O-G2
199				O-G1
200				O-P1
201				O-P3
202				O-P2
203				O-P3
204				O-P2
206				O-P2
207			O-J2	
208		O-P2		
209			O-J1	
210	J1-J1			
214			G2–G2	
215			O -P2	
216	J1-J1			
217	J1-J1			
218	J1–J3			
219		J1-J2		
220			J1–J1	
221			O-F2	
222				O-P3
230			O-P1	
244	J1-J2			
250			-P1	
251	J2			
254			J1	
255		P2	O-G1	
256	P-			

Key:
J = Jelly-like curd.
F = Flocculent "
P = Peptonized "
G = Gaseous "

TABLE XII.—SUMMARY OF CURDS FORMED IN VARIOUS GRADES OF MILK.

	−18 hrs.	+48 hrs.
RAW MILKS—Number tested 17		
No curd	0	0
J1 "	9	4
J2 "	1	6
J3 "	1	2
P2 "	1	2
F2 "		1
PASTEURIZED MILK—Number tested 12		
	−18 hrs.	+48 hrs.
No curd	2	0
J1 "	5	0
J2 "	2	4
J3 "	0	3
P2 "	2	2
P3 "	0	2
G1 "	0	1
INSPECTED MILKS—Number tested 19		
	−18 hrs.	+18 hrs.
No curd	8	0
J1 "	1	5
J2 "	1	1
P1 "	2	2
P2 "	1	2
P3 "	1	1
G1 "	0	3
G2 "	1	3
F "	0	2
CERTIFIED MILKS—Number tested 14		
	−18 hrs.	+48 hrs.
No curd	14	0
J1 "	0	2
J2 "	0	2
P1 "	0	1
P2 "	0	3
P3 "	0	3
G1 "	0	2
G2 "	0	1

As shown in the above tables (XI. and XII.) all of the seventeen samples of raw milk examined curdled in less than 18 hours and in nearly all cases the curd formed was of the lactic acid type. In the pasteurized milks, two out of twelve, remained fluid for 18 hours but otherwise the character of the curds was not much different from that of the raw milks. In the case of the inspected milks, nineteen samples, eight remained fluid for eighteen hours or over. The character of the curd varied more than in the previously considered classes with more P. and G. than J. curds. All of the certified milks remained fluid for more than 18 hours and the P. and G. curds were considerably in excess of the J. curds.

IV. EXPERIMENTAL PASTEURIZATION.

From the results which have just been discussed, especially in testing for B. coli in pasteurized milk, it seemed necessary to undertake some pasteurization experiments where the conditions could be accurately controlled. For this work a specially constructed water-bath has been used. This consists of a bath containing about 10 liters of water, fitted with a Roux thermoregulator, and a standardized thermometer, and also provided with a mechanical stirrer in the shape of a fan or paddle wheel run by a small electric motor. The milk was pasteurized either in test-tubes or in bottles. When the test-tubes were used, some of them were stoppered with cotton plugs, but in these cases duplicates were always made in test-tubes closed with rubber stoppers. The bottles were either pint milk bottles, closed with the ordinary paper cap, eight ounce bottles fitted with a perforated rubber cork containing a thermometer, or oil sample-bottles which were fitted with a screw cap. In the test-tube experiments only a few centimeters of milk were placed in the bottom of the tube, and care was taken to immerse the test-tube in the water-bath as low as possible. Some of the bottles were immersed entirely; in other cases only up to the caps, but not over them.

The results obtained are shown in the following table (XIII).

TABLE XIII.—EXPERIMENTAL PASTEURIZATION.

No.	Source.	Bacteria per c.c.	B. coli added after making counts in such numbers that the unheated milk would contain at least 1000 b. coli per c. c.	Time and Temp.	Bacteria per c. c.	Fermentation lactose bile.		
						1 c. c.	1/10 c.c.	1/100 c. c.
Market milks						%	%	%
226	K	5,265,000		145 22	69,500	0	0	.....
226	K	5,265,000		145 22	35,700	0	0	.....
226	K	5,265,000		145 22	47,000	52	0	.....
226	K	5,265,000		145 22	43,000	40	0	.....
228	K	11,825,000		145 30	577,500	0	.....	0
228	K	11,825,000		145 30	680,000	0	.....	0
233	K	2,075,000		145 30	34,000	0	.....	0
233	K	2,075,000		145 30	47,600	0	.....	0
248	K	200,000		145 20	7,000	0	0	.....
234	L	1,370,000		145 20	1,000	0	.....	0
234	L	1,370,000		145 20	800	0	.....	0
235	L	6,450,000		145 20	49,000	15	0	.....
235	L	6,450,000		145 20	44,000	0	.....	0
245	L	1,360,000		145 20	11,000	70	0	.....
245	L	1,360,000		145 20	7,000	70	65	.....
257	L	6,000,000		145 20	24,000	15	0	0
257	L	6,000,000		145 20	37,000	0	0	0
268	L	11,750,000		145 20	77,000	25	0	0
272	L	3,525,000		145 20	37,000	60	70	0
Inspected milks								
266	N	23,000		145 20	4,350	0	0	0
270	N	16,000		145 20	3,800	60	60	70
326	N	500,000		145 20	1,400	0	0	0

From the above table it appears that is is not always possible to pasteurize milk, at the temperature and time used, when it is heavily seeded with B. coli, so that one c. c. will not ferment lactose.

That lactose fermenters may not always be B. coli has already been discussed (see p. 1345). The high per cent of gas especially in fractions of a c. c. are to be regarded as due to some anaërobe and not as B. coli.

V. SUMMARY AND CONCLUSIONS.

A collecting case for carrying milk samples of 120 c. c. capacity is described.

A study of the loss of volume during sterilization in the autoclave reveals the fact that in the case of water blanks the loss varies from 1 to 8 per cent; that the loss varies with the autoclave; that the loss can be prevented by closing the autoclave up cold and not permitting the escape of steam, and that the insufficiency of sterilization in this way can be avoided by running the material to be sterilized a second time. The use of caps of paraffined paper is suggested on water blanks to prevent evaporation. In making dilutions and shaking them it is recommended that the sterile paper cap be placed over the neck of the bottle and forced in place with a cork which is suggested for use instead of the usual cotton plug.

A study of pipettes leads to certain suggestions in regard to form and methods of cleaning.

A new piece of apparatus is described to be known as the "Mechanical volumetric pipette" or "pipettometer." This makes the accurate measurement of fractions of a cubic centimeter, with an ungraduated pipette, easily possible. It possesses other advantages over the ordinary pipette used in bacteriological work. It will also be found useful in graduating pipettes.

A study of Schroeder's ring method shows it to be considerably less accurate than the ordinary methods, and on this account unworthy of general adoption.

Reasons for the use of an incubation temperature of 21° C. instead of 37° C. are suggested.

A new form of apparatus for counting colonies is described.

In tests for B. coli in milk a new medium (neutral red milk broth) is described; a comparison of the Smith and Durham fermentation tubes is made, and a simple form of gasometer for the latter is suggested.

Endo's medium is discussed as a means of detecting B. coli in milk as well as certain phases of its manufacture.

A new method of determining the thermal death-point of bac-

teria, in connection with the "pipettometer" is described, and the results for B. coli in milk are discussed.

A study of the inhibiting action of milk on the amount of gas produced in the fermentation tube, when compared with results obtained in ordinary lactose media, shows that while this reaction is pronounced in the case of milk that it does not apparently modify the results when a cubic centimeter or less of milk is added to a fermentation tube of other lactose medium.

A modified form of a common test for the streptococci in milk, other than those of sour milk, is suggested, together with experimental data of its value.

A modification of Savage's method for a quantitative test for Bact. Welchii is described.

A description of a new form of fermentation tube is given. This tube collects the gas from a constant amount of the medium and is especially useful in the study of anaërobes, and was used to test out certain doubtful cultures of Bact. Welchii.

Thirty samples of certified milks were analyzed from eight different sources.

Thirty-two samples of inspected milks were examined from seven different sources.

Thirty-seven samples of pasteurized milks were studied from six different sources.

Forty-two samples of raw milk were tested from ten different sources.

On all of the samples the following tests were made: 1) Total number of bacteria growing at 21° C.; 2) gas production in lactose media; 3) Bact. Welchii, quantitative; 4) spores or bacteria resisting heat at 80° C. for 10 minutes.

On part of the samples the following additional tests were run: 5) streptococci; 6) character of the curd at 38° C.

The analyses of these milks under winter conditions, presumably the most favorable for both producer and consumer, show that the raw milks have a bacterial content ranging from 30,000 to 14,400,000 per c. c. The average count of milks sold in a raw state was found to be approximately 2,000,000 per c. c.; the average count of raw milks to be pasteurized in bulk was practically the same, while the average count for the milks to be pasteurized in bottles was 532,000 per c. c. The inspected milks have an average count of 159,560 per c. c. and the certified milks of approximately 20,000.

Bacteria fermenting lactose with the formation of gas—colon-like bacilli—were found to be distributed in the various grades of milk as follows:

Raw milks	gas in	83%	of 1/100	c. c. sample
Raw milks	gas in	71%	of 1/1000	c. c. sample
Inspected milks	gas in	54%	of 1	c. c. sample
Inspected milks	gas in	30%	of 1/100	c. c. sample
Certified milks		0%	of 1	c. c. sample
Pasteurized in bulk,	gas in	83%	of 1	c. c. sample
Pasteurized in bulk,	gas in	25%	of 1/100	c. c. sample
Pasteurized in bottle,	gas in	4%	of 1	c. c. sample
Pasteurized in bottle,	gas in	0%	of 1/100	c. c. sample

Endo's medium was found to be only fairly satisfactory as a means of detecting colon-like organisms in milk, especially where as much as 1 cubic centimeter of milk needs to be used. Endo plates run with fermentation-tube test obviate the possibility of confusing coli with anaërobic bacteria capable of fermenting lactose, since such organisms do not grow similar to B. coli on the Endo plates.

Bact. Welchii was found to be present in considerable numbers in raw milks, 3.2 being the average number found to each 20 c. c. It was found with practically equal frequency in pasteurized milks, less frequently in inspected milks, and rarely if ever in certified. Apparently one such spore per 20 cubic centimeters of milk is of little significance, but a greater number, such as three or four per c. c. would seem to be a good indication that a milk is rather seriously contaminated. The presence of this germ in considerable quantities in pasteurized milk is apparently a good indication that the milk used for the purpose of pasteurization is seriously contaminated. This method seems, then, to be especially useful where a pasteurized milk is under investigation whose condition in a raw state was unknown. On this account, and for this purpose, the use of this method merits further study.

The number of spores, or those forms capable of resisting a temperature of 80° C. for ten minutes, furnishes data of value in connection with the other facts in regard to a particular milk, e. g., a raw milk having a high total count and a low spore count has probably not been kept at a temperature sufficiently low, or if it has been kept at a low temperature, not for a long enough time to allow germination and growth; a high spore count in a pasteurized milk indicates either a poor raw milk, a low pasteurizing temperature, or a contamination with heat-resisting forms

after pasteurization, a condition frequently obtaining in pasteurizing plants at the present time. Certified milk and good inspected milks have surprisingly few spore forms.

The rate at which colonies on agar plates, incubated at 21° C., develop, may be used to differentiate different grades of milk. The bacteria from raw market milks grow out much faster than do the bacteria in pasteurized or certified milks.

The character of the curd produced by milks of the various classes at 37° C. was studied. The raw milks all promptly formed lactic acid curds. The same was true of the pasteurized milks. The inspected and certified milks more frequently formed sweet or gaseous curds.

A number of milks were heavily seeded with B. coli and then pasteurized at 60° C. for 20 minutes. By this procedure it was found impossible to always kill all of the B. coli present.

I desire to express my indebtedness to Dr. M. J. Rosenau who has been ever ready with suggestions and encouragement, and who has followed the progress of this work with interest and appreciation; to the Boston Milk and Baby Hygiene Association for their liberality and foresight in providing a fellowship under which this work has been done; and to Drs. L. E. Poole and A. D. Browne, and Mr. John Foley, for assistance at various times.

LIST OF OFFICERS AND MEMBERS, CORRECTED TO MARCH 1, 1914.

OFFICERS.

President, D. C. MUNRO, Madison.

Vice-President, Sciences,
I. N. MITCHELL, Milwaukee*.

Vice-President, Arts,
A. C. CLAS, Milwaukee.

Vice-President, Letters,
F. M. ERICKSON, Ripon.

Secretary,
ARTHUR BEATTY, Madison.

Treasurer,
ARTHUR BEATTY, Madison.

Curator,
C. E. BROWN, Madison.

Librarian,
WALTER M. SMITH, Madison.

Committee on Publication,
The President, ex officio.
The Secretary, ex officio.
C. E. ALLEN, Madison.

COUNCIL.

The President, Vice-Presidents, Secretary, Treasurer, Librarian, and Past Presidents retaining their residence in Wisconsin.

*Deceased

Committee on Library,

The Librarian, ex officio.
P. H. DERNEHL, Milwaukee.
GEORGE WAGNER, Madison.
R. G. THWAITES**, Madison.
C. A. YOUTZ, Appleton.

Committee on Membership.

The Secretary, ex officio.
H. L. WARD, Milwaukee.
A. F. MCLEOD, Beloit.
HELEN SHERMAN, Washington.
L. R. INGERSOLL, Madison.

Past Presidents.

HONORABLE JOHN W. HOYT, M. D., LL. D., Washington, D. C., 1870–75.
DR. P. R. HOY, M. D.,* 1876–78.
PRESIDENT A. L. CHAPIN, D. D.,* 1879–81.
PROFESSOR ROLAND D. IRVING, Ph. D.,* 1882–84.
PROFESSOR THOMAS C. CHAMBERLIN, Ph. D., Sc. D., LL. D., Chicago, Ill., 1885–87.
PROFESSOR WILLIAM F. ALLEN,† 1888–89.
PROFESSOR EDWARD A. BIRGE, Ph. D., Sc. D., LL. D., Madison, 1889–90.
LIBRARIAN GEORGE W. PECKHAM, LL. D., Milwaukee, 1891–93.††
PRESIDENT CHARLES R. VAN HISE, Ph. D., LL. D., Madison, 1894–96.
PROFESSOR C. DWIGHT MARSH, A. M., Ph. D., Washington, D. C., 1897–99.
PROFESSOR CHARLES S. SLICHTER, M. S., Madison, 1900–1902.
DR. JOHN J. DAVIS, M. D., Racine, 1903–1905.
PROFESSOR LOUIS KAHLENBERG, Ph. D., Madison, 1906–1909.
PRESIDENT SAMUEL PLANTZ, Ph. D., D. D., LL. D., Lawrence College, Appleton, 1910–1912.

**Deceased
* Deceased. † Deceased December 9, 1899. Professor Birge elected to fill unexpired term. ††Deceased.

HONORARY MEMBERS.

CHAMBERLIN, Thomas Chrowder, Hyde Park, Hotel, Chicago, Ill.

A. B. (Beloit); Ph. D. (Wisconsin, Michigan); LL. D. (Michigan, Beloit, Columbian, Wisconsin); Sc. D. (Ilinois). Head of Geological Department and Director of Walker Museum, University of Chicago, Consulting Geologist U. S. Geological Survey; Consulting Geologist, Wisconsin Natural History Survey; Geological Commissioner, Illinois Geological Survey; Editor. *Journal of Geology.*

GARLAND, Hamlin, New York, N. Y.

Vice-President, International Institute of Arts and Letters. Chairman of Cliff-Dwellers, of Chicago.

JORDAN, David Starr,

President Emeritus of Stanford University, Stanford University, Cal.

M. S., Cornell University, 1872; M. D., Indiana Medical College, 1875; Ph. D., Butler College, 1878; LL. D., Cornell University, 1886, Johns Hopkins University, 1902, Illinois College, 1903; Instructor in Botany, Cornell University, 1871–72; Professor of Natural History, Lombard University, 1872–73; Principal of Appleton (Wis.) Collegiate Institute, 1873–74; Lecturer in Marine Botany at Penikese, 1873–74; Teacher of Natural History, Indianapolis High School, 1874–75; Professor of Biology, Butler College, 1875–79; Instructor in Botany, Harvard Summer School, Cumberland Gap, 1875–76 Assistant to U. S. Fish Commission, 1877–81; Professor of Zoology, Indiana University, 1879–85; President of Indiana University, 1885–91; President of the California Academy of Sciences, 189*–98, 1901–03, 1908; U. S. Commissioner in charge of Fur Setl. Investigations, 1896–98; of Salmon Investigations, 1904; International Commissioner of Fisheries, since 1908; President of the American Association for the Advancement of Science, 1903–09.

TRELEASE, William, Botanical Garden, St. Louis, Mo.

B. S. (Cornell); S. D. (Harvard); LL. D. (Wisconsin, Missouri, Washington University). Director of Missouri Botanical Garden; Engelmann Professor of Botany, Henry Shaw School of Botany, Washington University; President, Academy of Science of St. Louis; Secretary, The Round Table, St. Louis; Honorary President, Engelmann Botanical Club, St. Louis; Chairman, City Plan Committee, Civic League, St. Louis; Vice President, Board of Commissioners, Tower Grove Park, St. Louis.

WHEELER, W. M., Forest Hills, Boston, Mass.

Ph. D. Professor of Economic Entomology, Harvard University.

WHITMAN, Charles Otis, University of Chicago, Chicago, Ill.

A. B., A. M. (Bowdoin); Ph. D. (Leipzig); LL. D. (Nebraska). Head Professor of Zoology, University of Chicago; Director of Marine Biological Laboratory, Woods Hole, Mass.

LIFE MEMBERS.

BIRGE, Edward Asabel, 744 Langdon St., Madison
A. B., A. M. (Williams); Ph. D. (Harvard); Sc. D. (Western University of Pennsylvania); LL. D. (Williams). Professor of Zoology and Dean of the College of Letters and Science, University of Wisconsin; Secretary of Commissioners of Fisheries, Wisconsin; Director and Superintendent, Wisconsin Geological and Natural History Survey; Member, Wisconsin State Board of Forestry; Wisconsin Conservation Commission, Senator, Phi Beta Kappa

DAVIS, John Jefferson, 629 Mendota Court, Madison
B. S. (Illinois); M. D. (Hahnemann). Physician. Curator of Herbarium, University of Wisconsin.

FLINT, Albert Stowell, 450 Charter St., Madison
A. B. (Hard); A. M. (Cincinnati). Astronomer, Washburn Observatory, University of Wisconsin.

HOBBS, William Herbert, 820 Oxford Road, Ann Arbor, Mich.
B. S. (Worcester Polytechnic Institute); A. M., Ph. D. (Johns Hopkins). Professor of Geology, University of Michigan.

HOYT, John Wesley, Washington, D. C.
A. M. (Ohio Wesleyan); M. D. (Cincinnati); LL. D. (Missouri) Chairman of the National Committee of Four Hundred to Promote the Establishment of the University of the United States.

MARSH, Charles Dwight, 3430 Brown St., N. W., Washington, D. C.
A. B., A. M. (Amherst); Ph. D. (Chicago). Physiologist in Bureau of Plant Industry, United States Department of Agriculture.

PLANTZ, Samuel, 545 Union St., Appleton
A. M. (Lawrence); Ph. D. (Boston); D. D. (Albion); LL. D. (Baker). President, Lawrence College.

SHARP, Frank Chapman, 27 Mendota Court, Madison
A. B. (Amherst); Ph. D. (Berlin). Professor of Philosophy, University of Wisconsin.

SKINNER, Ernest Brown, 210 Lathrop St., Madison
A. B. (Ohio); Ph. D. (Chicago). Assistant Professor of Mathematics, University of Wisconsin.

SLICHTER, Charles Sumner, 636 Frances St., Madison
B. S., M. S. (Northwestern). Professor of Applied Mathematics. University of Wisconsin; Consulting Engineer.

VAN CLEEF, Frank Louis, 39 For Green Place, Brooklyn, N. Y.
A. B. (Oberlin, Harvard); Ph. D. (Bonn). Chief of Sixth Division and Translator in Office of Commissioner of Records, Kings County.

VAN HISE, Charles Richard, 772 Langdon St., Madison
B. Met. E., B. S., M. S., Ph. D. (Wisconsin); LL. D. (Chicago, Yale, Harvard, Williams, Dartmouth). President, University of Wisconsin; Consulting Geologist, Wisconsin Geological Survey; President, Board of Commissioners, Wisconsin Geological and Natural History Survey; President, Wisconsin State Board of Forestry.

ACTIVE MEMBERS.

ALLEN, Bennett Mills, Lawrence, Kansas
Ph. B. (De Pauw); Ph. D. (Chicago). Professor of Zoology University of Kansas.

ALLEN, Charles Elmer, 2014 Chamberlin Ave., Madison
B. S., Ph. D. (Wisconsin). Professor of Botany, University of Wisconsin.

ALLEN, Ruth Florence, East Lansing, Mich.
A. B., A. M. (Wisconsin). Instructor in Botany, Michigan Agricultural College.

ARZBERGER, Emil Godfrey,
4233 Shenandoah St., St. Louis, Mo.
Ph. B. (Wisconsin). Research Fellowship, Missouri Botanical Garden.

BAGG, Rufus M. Jr., 466 Alton St., Appleton
Professor of English, Lawrence College.

BARBER, W. Harley, 120 Thorn St., Ripon Wis.
A. B. (University of Wisconsin); M. A. (University of Wisconsin) Registrar and Professeror of Physics, Ripon College, Ripon, Wis. Member of City Council.

BARBOUR, Harris Merrill, Milton
M. A., B. D. Professor of Philosophy and History, Milton College.

BARDEEN, Charles Russell, 25 Mendota Court, Madison
A. B. (Harvard); M. D. (Johns Hopkins). Professor of Anatomy, and Dean of the Medical School, University of Wisconsin.

BARRETT, S. A., Public Museum, Milwaukee
B. S., M. S., Ph. D. (University of California). Anthropologist; Curator of Anthropology, Public Museum, Milwaukee.

BARTH, George P., 302 21st St., Milwaukee
Physician.

BARTHOLOMEW, Elbert T., 803 State St,, Madison
Instructor in Botany, University of Wisconsin.

Bascom, Lelia, 139 W. Gilman St., Madison
Instructor in English, University of Wisconsin.

BASSETT, Harry Kendall, 110 Spooner St., Madison
Assistant Professor of English, University of Wisconsin.

BEATTY, Arthur, 1824 Vilas St., Madison
A. B. (Toronto); Ph. D. (Columbia). Assistant Professor of English, University of Wisconsin.

BLACKSTONE, Dodge Pierce, 921 Wisconsin St., Berlin
A. B., A. M., C. E. (Union).

BLEYER, Willard Grosvenor, 625 Langdon St., Madison
B. L., M. L., Ph. D. (Wisconsin). Associate Professor of Journalism, University of Wisconsin.

BOREN, Welz E., Milwaukee

BOYD, C. E. Tallahasse, Fla.
Professor, Florida State College for Women.

BRAUN, Adolph R., 832 38th St., Milwaukee
Graduate of National German-American Teachers' Seminary, Milwaukee.
Teacher of Modern Languages, Milwaukee High School.

BRINCKLEY, William Joshua, 1303 Grand Ave., Milwaukee
A. B. (Salina); B. S., A. M. (De Pauw); Ph. D. (Austin). Lecturer, Public Museum.

BROWN, Charles E., 910 Van Buren St., Madison
Secretary and Curator, Wisconsin Archaeological Society; Chief, State Historical Museum.

BROWN, Charles Newton, 271 Langdon St., Madison
LL. B. (Wisconsin). Lawyer.

BROWN, Eugene Anson, 2015 Jefferson St., Madison
M. D. (Hahnemann). Physician and Surgeon; Secretary of Board of Federal Pension Examiners, Madison District.

BROWN, HAROLD GIBSON, 803 State St., Madison
Instructor in English, University of Wisconsin.

BRUES, Charles Thomas,
Bussey Institution, Forest Hill, Boston, Mass.
B. S., M. S. (Texas). Instructor in Economic Entomology, Harvard University.

BRUNDAGE, Albert H.,
375 Gates Ave., Brooklyn Borough, New York City
Emeritus Professor of Toxicology and Physiology, Marquette University; Physician.

BUEHLER, Henry Andrew, Rolla, Mo.
B. S. (Wisconsin). Geologist; State Geologist of Missouri.

BUNTING, Charles Henry, 2020 Chadbourne Ave., Madison
Professor of Pathology, University of Wisconsin.

BURRILL, Alfred C., 2208 Monroe St. Madison
S. B. (Harvard). Instructor in Economic Entymology, University of Wisconsin.

BUSSEWITZ, M. A. Milwaukee
Professor, Milwaukee State Normal School.

CAIRNS, William B., 2010 Madison St., Madison
A. B., Ph. D. (Wisconsin), Assistant Professor of American Literature, University of Wisconsin.

CAMPBELL, O. J. Jr., 15 E. Gilman St., Madison
Ph. D. (Harvard) Assistant Professor of English, University of Wisconsin.

CARR, Muriel B., The Irving, Madison
Instructor in English, University of Wisconsin.

CHANDLER, Elwyn Francis, University, N. D.
A. B., A. M. (Ripon). Professor of Mathematics, University of North Dakota; Assistant Engineer, United States Geological Survey.

CHASE, Wayland J., 141 Summit Ave., Madison
A. B., A. M. (Brown). Associate Professor of History, University of Wisconsin.

CHENEY, Lellen Sterling, Barron
B. S., M. S. (Wisconsin). County Superintendent.

CLAS, Alfred Charles,
Flat 2, St. James Ct., 815 Grand Ave., Milwaukee
Architect (Ferry & Clas), 419 Broadway, Milwaukee; Member, Board of Park Commissioners.

CLAWSON, Arthur Brooks, Washington, D. C.
A. B. (Michigan). Department of Agriculture, Washington.

COFFIN, Victor, 1919 Arlington Pl., Madison
Ph. D. (Cornell). Assistant Professor of European History, University of Wisconsin.

COLE, Leon J., 1915 Keyes Ave., Madison
A. B. (Michigan); A. M. (Harvard); Ph. D. (Wisconsin). Associate Professor of Experimental Breeding, University of Wisconsin.

COMPTON, J. S., Eureka, Illinois

CONKLIN, G. H., 1204 Tower Ave., Superior
Practicing Physician.

COOL, Charles Dean, 1607 Adams St., Madison
A. B. (Michigan); A. M. (Harvard); Ph. D. (Wisconsin). Assistant Professor of Romance Languages, University of Wisconsin.

CULVER, Garry Eugene, 1103 Main St., Stevens Point
A. M. (Denison). Professor of Physical Science, State Normal School.

DALAND, William Clifton, Milton
M. A., D. D. President and Professor of the English Language and of Bibical Literature, Milton College.

DEAN, Alletta F., The Hamilton, Madison
Ph. B., Ph. M. (Wisconsin). Instructor in Biology, Madison High School.

DENNIS, Alfred Lewis Pinneo, 518 Wisconsin Ave., Madison
A. B. (Princeton); Ph. D. (Columbia). Professor of European History, University of Wisconsin.

DENNISTON, Rollin Henry, Science Hall, Madison
Ph. G., B. S., Ph. D. (Wisconsin). Assistant Professor of Botany, University of Wisconsin.

DERNEHL, Paul Herman,
717–718 Majestic Building, Milwaukee
B. S. (Wisconsin); M. D. (Johns Hopkins). Physician.

DIETRICH, Otto, 730 Grand Ave., Milwaukee
Ph. D. (Halle). Director, Milwaukee University School.

DODGE, B. O., New York, N. Y.
Ph. B. (Wisconsin); Ph. D. (Columbia). Instructor in Botany, Secretary-Treasurer Torrey Botanical Club. Department of Botany, Columbia University.

DODGE, Robert Elkin Neil, 15 W. Gorham St., Madison
A. B., A. M. (Harvard). Assistant Professor of English, University of Wisconsin.

DOWLING, Linnaeus Wayland, 2 Roby Road, Madison
Ph. D. (Clark). Assistant Professor of Mathematics, University of Wisconsin.

DOWNES, Robert Hugh, 53 West Algoma St., Oshkosh
B. L. (Wisconsin).

EISENMANN, William H., Sioux City, Iowa
High School, Sioux City.

ELLSWORTH, William H., 3302 Wells St., Milwaukee
President, Ellsworth and Thayer Manufacturing Company.

ELY, Richard Theodore, 205 Prospect Ave., Madison
A. B., A. M. (Columbia); Ph. D. (Heidelberg); LL. D. (Hobart). Professor of Political Economy, University of Wisconsin.

ERICKSON, Frank Morton, 529 Woodside Ave., Ripon
A. B. (Wabash); A. M. (Chicago). Dean, and Professor of Greek, Ripon College.

FAIRCHILD, R. W. Stevens Point
Teacher of Biology, State Normal School.

FARLEY, John Herbert, 482 South St., Appleton
A. M. (Lawrence). Professor of Philosophy, Lawrence College.

FERRY, George Bowman, Woodland Court, Milwaukee
Architect (Ferry and Clas).

FINGER, William, 297 12th St., Milwaukee
Insurance, Loans and Real Estate Broker.

FINKLER, Adolph, 612 Commerce St., Milwaukee
Secretary, Albert Trostel and Sons Company; President, Board of Trustees, National German-American Teachers' Seminary; President, Board of Trustees, German-English Academy.

FISCHER, Richard, 119 East Johnson St., Madison
Ph. C., B. S. (Michigan); Ph. D. (Marburg). Assistant Professor of the Theory and Practice of Pharmacy, University of Wisconsin; State Chemist, Wisconsin.

FISH, Carl Russell, 625 Mendota Court, Madison
A. B. (Brown); A. M., Ph. D. (Harvard). Professor of American History, University of Wisconsin.

FLING, Harry R., 601 Jackson St., Oshkosh
A. B. (Bowdoin). Professor of Biology, State Normal School.

FROST, William Dodge, 310 Bruen St., Madison
B. S., M. S. (Minnesota); Ph. D. (Wisconsin). Associate Professor of Bacteriology, University of Wisconsin.

GAY, Lucy Maria, 216 North Pinckney St., Madison
B. L. (Wisconsin). Assistant Professor of Romance Languages, University of Wisconsin.

GILBERT, Edward Martinius, 109 Spooner St., Madison
A. B. (Wisconsin). Assistant Professor of Botany, University of Wisconsin.

GILMAN, Albert G., Ripon, Wis.
Professor of Chemistry, Ripon College.

GLOYER, Walter O., Geneva, N. Y.
B. A., M. A. (Wisconsin). Associate Botanist, New York Agricultural Experiment Station.

GRAENICHER, Sigmund, 116 Harmon St., Milwaukee
Ph. D. (Basel); M. (Munchen). Curator, Public Museum.

GREGORY, John Goadby, 717 Jefferson St., Milwaukee
Associate Editor, Evening Wisconsin.

GRIGGS, Horace William, 2421 Sycamor St., Milwaukee
Roundhouse Foreman, C., M. & St. P. Ry. Co.

GUTSCH, Milton R., Austin, Texas
Professor of History, University of Texas.

GUYER, Michael F., 138 Prospect Ave., Madison
Professor of Zoology, University of Wisconsin.

HAASE, Ewald, 182 Wisconsin St., Milwaukee
Secretary, Milwaukee Gas Light Company.

HAERTEL, Martin H., 1927 West Lawn Ave., Madison
Ph. B. (Chicago), Ph. D. (Wisconsin). Assistant Professor of German, University of Wisconsin.

HAESSLER, Luise, 1230 Amsterdam Ave., New York, N. Y.
A. B. (Chicago). Assistant Professor of German, Normal College of the City of New York.

HALL, Edward Bennington, 747 N. Main St., Springfield, Mo.
B. S. (Drury). Assistant Professor, Geology and Mineralogy, Drury College, Springfield.

HARPER, Edward T., Geneseo, Illinois

HARWOOD, Mary Corinthia, 121 Thorn St., Ripon
B. L., M. A. (Lawrence). Professor of French and German and Dean of Women, Ripon College.

HEDDLE, John R., Milwaukee
Public Museum.

HERRICK, Alfred James, Stevens Point
Teacher of Physics and Agriculture, State Normal School.

HIPPENSTEEL, H. S. Stevens Point
Teacher of Literature, State Normal School.

HOHLFELD, Alexander Rudolph, 104 Breese Terrace, Madison
Ph. D. (Leipzig). Professor of German, University of Wisconsin; President, Modern Language Association of America; Member of Board of Administration, National German-American Teachers' Seminary, Milwaukee.

HOLMES, Samuel Jackson, Berkeley, California
B. S., M. S. (California); Ph. D. (Chicago). Professor of Zoology, University of California.

HOTCHKISS, W. O., Madison
Geologist, State Highway Commission.

HUMPHREY, Clarence J., Madison
Pathologist, Forest Products Laboratory.

HUTCHINS, E. B., Fond du Lac
Boise-Holman Company.

HUTTON, Andrew J., Box 378, Waukesha
Superintendent, Wisconsin Industrial School for Boys.

INGERSOLL, Leonard R., 1933 West Lawn Ave., Madison
B. S. (Colorado College); Ph. D. (Wisconsin). Associate Professor of Physics, University of Wisconsin.

INGLIS D. Nelson, Milton
Professor of Romance Languages, Milton College.

JACKSON, Hartley H. T., Washington, D. C.
U. S. Biological Survey.

JANA, Ashutosh, Haria, Bengal, India

JASTROW, Joseph, 237 Langdon St., Madison
A. B., A. M. (Pennsylvania); Ph. D. (Johns Hopkins). Professor of Psychology, University of Wisconsin.

JENKS, Judge Aldro, Dodgeville

JOHNSON, Aaron Guy, Madison
Plant Pathologist, University of Wisconsin.

JOHNSON, Arden Richard, Ames, Iowa
B. S., M. S. (Wisconsin). Professor of Chemistry, Iowa State College.

JOLIVETTE, Hallie D. M., 900 Campus Ave., Pullman, Wash.

JONES, Lewis R., 1731 Regent St., Madison
Ph. B. (University of Michigan); Ph. D. (University of Michigan); Sc. D. (Honorary, University of Vermont). Professor of Plant Pathology, University of Wisconsin.

JUDAY, Chancey, 35 Lathrop St., Madison
A. M. (Indiana). Biologist, Wisconsin Geological and Natural History Survey.

KELLEY, Frank J., 1019 W. Johnson St., Madison
Assistant in Experimental Breeding, University of Wisconsin.

KELSEY, Rachel M., Milwaukee
State Normal School.

KIND, John Louis, The Irving, Sterling Court, Madison
A. B., A. M. (Nebraska); Ph. D. (Columbia). Assistant Professor of German, University of Wisconsin.

KREMERS, Edward, 1720 Vilas St., Madison
Ph. G., B. S. (Wisconsin); Ph. D. (Gottingen); D. Sc. (Michigan). Director of Course in Pharmacy and Professor of Pharmaceutical Chemistry, University of Wisconsin.

KUHN, Harry, Toledo, Ohio
The Home Brewing Company.

KUTCHIN, Mrs. Harriet Lehmann,
804 Chestnut St., Missoula, Mont.
A. B. (Ripon); A. M. (Northwestern). Engaged in zoological research.

LANNERD, Willard, 1014 Washington Ave., Racine
B. S. (Purdue). Instructor in Science and Mathematics, Racine High School.

LEITH, Charles Kenneth, 240 Langdon St., Madison
B. S., Ph. D. (Wisconsin). Professor of Geology, University of Wisconsin; Non-resident Professor of Structural and Metamorphic Geology, University of Chicago.

LENHER, Victor, 158 Summit Ave., Madison
Ph. D. (Pennsylvania). Professor of Chemistry. University of Wisconsin.

LEONARD, William Ellery, 415 N. Park St., Madison
A. B. (Boston University); M. A. (Harvard); Ph. D. (Columbia). Assistant Professor of English, University of Wisconsin.

LEWIS, Ivey Foreman, Madison
Assistant Professor of Botany, University of Wisconsin.

LIGHTY, William Henry, Highlands, R F D 7 Madison
Ph. B. (Cornell). Secretary of Correspondence-Study Department, University of Wisconsin.

LLOYD–JONES, Chester, 151 Summit Ave., Madison
Associate Professor of Political Science, University of Wisconsin.

MCALLISTER, Fred, Austin, Texas
Department of Botany, University of Texas.

MCCASKILL, Virgil E., Superior
President, State Normal School.

MCGILVARY, Evander Bradley, 1902 Arlington Place, Madison
A. B. (Davidson); A. M. (Princeton); Ph. D. (California). Professor of Philosophy, University of Wisconsin.

MCKENNA, Maurice, 114 Third St., Fond du Lac
Lawyer; President, Bar Association of Fond du Lac County.

MCLEOD, Andrew Fridley, Beloit
Ph. D. (Wisconsin). Professor of Chemistry, Beloit College.

MCMINN, Amelia, 172 21st St., Milwaukee
B. S. (Wisconsin). Instructor in Biology, Milwaukee West Side High School.

MARQUETTE, William George, New York, N. Y.
Ph. G. (Northwestern); B. S., Ph. D. (Wisconsin). Assistant Professor of Botany, Columbia University.

MARSHALL, Ruth, Rockford, Ill.
B. Sc., M. S. (Wisconsin); Ph. D. (Nebraska). Head, Department of Biology, Rockford College.

MARSHALL, William Stanley, 139 East Gilman St., Madison
B. S. (Swarthmore); Ph. D. (Leipzig). Associate Professor of Entomology, University of Wisconsin.

MASON, Max, 152 W. Gorham St., Madison
B. S. (Wisconsin). Professor of Mathematical Physics, University of Wisconsin.

MATHEWS, Mrs. Lois Kimball, Lathrop Hall, Madison
Dean of Women, Associate Professor of History, University of Wisconsin.

MAURER, Edward Rose, 167 Prospect Ave., Madison
B. C. E. (Wisconsin). Professor of Mechanics, University of Wisconsin.

MAVOR, J. W., Madison
Instructor in Zoology, University of Wisconsin.

MAXSON, Mabel, Milton
M. A. Instructor in English, Milton College.

MEACHEM, John Goldesbrough, Jr., 745 College Ave., Racine
M. D. (Rush). Physician.

MEAD, Warren J., 922 Van Buren St., Madison
Assistant Professor of Geology, University of Wisconsin.

MEARS, Louise W., Milwaukee
State Normal School.

MERRILL, Mrs. Sherburne S., 3355 Grand Ave., Milwaukee
First Vice-President, Wisconsin Humane Society; Second Vice-President, Woman's Club of Wisconsin; President, Public School Art League.

METZDORF, William, St. Francis
Professor of Natural Sciences, St. Francis Seminary.

MEYER, Balthasar Henry, Washington, D. C.
B. L., Ph. D., LL. D., (Wisconsin). Member Interstate Commerce Commission.

MILLER, E. R., 1120 W. Johnson
U. S. Weather Bureau.

MILLER, William Snow, 415 W. Wilson St., Madison
M. D. (Yale). Associate Professor of Anatomy, University of Wisconsin.

MONROE, C. E., 512 Van Buren St., Milwaukee
A. B. (Oberlin College); LL. B. (Michigan University). Lawyer.

MOORE Samuel, 112 Lathrop St., Madison
A. B. (Princeton), Ph. D. (Harvard). Assistant Professor of English, University of Wisconsin.

MORRIS, William Augustus Pringle, 26 W. Mifflin St., Madison
A. B. (Hamilton). Lawyer.

MUELLER, Alexander, 788 Cramer St., Milwaukee

MUNRO, Dana Carleton, 515 N. Lake St., Madison
A. B., A. M. (Brown). Professor of European History, University of Wisconsin.

MUTTKOWSKI, Richard Antony, 423 N. Lake St., Madison
Assistant in Zoology, University of Wisconsin.

NADER, John, 302 West Main St., Madison
Architect and Civil Engineer.

NAGLER, Mrs. Ellen Torelle, 151 W. Wilson St., Madison

NAYLOR, Wilson Samuel, Appleton
Professor, Lawrence College.

NEILSON, Walter Hopper, 114 Garfield Ave., Milwaukee
M. D. (Rush). Dean of the Medical Faculty and Professor of the Principles and Practice of Medicine and Clinical Medicine, Milwaukee Medical College.

NICHOLS, Susie Percival, Shelbyville, Kentucky.
B. S. (Cornell); Ph. D. (Wisconsin).

OLIN, John Myers, 130 Prospect Ave., Madison
A. B., A. M. (Williams); LL. B. (Wisconsin). Lawyer; Professor of Law, University of Wisconsin.

O'SHEA, M. Vincent, 140 Langdon St., Madison
B. L. (Cornell). Professor of the Science and Art of Education, University of Wisconsin.

OVERTON, James Bertram, 512 Wisconsin Ave., Madison
Ph. B. (Michigan); Ph. D. (Chicago). Associate Professor of Plant Physiology, University of Wisconsin.

OWEN, Edward Thomas, 614 State St., Madison
A. B., Ph. D. (Yale). Professor of French and Linguistics, University of Wisconsin.

OWEN, Ralph W., 21 Mendota Court, Madison
Litt. B. Princeton; M. A, (Wisconsin). Instructor in English, University of Wisconsin.

PARKER, Fletcher Andrew, 14 W. Gilman St., Madison
Professor Emeritus of Music, University of Wisconsin; Vice-President, Music Teachers' National Association.

PARKINSON, John Barber, 516 Wisconsin Ave., Madison
A. B., A. M. (Wisconsin). Vice-President and Professor Emeritus of Constitutional and International Law, University of Wisconsin.

PAXSON, Frederick L., 629 Frances St., Madison
Ph. D. (Pennsylvania); Professor of American History, University of Wisconsin.

PEABODY, Arthur, 2114 Chadbourne Ave., Madison
B. S. (Illinois). Supervising Architect, University of Wisconsin.

PEASLEE, Leon D., Milwaukee
Curator of Education, Public Museum.

PELTIER, George L., Urbana, Ill.
Illinois Agricultural Station.

PERROW, Eber Carle, 119 W. Broadway, Louisville, Ky.
A. B., A. M., Ph. D. (Harvard). Professor of English, University of Louisville.

PETERSON, W. H., 116 W. Washington Ave., Madison
Instructor in Agricultural Chemistry, University of Wisconsin.

PHILLIPS, James David, 1010 Grant St., Madison
B. S. (Illinois). Professor of Drawing, University of Wisconsin.

PIERSON, Merle Pierson, Jefferson
Teacher of English, High School, Jefferson.

PITMAN, Annie, 414 N. Henry, Madison
B. A., Ph. D. (Wisconsin). Assistant Professor in Latin, University of Wisconsin.

PORTER, William, 735 College Ave., Beloit
A. B., A. M., D. D. (Williams). Professor Emeritus of Latin, Beloit College.

PRETTS, William Walter, Platteville
B. S. (Wisconsin); M. D. (Northwestern). Physician and Surgeon.

QUAIFE, Milo M., Madison
Secretary. State Historical Society.

REED, George Matthew, 809 Virginia Ave., Columbia, Mo.
A. B. (Geneva); A. M., Ph. D. (Wisconsin). Assistant Professor of Botany, University of Missouri.

RICE, Ole S., Madison
B. S. (Wisconsin). Library Clerk, Office of State Superintendent of Public Instruction.

ROEDDER, E. C. L. C., 1614 Hoyt St., Madison
A. B., A. M., Ph. D. (all from University of Michigan). Associate Professor of German Phililigy, University of Wisconsin.

ROHDE, Hugo W., 703 First St., Milwaukee
Chemist, Schlitz Brewing Company.

RUENZEL, Henry Gottlieb, 2332 Vliet St., Milwaukee
Ph. G. (Wisconsin). Pharmacist; Member, State Board of Pharmacy.

SAMMIS, J. L., 234 Breese Terrace, Madison
Associate Professor of Dairying. University of Wisconsin.

SANBORN, John Bell, Wisconsin Building, Madison
B. L., M. L., Ph. D. (Wisconsin). Lawyer; Treasurer, Wisconsin State Bar Association; Lecturer, University of Wisconsin Law School; Member, Wisconsin Council, American Bar Association.

SANDERS, J. G., 444 N. Charter St., Madison
Ph. B. (Otterbein University); M. A. (Ohio State University) Entomologist of Agricultural Experiment Station; State Orchard and Nursery Inspector; Sec'y. Nat. Horticultural Inspector's Assoc. Professor of Economic Entymology University of Wisconsin.

SCHINNER, Augustin, Right Reverend, 628 Bay St., Superior
D. D., Bishop.

SCHLUNDT, Herman, Columbia, Mo.
Professor of Chemistry, University of Missouri.

SHERMAN, Helen, Washington, D. C.
B. S., A. M. (Wisconsin). Bureau of Chemistry.

SHERMAN, Lewis, 448 Jackson St., Milwaukee
B. S., A. M. (Union); M. D. (New York). Physician and Pharmacist.

SHOWERMAN, Grant, 410 N. Butler St., Madison
A. B., Am., Ph. D., University of Wisconsin. Professor of Latin, University of Wisconsin.

SIEKER, William Christian, 753 Murray Ave., Milwaukee
B. S. (Wisconsin). Secretary and Treasurer, Manthey-Sieker Company.

SLAUGHTER, Moses Stephen, 633 Frances St., Madison
A. B., A. M. (De Pauw); Ph. D. (Johns Hopkins). Professor of Latin, University of Wisconsin.

SMITH, Cornell Rae, Milwaukee
Assistant Geologist, Public Museum.

SMITH, Erastus Gilbert, 649 Harrison Ave., Beloit
A. B., A. M. (Amherst); A. M., Ph. D. (Gottingen). Professor of Chemistry, Beloit College.

SMITH, Gilbert Morgan, 1606 Hoyt St., Madison
Instructor in Botany, University of Wisconsin.

SMITH, Walter McMynn, 127 Langdon St., Madison
A. B. (Wisconsin). Librarian, University of Wisconsin.

SMYTHE, Sidney T., Delafield
A. B., A. M. (St. Stephen's); B. D. (Nashotah); D. D., Ph. D. (Hobart). President, St. John's Military Academy; Member, Committee on Canons, Protestant Episcopal Church.

SNOW, Benjamin Warner, 221 Langdon St., Madison
Ph. D. (Berlin). Professor of Physics, University of Wisconsin.

SPENCER, Matthew Lyle, 8 Alton Place, Appleton
A. B., A. M., Kentucky Wesleyan College; A. M., Northwestern University; Ph. D., University of Chicago. Professor of English, Lawrence College.

SQUIER, George Hull, Trempealeau
Dairyman.

STARR, William J., 135 Marston Ave., Eau Claire
LL. B. (Columbia). Member, Board of Commissioners of Fisheries, Wisconsin; President, Eau Claire Public Library.

STEIDTMANN, E., 2002 Monroe St., Madison
A. B., A. M., Ph. D., (University of Wisconsin). Assistant Professor of Geology, University of Wisconsin.

STEPHENS, W. T., Milwaukee
State Normal School.

STICKNEY, M. E., Granville, O.
Denison University.

STOUT, Arlow Burdette, 924 Clymer Place, Madison
A. B. (Wisconsin). Instructor in Botany, University of Wisconsin.

TALBERT, George A., Ripon
B. S., M. S. (Ohio Wesleyan). Instructor in Biology, Ripon College.

TELLER, Edgar Eugene, 3321 Sycamore St., Milwaukee

THORKELSON, Halsten Joseph Berford,
1526 W. Washington Ave., Madison
B. S., M. E. (Wisconsin). Professor of Steam Engineering, University of Wisconsin.

TOOLE, William Alexander, Pansy Heights, Baraboo, Wis.
Pansy Specialist.

TREVER, A. A. 368 State St., Appleton
Ph. D. (Chicago). Professor of Greek, Lawrence College.

TURNEAURE, Frederick Eugene, 166 Prospect Ave., Madison
C. E. (Cornell). Professor of Engineering and Dean of the College of Engineering, University of Wisconsin.

UPDIKE, Eugene Grover, Rev., 148 Langdon St., Madison
Pastor, First Congregational Church, Madison.

VAN VLECK, Edward Burr, 519 North Pinckney St., Madison
A. B., A. M. (Wesleyan); Ph. D. (Gottingen); LL. D. (Clark). Professor of Mathematics, University of Wisconsin; Editor, *Transactions of the American Mathematical Society.*

VAUGHAN, R. E., 1126 Chandler St., Madison
Assistant in Plant Pathology, University of Wisconsin.

VOGEL, Mrs. Guido Charles, 409 Terrace Ave., Milwaukee
B. S. (Wisconsin).

VORHIES, Charles Taylor, Salt Lake City, Utah
B. S. (Iowa Wesleyan). Professor of Zoology, University of Wisconsin.

VOSS, Ernest Karl Johnann Heinrich,
Nelson Avenue, West Lawn Heights
Ph. D. (Leipzig). Professor of German Philology, University of Wisconsin; Vice-President, Germanic Museum Association.

WADMOND, Samuel C., Delavan
Vice-President, Jackson and Jackson Company, Delavan; Secretary of Board, Aram Public Library, Delavan.

WAGNER, George, 1901 Jefferson St., Madison
Ph. C. (Michigan); A. B. (Kansas); A. M. (Michigan). Assistant Professor of Zoology, University of Wisconsin; Ichthyologist, State Geological and Natural History Survey.

WARD, Henry Levi, Milwaukee Public Museum, Milwaukee
Director, Milwaukee Public Museum; Vice-President, Wisconsin Natural History Society.

WATSON, Charles Francis, Stevens Point
Teacher of Geography, State Normal School.

WATT, Homer A., 1913 Rowley Ave., Madison, Wis.
A. B. (Cornell U.); A. M., Ph. D. (Wisconsin). Instructor in English, University of Wisconsin.

WEIDMAN, Samuel, 410 North Henry St., Madison
B. S., Ph. D. (Wisconsin). Geologist, Wisconsin Geological and Natural History Survey.

WEST, George A., 97 Wisconsin St., Milwaukee
Lawyer; President, Board of Trustees, Milwaukee Public Museum.

WHITFORD, Alfred Edward, Milton
M. A. Professor of Mathematics and Physics, Milton College.

WHITSON, Andrew Robinson, Route 7, Madison
B. S. (Chicago). Professor of Soils and Drainage, University of Wisconsin; Field Agent, United States Department of Agriculture.

WINCHELL, Alexander N., 200 Prospect Ave., Madison
B. S. and M. S. (University of Minnesota); D. Sc. (University Paris) Professor of Mineralogy and Petrology, University of Wisconsin, Geologist, Oregon Bureau of Mines and Geology.

WOLFENSON, Louis B., 1620 Madison St., Madison
Assistant Professor of Hebrew and Hellenistic Greek, University of Wisconsin.

WOLFF, Henry Charles, 6 South Prospect Ave., Madison
B. S., M. S. (Wisconsin). Instructor in Mathematics, University of Wisconsin.

WOLL, Fritz Wilhelm, Davis, Calif.
B. S., Ph. B. (Christiana); M. S., Ph. D. (Wisconsin). Professor in the California State Agricultural College.

WRIGHT, Clement Blake Bergin, 284 Martin St., Milwaukee
A. B., A. M. (Toronto); B. D. (Nashotah); Ph. D. (Kansas City); Clergyman; Canon, Milwaukee Cathedral; Secretary, Diocese of Milwaukee; Librarian, Diocesan Library; Examining Chap-

YODER, Albert Henry, Whitewater
President, State Normal School, Whitewater.

YOUNG, Karl, 406 N. Henry St., Madison
A. B. (Michigan); A. M. and Ph. D. (Harvard). Associate Professor of English, University of Wisconsin.

YOUTZ, Lewis Addison, Appleton
Ph. B., M. S. (Simpson); Ph. D. (Columbia). Professor of Chemistry, Lawrence College.

ZDANOWICZ, Casimir Douglass, 1818 Madison St., Madison
Assistant Professor of Romance Languages, University of Wisconsin.

ZIMMERMAN, Oliver Brunner, Brussels, Belgium
B. S., M. E. (Wisconsin). International Harvester Corporation.

CORRESPONDING MEMBERS.

ABBOTT, Charles Conrad, Trenton, N. J.
M. D. (Pennsylvania).

ARMSBY, Henry Prentiss, State College, Pa.
B. S. (Worcester Polytechnic); Ph. B., Ph. D. (Yale); LL. D. (Wisconsin). Director of Institute of Animal Nutrition; Expert in Animal Nutrition, United States Department of Agriculture.

BENNETT, Charles Edwin, 1 Grove Place, Ithaca, N. Y.
A. B., Litt. D. (Brown). Professor of Latin Language and Literature, Cornell University.

BRIDGE, Norman, Auditorium Building, Los Angeles, Cal.
A. M. (Lake Forest); M. D. (Northwestern, Rush). Emeritus Professor of Medicine, Rush Medical College. Physician.

CAVERNO, Charles, Lombard, Ill.
A. B., A. M. (Dartmouth). Professor Emeritus, Ripon College.

CHANDLER, Charles Henry, New Ipswich, N. H.
A. B., A. M. (Dartmouth). LL. D. (Colorado). Clergyman, retired.

COULTER, John Merle, University of Chicago, Chicago, Ill.
A. B., A. M., Ph. D. (Hanover); Ph. D. (Indiana). Professor of Botany and Head of Department, University of Chicago.

CROOKER, Joseph Henry,
820 South St., Roslindale, Boston, Mass.
D. D. (St. Lawrence, Nashville). Minister, Unitarian Church.

DAVIS, Floyd,
317 Iowa Loan and Trust Building, Des Moines, Iowa
Ph. B., C. E., E M. (Missouri); Ph. D. (Miami). Analytical and Consulting Chemist.

EATON, Edward Dwight, Beloit
A. B., A. M. (Beloit); B. D. (Yale); LL. D. (Wisconsin); D. D. (Northwestern, Yale). President, Beloit College.

ECKELS, William Alexander, Easton, Pa.
A. B., A. M. (Dickinson); Ph. D. (Johns Hopkins). Associate Professor of Greek, Lafayette College.

FALLOWS, Samuel, 2344 Monroe St., Chicago, Ill.
A. B., A. M., LL. D. (Wisconsin); D. D. (Lawrence, Marietta). Presiding Bishop. Reformed Episcopal Church; President, Board of Managers, Illinois State Reformatory.

HARPER, Robert Aylmer, New York, N. Y.
A. B. (Oberlin), Ph. D. (Bonn). Professor of Botany, Columbia University.

HENDRICKSON, George Lincoln,
68 Trumbull St., New Haven, Conn.
A. B. (Johns Hopkins); L. H. D. (Western Reserve). Professor of Latin. Yale University.

HODGE, Clifton Fremont, 3 Charlotte St., Worchester, Mass.
A. B. (Ripon); Ph. D. (Johns Hopkins). Professor of Physiology and Neurology. and Professor of Biology in the Collegiate Department, Clark University.

HOLDEN, Edward Singleton,
United States Military Academy, West Point, N. Y.
B. S., A. M. (Washington); Sc. D. (Pacific); LL. D. (Wisconsin, Columbia). Astronomer; Librarian, United States Military Academy, West Point.

HOSKINS, Leander Miller, 365 Lincoln Ave., Palo Alto, Cal.
M. S., C. E. (Wisconsin). Professor of Applied Mathematics, Leland Stanford Jr. University.

IDDINGS, Joseph Paxon, 5730 Woodlawn Ave., Chicago, Ill.
Ph. B. (Yale). Professor of Petrology, University of Chicago; Geologist, United States Geological Survey.

KINLEY, David, Urbana, Ill.
A. B. (Yale); Ph. D. (Wisconsin). Dean of the Graduate School and Professor of Economics, University of Illinois.

LEVERETT, Frank, 312 N. Thayer St., Ann Arbor, Mich.
B. Sc. (Iowa Agricultural). Geologist, United States Geological Survey; Lecturer in Geology, University of Michigan.

LIBBY, Orin Grant, Grand Forks, N. D.
B. L., M. L., (Wisconsin). Professor of History, University of North Dakota, State Historical Society of North Dakota.

LURTON, Freeman Ellsworth, Fergus Falls, Minn.
B. S., M. S. (Carleton); A. M. (Upper Iowa); Ph. D. (Gale). Superintendent of Public Schools; Member, Board of Directors, Fergus Falls Public Library.

LUTHER, George Elmer,
262 South College Ave., Grand Rapids, Mich.
Cashier, People's Savings Bank; Treasurer, Historical Society of Grand Rapids.

MARX, Charles David, Palo Alto, Cal.
B. C. E. (Cornell); C. E. (Karlsruhe). Professor of Civil Engineering, Leland Stanford Jr. University.

MCCLUMPHA, Charles Flint, 56 Church St., Amsterdam, N. Y.
A. B., A. M. (Princeton); Ph. D. (Leipzig). Treasurer, McClumpho Company; Member, Fort Johnson Club; Treasurer, Amsterdam Free Library; Historian, Montgomery County Historical Society; Member, New York State Historical Society.

MOOREHOUSE, George Wilton, 2069 East 96th St., Cleveland, O.
B. L., M. L. (Wisconsin); M. D. (Harvard). Physician to the Dispensary of Lakeside Hospital and Western Reserve University.

NEHRLING, Henry, Palm Cottage Experiment Garden, Gotha, Orange County, Fla.

OLIVE, Edgar W. Brookings, S. D.
Professor of Botany, South Dakota Agricultural College.

PEET, Stephen Denison, 438 57th St., Chicago, Ill.
A. M., Ph. D. (Beloit). Clergyman; Editor, *American Antiquarian and Oriental Journal.*

POTTER, William Bleecker, 1225 Spruce St., St. Louis, Mo.
A. B., A. M., M. E., Sc. D. (Columbia). Mining Engineer and Metallurgist.

POWER, Frederick Belding, 535 Warren St., Hudson, N. Y.
Ph. G. (Philadelphia College of Pharmacy); Ph. D. (Strassburg). Director of Wellcome Chemical Research Laboratories, London, England.

SALISBURY, Rollin D., 5730 Woodlawn Ave., Chicago, Ill.
A. M., LL. D. (Beloit). Professor of Geographic Geology, Head of the Department of Geography and Dean of the Graduate School of Science, University of Chicago; Geologist, United States Geological Survey and State Geological Survey of New Jersey.

SAWYER, Wesley Caleb, 725 Asbury St., San Jose, Cal.
A. B., A. M. (Harvard); A. M., Ph. D. (Gottingen). Professor of French and German and Lecturer on Tuetonic Mythology, University of the Pacific.

STONE, Ormond, University Station, Charlottesville, Va.
A. M. (Chicago). Director of the Leander McCormick Observatory and Professor of Practical Astronomy, University of Virginia.

TOLMAN, Albert Harris, 5750 Woodlawn Ave., Chicago, Ill.
A. B. (Williams); Ph. D. (Strassburg). Associate Professor of English Literature, University of Chicago.

TOLMAN, Herbert Cushing, Nashville, Tenn.
A. B., Ph. D. (Yale); D. D. (Nashville). Professor of Greek, Vanderbilt University; Canon, All Saints' Cathedral.

TOWNLEY, Sidney Dean, Ukiah, Cal.
B. S., M. S. (Wisconsin); Sc. D. (Michigan). Astronomer in Charge of International Latitude Observatory; Lecturer in Astronomy, University of California; Editor of Publications, Astronomical Society of the Pacific.

TURNER, Frederick Jackson, Cambridge, Mass.
A. B., A. M. (Wisconsin); Ph. D. (Johns Hopkins); LL. D. (Illinois); Litt. D. (Harvard). Professor of American History, Harvard University; President, American Historical Association; Member, Massachusetts Historical Association; American Antiquarian Society; Colonial Society of Massachusetts; Wisconsin Historical Society; Mississippi Valley Historical Society, etc.

VAN DE WARKER, Ely, 404 Fayette Park, Syracuse, N. Y.
M. D. (Albany Medical and Union). Surgeon, Central New York Hospital for Women; Consulting Physician, St. Ann's Maternity Hospital; Senior Surgeon, Women's and Children's Hospital; Commissioner of Education, Syracuse.

VERRILL, Addison Emery, 86 Whalley Ave., New Haven, Conn.
B. S. (Harvard); A. M. (Yale). Professor of Zoology, Yale University, Curator of Zoology, Yale University Museum; President Connecticut Academy of Arts and Sciences.

WINCHELL, Newton Horace,
501 East River Road, Minneapolis, Minn.
A. M. (Michigan). Geologist and Archaeologist.

YOUNG, Albert Adams,
531 South Claremont Ave., Chicago, Ill.
A. B., A. M. (Dartmouth); B. D. (Andover). Clergyman.

MEMBERS DECEASED.

Information of whose decease has been received since the issue of Volume XVI.

BASCOM, John,
A. B., A. M. (Williams); D. D. (Iowa); LL. D. (Amherst, Williams, Wisconsin). Greylock Commissioner.

BLAIR, Emma Helen,
B. S., A. M. (Ripon and Wisconsin). Joint Editor of "The Philippines, 1493–1898," and Editor of "The Indian Tribes of the Upper Mississippi Valley."

BUCKLEY, Ernest Robertson, Rolla, Mo.
B. S.. Ph. D. (Wisconsin). Mining Geologist; President, American Mining Congress.

CHANDLER, Charles Henry,
A. B., A. M. (Dartmouth); LL. D., Colorado.

CHAPIN, Robert Coit, Beloit
A. B. (Beloit); Ph. D. (Columbia). Professor of Economics and Secretary of the Faculty, Beloit College.

DANIELLS, William Willard, Madison
M. S., Sc. D. (Michigan Agricultural). Professor Emeritus of Chemistry, University of Wisconsin.

DYKE, LeGrand Grandis, Madison

HOLLISTER, Albert Henry, Madison
Pharmacist.

KIMBALL, Mather Dean,
A. B., A. M. (Northwestern).

KING, Franklin Hiram, Madison
D. Sc. (Wisconsin).

KOELKER, William F.,
Ph. D. (Berlin). Assistant Professor of Organic Chemistry, University of Wisconsin.

PECKHAM, George Williams, Milwaukee
LL. D. (Wisconsin). Librarian, Milwaukee Public Library.

PERELES, James Madison, Milwaukee
LL. B. (Wisconsin). Lawyer; President, Milwaukee Public Library; Chairman, Wisconsin Free Library Commission.

PERELES, Thomas Jefferson, Milwaukee
LL. B. (Wisconsin).

MITCHELL, Irving N., Milwaukee
Ph. B. (Michigan). Professor of Biology, State Normal School, Milwaukee.

THWAITES, Reuben Gold, Madison
LL. D. (Wisconsin); Secretary and Superintendent, State Historical Society of Wisconsin; Vice-Chairman, Wisconsin Free Library Commission; Secretary and Editor, Wisconsin History Commission; Member, American Library Institute; Councellor, American Library Association.

UIHLEIN, August, Milwaukee
President, Second Ward Savings Bank; Secretary, Joseph Schlitz Brewing Company.

VOGEL, Guido Charles, Milwaukee

WHITMAN, Charles Otes, Chicago
A. B., A. M., (Bowdoin), Ph. D. (Leipzig), LL. D. (Nebraska). Head Professor of Zoology, University of Chicago.

PROCEEDINGS OF THE ACADEMY.

THIRTY-SEVENTH ANNUAL MEETING.

The meetings of the Academy for the presentation of papers, excepting that of the afternoon of the first day, were held at Madison, Wisconsin, February 7–8, 1907, in the Lecture Room of the Historical Library building. The meeting of Thursday afternoon was held in the physics lecture room in Science Hall. The following program was carried out, except for some changes in the order of presentation of papers:

THURSDAY, FEBRUARY 7TH.

Morning Session, 9:00 o'clock.

Reports of officers and committees, and general business.

Reading of papers.

1. The electrolytic production of iodoform. Arden R. Johnson.
2. The action of chlorosubstituted esters on amines and aminoesters. (By title). W. F. Koelker.
3. On the addition of acetic acid to pinene and limonene. E. Kremers and A. Sievers.
4. On the rate of solution of sublimed sulphur in milk of lime. E. Kremers and S. M. Sorley.
5. The optical rotatory power of very dilute solutions. Frederick L. Shinn.
6. A case of separation of colloids from each other by dialysis. Louis Kahlenberg.
7. On the estimation of boric acid in urine. Louis Kahlenberg.
8. On the suspension of solids in fluids, and the nature of colloids and solutions. F. H. King.
9. On the formation and coagulation of colloidal solutions of the metals. (Preliminary communication.) Louis Kahlenberg and Simon G. Engle.
10. A new method for the separation of the chloride of lithium from the chlorides of the alkalies. Louis Kahlenberg and Francis C. Krauskopf.
11. The relation between the processes of solution and chemical action. An outline of a new theory of solutions. Louis Kahlenberg.

Afternoon Session, 2:30 o'clock.

Reading of papers.

12. Some high temperature measurements. C. E. Mendenhall and and L. R. Ingersoll.
13. Note on some curious high temperature phenomena. C. E. Mendenhall and L. R. Ingersoll.
14. The alterating current galvanometer. A. Hoyt Taylor.
15. Evidences of sexual reproduction in the slime molds. Edgar W. Olive.
16. Nuclear migrations and cell fusions in the rusts. Edgar W. Olive.
17. The morphology of the spore forms of the rusts. A. H. Christman.
18. Heredity in the lower fungi. R. A. Harper.
19. Diakinesis in Thalictrum. J. B. Overton.
20. Concerning the organization of the cell in Marsilia. W. G. Marquette.
21. Cell and nuclear fusions in the promycelial cells of certain smuts. B. F. Luhman.
22. The distribution of grandparental characters in Pisum. (By title). C. E. Allen.
23. Some reactions of the Isopods. A. B. Clawson.

6:30 o'clock.

The annual dinner for members of the Academy and their friends.

FRIDAY, FEBRUARY 8TH.

Morning Session, 9:00 o'clock.

Business session.

Reading of papers.

24. Some remarks on the caddis flies and their larvae. C. T. Vorhies.
25. A summer resting stage in the development of Cyclops bicuspedatus. E. A. Birge.
26. On Latona parviremis, a new species of the genus Latona. (By title). E. A. Birge.
27. Some aquatic invertebrates that live under anaerobic conditions. C. Juday.
28. The fish fauna of Lake Pepin. George Wagner.
29. Notes on the whitefishes of Wisconsin. George Wagner.
30. The behavior of Loxophyllum. S. J. Holmes.
31. Amitosis in the Malpighian tubules of the walking stick. W. S. Marshall.

32. A statistical study of the sex-cells of Chrysemys marginata. Bennet M. Allen.
33. The Permian glaciation and the distribution of vertebrate animals. E. C. Case.
34. Some experiments on automaticity and conductivity of the auricles of the mammalian heart. Joseph Erlanger and Julian R. Blackman.
35. Manganese—A normal element in the tissues of the fresh water clams, Unio and Anodonta. Harold C. Bradley.
36. The occurrence of hematite implements in Wisconsin. Charles E. Brown.
37. A record of Wisconsin's aboriginal remains. Charles E. Brown.
38. The man mound near Baraboo. A. B. Stout.
39. The effigies of Wisconsin. Stephen D. Peet.

Afternoon Session, 2:30 o'clock.

Reading of papers.

40. The resuscitation incident in popular tale, ballad and drama. Arthur Beatty.
41. The relation between folk-tale and ballad, as shown by J. F. Campbell's "Tales of the West Highlands" and F. J. Child's "English and Scottish popular ballads." Arthur Beatty and Jessie V. Seaver.
42. A decree of the honorable and wise council of the city of Nuremberg concerning the prohibition of the great vices of blasphemy, carousing and treating. E. K. J. H. Voss.
43. The neglect of the ancient classics at the early medieval universities. Louis J. Paetow.
44. Education in the Philippines; Development and problems. W. H. Shephard.
45. Some effects of a sleet storm in the Ozarks of Missouri, November, 1906. (By title). E. R. Buckley.
46. Peculiar local deposits on bluffs adjacent to the Mississippi. G. H. Squier.
47. Some new Wisconsin minerals. (By title). S. Wiedman.
48. The pre-glacial course of the Red Cedar river. E. B. Hall.
49. The co-operative state and federal water power survey of Wisconsin rivers. Leonard S. Smith.
50. Cold waves of south-central Wisconsin. James L. Bartlett.

A detailed account of the sessions is herewith given:

THURSDAY, FEBRUARY 7.

Morning Session.

The meeting was called to order by President Kahlenberg. The reading of the minutes of the previous meeting was dispensed with.

The treasurer's report was read by Mr. Denniston. Upon motion of Mr. Davis, it was voted that an auditing committee be appointed by the president. Such a committee, consisting of Mr. Davis and Mr. King, was appointed.

The secretary's report was read.

The report of the membership committee was read by the secretary. In accordance with the report of the committee, and upon motion of Mr. Kremers, the secretary was instructed to cast the ballot of the Academy for the following named persons as members of the Academy:

Ruth Florence Allen.....Madison
Emil G. Arzberger.....Madison
Arthur Beatty .....Madison
Simon A. Blackmore.....Chicago, Ill.
Harold C. Bradley.....Madison
Adolph R. Braun.....Milwaukee
Edward Everts Browne .....Waupaca
Charles Thomas Brues.....Milwaukee
Henry Andrew Buehler.....Rolla, Mo.
Earle Smead Burnett .....Madison
Victor Coffin .....Madison
Walter Fenno Dearborn.....Madison
A. L. P. Dennis.....Madison
Robert Elkin Neil Dodge.....Madison
Linnaeus Wayland Dowling.....Madison
Edmund Pendleton Randolph Duval.....Madison
Joseph Erlanger .....Madison
Marshall Blakemore Evans.....Madison
Louis Falge .....Reedsville
Carl Russell Fish.....Madison
Lucy M. Gay.....Madison
Edward M. Gilbert .....Madison
Henry N. Goddard.....Waukesha
Felicie M. Haberstich.....Milwaukee
Martin Henry Haertel.....Madison
William Otis Hotchkiss.....Madison
Edgar Burton Hutchins, Jr.....Waukesha
Ashutosh Jana .....Birulia, India
Arden Richard Johnson.....Madison
James Lloyd Jones.....Hillside
William Henry Lighty.....Madison
Herman William March.....Madison
Andrew Fridley McLeod .....Madison

William Metzdorf ..... St. Francis
Seth Enoch Moody ..... Madison
William Jonathan Neidig ..... Madison
John Myers Olin ..... Madison
Daniel Henry Otis ..... Madison
Louis J. Paetow ..... Madison
David Leslie Patterson ..... Madison
Otto Patzer ..... Madison
Arthur Peabody ..... Madison
William David Pence ..... Madison
Eduard Prokosch ..... Madison
Frederick William Roe ..... Madison
Augustin F. Schinner ..... Superior
Paul A. Seifert ..... Gotham
Helen Sherman ..... Milwaukee
Edwin Raymond Smith ..... Madison
George Hull Squier ..... Trempealeau
Arlow Burdette Stout ..... Baraboo
Albert Hoyt Taylor ..... Madison
Ellen Torelle ..... Milwaukee
Abram Ray Tyler ..... Beloit
Oliver P. Watts ..... Madison
George A. West ..... Milwaukee

Mr. Wagner read the report of the exchange committee. Upon motion of Mr. Davis, it was voted that the report be accepted, the committee continued, and that there be placed at the committee's disposal such sum of money as the council may find it advisable to appropriate for such purpose.

Upon motion of Mr. Davis, the librarian was made an additional member of the exchange committee.

The following proposed amendment to the constitution, which had been proposed by five members, and notice of which had been sent to all members of the Academy more than one month before the present meeting, was then read by the secretary:

"Article III, Section 4, is hereby amended by inserting the words "or the council" after the word "Academy" in the first line of said section, so that this section when amended shall read as follows:

'Active members shall be elected by the Academy or the council and shall enter upon membership on the payment of an initiation fee of two dollars which shall include the first annual assessment of one dollar. The annual assessment shall be omitted for the president, secretary, treasurer, and librarian during their term of office.'"

After some discussion, the amendment was adopted by unanimous vote of the members present.

The reading of papers was then taken up.

During the reading by Mr. Kahlenberg of papers numbers 6, 7 and 11, the chair was occupied by Mr. Davis.

Afternoon Session.

The meeting was called to order by President Kahlenberg.

The whole of the session was devoted to the reading and discussion of papers.

Thursday Evening.

The annual dinner, given by the local members of the Academy, complimentary to the visiting members and guests, was held at the Madison Woman's Club building. Thirty-six persons were present, of whom ten were from out of town.

After the dinner, President Kahlenberg acting as toastmaster, short talks were given by Messrs. W. W. Daniells, E. B. Hutchins, E. A. Birge, R. A Harper, and E. B. Skinner, and Miss Lutie Stearns.

FRIDAY, FEBRUARY 8.

Morning Session.

The meeting was called to order by President Kahlenberg, and the reading of papers was at once taken up.

Paper number 38 was read by the secretary in the absence of the author.

Dr. Davis presented the report of the auditing committee, who had examined the accounts and vouchers of the treasurer and had found his report correct. The reports of the treasurer and of the committee were received and placed on file.

Afternoon Session.

The meeting was called to order by President Kahlenberg.

A supplementary report of the membership committee was read by the secretary. In accordance with this report, and upon motion of B. M. Allen, the secretary was instructed to cast the ballot of the Academy for the following named persons as members of the Academy:

Katherine Bones ..... Genoa Junction
T. E. Brittingham ..... Madison
Adolph Finkler ..... Milwaukee
Eugene Allen Gilmore ..... Madison
Edward B. Hall ..... Madison
John Louis Kind ..... Madison
Jonathan Risser ..... Beloit
William Henry Shephard ..... Madison

The reading of papers was then resumed, and the program was completed, paper number 39 being read by the secretary in the absence of the author.

The meeting then adjourned.

C. E. ALLEN, Secretary.

REPORT OF THE SECRETARY, FEBRUARY 7, 1907.

To the Council of the Academy:—

The secretary begs to submit the following report for the year 1906:

At the last meeting of the Academy the number of honorary members reported was 6; of life members 12; of active members 189; and of corresponding members 43. During the year one honorary member died. One life member whose name was included in last year's list has died, and two life members were elected at the last meeting; the present number of life members is therefore 13. Of the active members, two have died during the year, one had died previously, notice of whose death had not come to the secretary, seven have resigned or been dropped for non-payment of dues; and three were transferred to the corresponding membership list, and two to the life membership list, making a total loss of 15. Of the persons elected to membership in December 1904, who had not qualified previous to the last meeting, six have since qualified; and of the 31 elected a year ago, 9 have qualified; one name has been transferred from the corresponding to the active list; the net gain in number of active members during the year therefore is 21, and the present number 210. Of the 43 corresponding membes, one died during 1904 whose death had not been reported to the secretary; one has been transferred to the active list, and two have resigned; three names were added to the list by vote of the Academy at its last meeting, so that there has been a net loss of one. Summarizing, the membership list stands at present:

Honorary members	5
Life members	13
Active members	210
Corresponding members	42
Total	270

The deaths of the following members have occurred since the last meeting, or if they occurred earlier have not been previously reported:

Nathaniel Southgate Shaler, professor of geology in Harvard University and dean of the Lawrence Scientific School, an honorary member of the Academy from its earliest years, who died at his home in Cambridge, Mass., April 10, 1906.

Amos Arnold Knowlton, for many years a member of the faculty of the English department in the University of Wisconsin and an active member of the Academy since December 30, 1890, who died at Madison, April 14, 1906.

Herman Frederick Lueders, a teacher and a man of keen aptitude for scientific research, whose activities in his chosen field were sorely hampered by ill health, a member of the Academy since December 27, 1893, who died at Sauk City July 2, 1904.

Charles Frederick A. Zimmerman, principal of the seventeenth district school, Milwaukee, a member of the Academy since June 6, 1895, who died at his home June 20, 1906.

Edmund Andrews, physician and professor of clinical surgery in Northwestern University, a corresponding member of the Academy since 1875 or 1876, who died at his home in Chicago, January —, 1904.

Memorial sketches of these deceased members will appear in the forthcoming second part of Volume XV of the Transactions.

Since the last meeting, Volume XV, Part 1, of the Transactions has been published. This part contains twelve articles, occupying 272 pages, and illustrated by eight plates and seven text figures. Part 2 of Volume XV is now in the hands of the printers. In the printing of this half volume the same vexatious delays on the part of the state printer have obtained that have been experienced in past years. The time required for printing has been made somewhat greater by the increased amount of material included in this half volume, but this furnishes no satisfactory excuse for the printer's delay.

Two years ago, the secretary was authorized to have the volumes of the Transactions printed in smaller parts, of about one hundred pages each. Circumstances connected with the publication of Volume XV made it seem impracticable at that time to put the new plan into practice. The secretary is of the opinion that the adoption of this method of printing will do something toward obviating the present annoying delays, and unless unforeseen obstacles present themselves the plan will be put into effect in the publication of Volume XVI.

With the present income of the Academy, it will be possible to add at least one hundred dollars each year to the permanent fund, and also to appropriate a considerable amount for the extension of the library. The only apparent way in which the income of the Academy can be materially increased is by the extension of its active membership. To this end a canvass has been undertaken among those citizens of the state who might be supposed to be interested in the work of the Academy, with the gratifying result that a larger number of applications for election to membership are to be presented at this than at any previous meeting. It is intended to continue this canvass during the coming year. An amendment to the constitution is to be voted on at this meeting, which, if adopted, will authorize the council to elect persons to membership in the Academy in the interim between the annual meetings. The proposed change is in line with the practice of many similar societies, and would make possible a canvass for new members throughout the year, instead of practically confining it, as at present, to the few weeks immediately preceding the annual meeting.

Respectfully submitted,

C. E. ALLEN,
Secretary.

REPORT OF THE SECRETARY, FEBRUARY 14, 1908.

To the Wisconsin Academy of Sciences, Arts, and Letters:—

Your secretary begs to submit the following report:—

At the last annual meeting, the number of members of the Academy was:

Honorary	5
Life	13
Active	210
Corresponding	42
Total	270

At the last meeting, 64 persons were elected to active membership and two have since been elected by the council. Of the 66 persons so elected, 58 have qualified by the payment of the initiation fee. During the year, one corresponding member and four active members have died. There has thus been a net gain of 54 active members and a loss of one in the corresponding list, making the present membership:—

Honorary	5
Life	13
Active	264
Corresponding	41
Total	323

During the past year, the Academy has suffered the loss by death of the following five members:

Rufus H. Halsey, president of the State Normal School at Oshkosh, any active member of the Academy since December 28, 1900, who died July 25, 1907, at Gogebic, Michigan.

Katherine Herkimer Bones, principal of the Genoa Junction High School, elected to membership in the Academy February 8, 1907, who died at her home in Racine, September 7, 1907.

Augustus J. Rogers, principal of the Milwaukee South Division High School and for many years a prominent educator of the state, an active member of the Academy since December 30, 1884, who died at his home in Milwaukee, November 2, 1907.

James Lloyd Jones, a member of the Board of Regents of the University of Wisconsin, elected to membership in the Academy February 7, 1907, who died at his home at Hillside, November 22, 1907.

William Kerr Higley, secretary of the Chicago Academy of Sciences, and Editor of *Birds and Nature*, elected to membership in the Academy December 28, 1881, and a corresponding member since 1892, who died at Chicago, January 12, 1908.

As in the past, the state printer has caused great delay in the publication of the Transactions, the situation having been made somewhat worse than usual by the exceptionally long session of the legislature of 1907. The printing and binding of Part 2 of Volume XV have just been completed, and this part will be distributed in the immediate future. This half-volume consists of 762 pages, and contains 29 articles, besides miscellaneous matter, accompanied by 52 plates and other illustrations. Following the plan discussed in the secretary's report of a year ago, a start has been made, beginning with Volume XVI, in the matter of publishing the Transactions in smaller and more numerous parts. Part 1 and most of Part 2 of Volume XVI are now in type, and material is in the secretary's hands sufficient for two or three additional parts. It is hoped that the new method will to some extent alleviate the inconvenience of the delays in printing which, under the present system of state printing, can probably never be entirely done away with.

In conclusion, the secretary begs to submit his resignation, and requests that a successor be elected at this meeting.

Respectfully submitted,

C. E. ALLEN.

TREASURER'S REPORT.

RECEIPTS.

Balance in treasury January 1, 1906	$113.47
Received for annual dues January 1, 1906–December 31	203.00
Received for Transactions sold	5.50
Received for extra separates and plates	13.42
Interest on 15 bonds at 6%	90.00
2 bonds matured and paid	200.00
Interest on same	12.00
Total receipts for 1906	$637.39

DISBURSEMENTS.

Postage for treasurer (3) (12)		$8.00
Paid to Geo. Wagner (for library) Vouchers (1) (8) (10)		64.43
Clerical services (Mailing Trans.) (11)		18.50
Rental Safety deposit box (2)		3.00
Secretary (expenses) 1906 (15)		75.00
Stationery, printing and engraving		
Tracy, Gibbs & Co. (4) (5) (6) (14)	28.00	
Parsons Prtg. Co. (7) (9) (17) (18)	19.25	
Capital City Paper Co. (13)	7.35	
Democrat Prtg. Co. (19)	6.25	
Mandel Engraving Co. (20)	.75	
Rogers & Co. (21)	3.65	

Madison City Street Imp. bonds purchased		
No. 31 Prospect Ave. due 1914	107.00	
No. 32 Prospect Ave. due 1914	107.00	
No. 33 Prospect Ave. due 1915	108.00	
Total disbursements 1906	$556.18	556.18
Balance in treasury January 1, 1907		$81.21

SUPPLEMENTARY REPORT.

Jan. 1, 1907–Feb. 6 inclusive.

RECEIPTS.

Balance on hand Jan. 1, 1907	$81.21
Transactions sold	1.00
Annual dues	5.00
New members	30.00
Separates	5.25
	$122.46

DISBURSEMENTS.

Paid to Geo. Wagner (library)	$54.87	
Paid to Heliotype Prtg. Co.—draft	4.55	
		59.42
Balance on hand Feb. 6, 1907		$63.04

There is now invested $1,800.00 by the Wisconsin Academy of Science, Arts and Letters in a permanent fund.

The investment is in the form of 18 $100 street improvement bonds which bear 6% interest. These bonds are deposited in a safety deposit box rented by the Academy of Sciences, Arts and Letters in the Bank of Wisconsin.

R. H. DENNISTON,
Treasurer.

REPORT OF AUDITING COMMITTEE.

February 7, 1907.

To the Wisconsin Academy of Sciences, Arts and Letters—

Your auditing committee reports that it has examined the books and vouchers of the Treasurer and finds that his report corresponds fully therewith.

J. J. DAVIS,
F. H. KING,
Auditing Committee.

Your auditing committee would also report that one of its members inspected the Academy box in the vaults of the Bank of Wisconsin, and found therein eighteen Madison improvement bonds of the par value of one hundred dollars each as called for by the Report of the Treasurer.

REPORTS OF COMMITTEES ON EXCHANGES.

Madison, Wis., February 1, 1907.

To the Wisconsin Academy of Sciences, Arts and Letters:

Your Committee on Exchanges hereby submits the report of its work during the past year. During this period we have applied our energies to the following tasks:

1. The securing from exchanging societies of such of their earlier publications as are not on our shelves. This has been, and must be for several years to come, the chief work of such a committee as this. During the past year, or since our last report, there have been thus received:

629 volumes
200 parts of volumes.

With these, 7 different sets of publications, previously incomplete, were made complete; and 13 volumes were supplied with all missing parts. It is to be understood that the above numbers include no material for which money, outside of transportation or custom house charges, was paid by the Academy.

2. The arrangement of exchanges with Societies not now on our list. Thirty-five such societies were added during the past year.

3. The purchase of such volumes or parts as are not otherwise obtainable. For this purpose your Academy allotted at its last meeting, two hundred dollars, or so much thereof as the finances of the Academy would permit.

This committee has actually spent during the year $119.30 of the funds of the Academy. Besides this the Chairman of the Committee has had at his disposal, from outside sources he is not at liberty to disclose, $40, and a similar sum will be available the coming year. The expenditures include postage, custom house and transportation charges, and the cost of books purchased. Nothing was expended for clerical work. We ordinarly purchased such material only as was offered at bargain price, usually paying for bound volumes not more than the cost of the binding. Only in several cases where single volumes or numbers were needed to complete sets, were higher prices paid. We have not thought it necessary to enumerate all the purchases made. Among the principal ones were:

26 vols. Monatsberichte der k. preussischen Akademie.
9 vols. Gesellschaft Naturforschender Freunde.
1 vol. Transactions New Zealand Institute.
1 vol. Archives Néerlandaise des Sciences Exactes et Naturelles.
5 vol. Verhandlungen der k. k. Zoologisch botanischen Gessellschaft.

Many parts of the publications of the Agassiz Museum. This valuable set was presented by Mr. Agassiz, and is one of the most important we possess. The missing parts appear only rarely in the market.

It is hoped that the Academy will sanction further expenditure in this direction. Among the sets which we hope to complete this coming year are:

Publications of the K. Sachsische Gesellschaft der Wissenschaften.

Proceedings of the Royal Society, London.

Zeitschrift der Deutschen Geologischen Gesellschaft.

Academy at Amsterdam.

Besides this there should also be purchased various single numbers to complete volumes for binding.

4. Arrangements of exchange material with the other Libraries centered around the University, to such an extent as may be mutually beneficial. Such arrangements now exist with the General Library of the University and with the Historical Society. We hope to be able before long to renew certain negotiations with the Astronomical Library, opened nearly two years ago, but dropped through lack of time.

In this part of the work we have been guided by these principles:

a. The libraries housed here, form, for all purposes of their patrons, an organic whole; therefore, as a matter of economy of time, money, and space, duplication should in general be avoided.

b. Where partial sets of a given serial exist in different libraries, they should be brought together in one, and duplications eliminated; this not only as a matter of economy, but out of consideration to users of the libraries, as well as to employes.

c. The duty and privilege of our Academy, in this syndicate, is to accumulate as complete collections as possible of the serial publications of scientific societies, both great and small. In general it shall turn purely historical publications over the Historical Society. University publications, including dissertations, are the proper charge of the University. Purely astronomical material belongs to the Observatory; the publications of Agricultural Experiment Stations belong in the Agricultural Library.

Great advantage will accrue to the Academy by these arrangements the carrying out of which has only just begun. That the principles above cannot always be fully lived up to, depends entirely on the poverty of the Academy.

5. Disposing of the duplicates and separata in the Academy's collection. Little progress has been made here. It is intended to go over all our duplicates, including those derived from the Geol. & Nat. History Survey, carefully, to pick out all of which the retention in one library or another may be desirable. The rest we hope to offer for sale to such specialists as may have use for them.

6. Incorporating exchanges received by the Geological and Natural History Survey into the Academy Library. This work is now up to date.

Apart from its regular work the committee desires to acknowledge certain gifts to the Academy:

From Professor Chandler, a number of volumes of the Boston Journal of Chemistry.

From Professor W. S. Marshall: 12 nos. Allgemeine Zeitschrift für Entomologie. 4 vols. Insektenbröse.

This committee makes the following recommendations to the Academy:

1. That this committee be continued for another year, and that the Librarian be added to it to replace Professor Hobbs.

2. That the Academy sanction the expenditure of such a sum in its work during the coming year, as may seem proper to the Council.

Finally, this committee desires to acknowledge great indebtedness to the University Librarian, for his readiness at all time to cooperate with us.

Respectfully submitted,

EDWARD KREMERS,
GEORGE WAGNER.

REPORT OF THE COMMITTEE ON EXCHANGES.

February, 10, 1908.

To the Wisconsin Academy of Sciences, Arts and Letters:

The undersigned committee on exchanges desires to submit its third annual report. The primary function of the committee is to secure exchanges with societies not previously on our list, and to obtain missing parts of series already on our shelves. The result of this work during the past year has been as follows:

New exchanges secured	14
Missing volumes secured	290
Missing parts secured	409
Sets of serials made complete	10
Volumes made complete	56

These figures cover only the cases where material was obtained by solicitation from the publishing societies. The receipt of 85 volumes and 230 parts (completing 35 more volumes) is noteworthy.

In certain other cases it was necessary to purchase volumes or parts to complete our sets. Our previous policy of purchasing only real bargains, has been continued. Funds from these sources were available:

a. Allowed by executive committee from funds of the Academy as per Academy resolution	$144.11
b. Sale of duplicates of Academy collection	22.00
c. Donated, by unnamed person, through chairman of the committee	40.00

From the two sums emanating from the Academy were paid postage to the extent of $7.50, letter files, 75c, and custom house charges, $4.35. The remainder was spent on volumes or parts needed, of the publications of the following:

California Academy of Sciences, K. Sächsische Akademie, Zeitschrift für Naturwissenschaften, Naturhistorische Gesellschaft der Rheinlande, Deutsche Geologische Gesellschaft, K. Preussische Akademie, Queekett Microscopical Club, Australasian Association for the Advancement of Science, Musée Teyler, Museum of Comparative Zoology, K. Akademie van Wetenschappen, Amsterdam, and Academy of Natural Sciences at Philadelphia.

The last item was purchased an exceptional bargain at $60, to be paid for next year. But the volumes of the K. Sächsische Akademie, and the Deutsche Geologische Gesellschaft (outside of those mentioned above), announced in our last report as on the purchasing program, have been delayed in shipment, and payment for them was therefore postponed to the next fiscal year, and the above vols. from Philadelphia included in this year's accounts.

The above purchases have enabled us to complete our sets of the Journal of the Queekett Microscopical Society, of the Proceedings of the Philadelphia Academy, of the publications of the Amsterdam Academy (except Latin prize poems), and of the Archives du Musée Teyler and to bring the sets of the Naturhistorische Gesellschaft at Bonn, and of the Australasian Association for the Advancement of Science within one volume of completion. The proceedings of the K. Preussische Akademie we have now complete from 1866.

From the $40 donated were paid 95c for custom house charges. The remainder went for parts of the publications of the Agassiz Museum, The Condor, the Zoological Museum of the University of Naples, the Queckett Microscopical Club, the Finska Vetenskaps Societet, and certain minor publications. Four sets were thus completed, namely The Condor, Pacific Coast Avifauna, Annuario of the Zoological Museum at Naples, and the Zoologischer Garten.

We have been able, also, to secure 45 vols. and 55 parts by exchanging some of our duplicate material with the Library of Congress.

Another duty of this committee has been to correlate the Academy collections with those of the University and the Historical Society. The hearty cooperation of the librarians of these two institutions has made this work a pleasant and a profitable one. As a result many of our previously rather fragmentary sets have been made fairly complete, and we have further been able to remove from our shelves material much more appropriate elsewhere.

All these activities should be pursued further. The committee therefore begs to move:

That the exchange committee be continued for another year, and that it be allowed for its work such sum as the executive committee may deem wise, and that it further be allowed such sums as may be realized from the sale of duplicates in the Academy collections.

Respectfully submitted,
The Committee on Exchanges,
GEORGE WAGNER,
W. M. SMITH,
EDWARD KREMERS.

MEETINGS OF THE COUNCIL,

February 1, 1905.

Present: Davis, Van Hise, Birge, Skinner.

Mr. Birge was appointed delegate to the meeting of the Landmarks Committee of the Wisconsin Federation of Women's Clubs.

Voted, that the exchange committee be requested to prepare a list of things desired before expending further funds.

The secretary was authorized to offer to prospective members to supply two back volumes of the Transactions to those who may pay dues at the present time.

It was proposed by the librarian and secretary to discontinue sending copies of the Transactions to certain persons on the list of corresponding members except upon their request. This proposition was approved.

E. B. SKINNER,
Secretary.

November 13, 1906.

Present: Kahlenberg, Denniston, Birge, Slichter, Allen.

The question of the time and place for the holding of the next annual meeting was discussed. Letters on this subject were read from E. C. Case, G. W. Peckham, C. H. Chandler, and J. J. Davis.

Voted, that the meeting be held at Madison in February, 1907, at the time of the meetings of the agricultural and other societies of the state.

The secretary was instructed to send out notices of a proposed amendment to the constitution authorizing the council to elect members of the Academy at any time during the year except during a meeting of the Academy.

C. E. ALLEN,
Secretary.

May 28, 1907.

Present: Kahlenberg, Denniston, Wagner, Allen.

William Finger, Milwaukee, and Albert D. Whealdon, Superior, were elected active members.

The application of Arthur M. Edwards, Newark, N. J., for corresponding membership, was left for further consideration.

The president reported the receipt of an invitation to be represented by delegate at Bologna, Italy, June 12–13. He had responded that it would be impossible to be represented.

The secretary reported the receipt of an invitation to be represented by delegate at a bicentennial celebration of the birth of Linnaeus, under the auspices of the New York Academy of Sciences, May 23. He had responded that it would be impossible to be represented.

The secretary reported the receipt of an invitation to be represented by delegate at the 7th International Zoological Congress in Boston, August 19–23. Mr. W. S. Marshall was appointed delegate, with authority to select an alternate in case he could not attend the meeting.

The treasurer reported upon the financial condition of the Academy.

Mr. Wagner reported upon the work being done toward the extension of the library.

One hundred and twenty-five dollars was appropriated for the work of the exchange committee.

Five dollars was appropriated as a contribution toward the fund being raised by the Wisconsin Archaeological Society for the purchase of the Baraboo man mound.

C. E. ALLEN,
Secretary.

January 3, 1908.

Present: Kahlenberg, Denniston, Allen.

An application of Arthur M. Edwards, of Newark, N. J., for corresponding membership, was presented and referred to Dr. J. J. Davis.

Plans for the next annual meeting were discussed.

The resignation of E. C. Case as vice-president was presented. The secretary was instructed to notify Mr. Case that his resignation is not accepted.

C. E. ALLEN,
Secretary.

FORTY-FIRST ANNUAL MEETING

The meeting was held in conjunction with the Wisconsin Archeological Society, the Wisconsin Mycological Society, and the Wisconsin Natural History Society, in Madison, February 16 and 17, 1911.

The sessions were held in the Lecture Room of the State Historical Society. The following program was presented, President Plantz in the chair:

THURSDAY, FEBRUARY 16.

Morning Session, 10:00 o'clock.

Preliminary Business.

Presentation of Papers.

1. The Relation between Area and Temperature of Lakes. Edward A. Birge. Twenty minutes.
2. On *Lepisosteus sinensis*, Bleeker. George Wagner. Five minutes.
3. On the Whitefish of Green Lake. George Wagner. Five minutes.
4. A Trematode Parasite of the English Sparrow in the United States. Leon J. Cole. Ten minutes.
5. Apparent Mutations in the Meadow Vole (*Microtus pennsylvanicus*. Leon J. Cole and George Wagner. Ten minutes.
6. The Nests and Larvae of *Necturus*. B. G. Smith. Ten minutes.
7. Pholiotas of the Region of the Great Lakes. Edward T. Harper. (By title.)
8. The Effect of Poisons on Sap Flow. J. B. Overton. Ten minutes.
9. The Structure and Cell Development of the Root Tip of a Sedge. A. B. Stout. Ten minutes.
10. Temperature in Relation to Infection with Certain Downy Mildews. I. E. Melhus. Fifteen minutes.
11. Nuclear Phenomena in the Tremellineae. E. M. Gilbert. Ten minutes.
12. The Structure and Development of *Collema crispa*. Freda M. Bachman. Ten minutes.
13. The Structure of the Central Body in the Trout. W. G. Marquette. Fifteen minutes.
14. The Cilia-forming Organ of Motile Plant Cells. C. E. Allen. Ten minutes.
15. Studies on Some Lakes in Central America. Chancey Juday. Ten minutes.

Afternoon Session, 2:00 o'clock.

Presentation of Papers.

16. Socrates and the Greek Gods. William Ellery Leonard. Twenty-five minutes.
17. A Dramatic Office for the Feast of the Presentation. Karl Young. Fifteen minutes.
18. Browning's Idealism. J. W. Cunliffe. Thirty minutes.
19. Some Tendencies of Seventeenth Century Autobiography. E. H. Gardner. Twenty minutes.
20. The Purpose of the Book of Ruth. Louis B. Wolfenson. Twenty minutes.
21. The Last Will and Testament as a Form of Literature. Eber Carle Perrow. Fifteen minutes.
22. Tennyson and Unitarianism. Margaret Ashmun. Twenty minutes.
23. The Dream Dance of the Chippewa and Menominee Indians of Wisconsin. Samuel A. Barrett. With lantern slide illustrations. (In Room 112, University Hall, at 4:30 o'clock.)

Evening, at 6:30 o'clock.

A dinner to the visiting members was served to the visiting members. The Centenary of Increase A. Lapham was commemorated. A very pleasant feature of the occasion was the presence of Mr. Lapham's daughter and son, Miss Julia Lapham, and Mr. Charles Lapham.

FRIDAY, FEBRUARY 17.

Morning Session, 9 o'clock.

24. Public Libraries and Literary Culture in Ancient Rome (Early Empire). Clarence E. Boyd. Twenty minutes. To be read by M. S. Slaughter.
25. The Cost of Living in the Twelfth Century. D. C. Munro. Twenty minutes.
26. The Railways of the Old Northwest before the Civil War. Frederic L. Paxson. Twenty minutes.
27. Fulk of Neuilly. Milton R. Gutsch. (By title).
28. The Censorship under the First Empire. Victor Coffin. (By title).
29. On a Certain Caution to be Observed in the Hunting of Sources and Parallels. R. E. N. Dodge. Twenty minutes.
30. The Musical Elements of French Versification. Mathurin M. Dondo. Twenty minutes.
31. The Regulations of the University of Wittenberg, issued in the year 1546, regarding the dress of the Professors, their Wives, and the Student Body; also Restrictions in regard to the Wearing of Jewelry, the Cost of Weddings, Betrothals, Baptismals, and other Festivities. Ernst Voss. Fifteen minutes.

32. On a Recently Recovered Version of the American Ballad, *Fair Charlotte.* Arthur Beatty. Five minutes.
33. Recent Progress in Physics. E. C. Mendenhall. Twenty-five minutes.
34. The Mythological Concepts of the Cayapa Indians of Ecuador. Samuel A. Barrett. Twenty minutes.
35. Wormwood in Wisconsin. Edward Kremers. Ten minutes.
36. Recent Work in Securing the Preservation and Marking of Indian Earthworks about Madison. Charles E. Brown. Ten minutes.
37. The Silver Trade Crosses of Wisconsin. Charles E. Brown. (By title.)
38. The Need of Proper State Protection for the Prehistoric and Historic Indian Remains Located upon the Public Lands, Reserves, Parks, and other Public Places in the State. H. T. Field. (By title.)
39. The Discussion of Some Formulas Used in Depreciation Problems. E. B. Skinner. Twenty minutes.

Afternoon Session, 2:00 o'clock.

40. On Certain Instincts in the Larvae of Some Parasitic Bees. Sigmund Graenicher. Fifteen minutes.
41 Psychological Study of the Common Black Ant (*F. subsericea*); proving that in a Maze an Ant will take the straightest Course. A. C. Burrill. (By title.)
42. Aeshnine Wing Venation (*Odonata*). Richard A. Muttkowski. (By title.)
43. The Ethical Philosophy of Richard Cumberland. Frank C. Sharp. Thirty minutes.
44. The Psychological Basis and Limitations of Individualism. W. K. Wright. Twenty-five minutes.
45. A Study of Retarded Children in a Group of Northwestern School Systems. Freeman E. Lurton. (By title.)
46. The Glacial Lake of the Fox River Valley and Outlet, and the Diversion of the Wisconsin River. Samuel Weidman. Twenty minutes.
47. The Chlorin Content of Drinking Water. A. F. Gilman. Twenty minutes.
48. Note on the Synthesis of Esters, (so-called Volatile Oil), in Saw Palmetto Berries. Edward Kremers. Five minutes.
49. An Alkaloidal Derivative from a Volatile Oil Constituent. Nellie Wakeman and Edward Kremers. Five minutes.

After the presentation of the papers, Mr. R. H. Denniston, Treasurer of the Academy since 1905, presented his resignation. A committee consisting of Samuel Weidman, D. C. Munro, and Arthur Beatty was appointed by the chair to nominate a successor. The committee nominated W. G. Marquette, Madison, and the report was adopted.

The committee on membership reported the following list of names for membership, which was approved:

Clarence E. Boyd	Tallahassee, Fla.
Leon J. Cole	Madison
John William Cunliffe	Madison
Mathurin M. Dondo	Madison
Milton R. Gutsch	Madison
Edward T. Harper	Madison
W. C. Hotchkiss	Madison
E. B. Hutchins	Fond du Lac
Frederic L. Paxson	Madison
Louis E. Reber	Madison
Fredrick C. Ruff	Appleton
Louis B. Wolfenson	Madison
William K. Wright	Madison

The Committee on Exchanges presented the following report, which was accepted:

REPORT OF THE COMMITTEE ON EXCHANGES.

Madison, February 15, 1911.

To the Wisconsin Academy of Sciences, Arts, and Letters:

The Exchange Committee, first appointed five years ago, herewith presents its report for the past year. Due to many and unavoidable causes its activities have been much less in extent than in previous years. As heretofore our primary work has been to secure missing parts of sets, as well as new exchanges, especially by correspondence with the societies concerned. The result has been as follows:

Missing volumes received	83
Missing parts received	28
Volumes completed	2
Sets completed	5
New exchanges	5

As heretofore an annual sum of $40.00 has been at the disposal of the Committee, which has expended for similar purposes, with the following result:

Volumes purchased	19
Parts purchased	5
Sets completed	4

Of the funds of the Academy $45.00 has been expended since our last report, $3 for postage, the rest for the completion of our set of the Proceedings of the Royal Society, London.

The new exchanges are as follows:

Statens Skogs-Försoksanstalt, Stockholm.
Revue Scientifique du Bourbonnais.
Colner Akademie für Praktische Medizin.
Kaiserliche Biologische Anstalt für Land- und Forstwirthschaft.
Musee Zoölogique, Imperiale des Sciences, St. Petersburg.

Probably the most important part of the Committee's work during the past year has been its activity as an advisory board during the process of cataloguing the Academy library by the staff of the University Library. This work has raised many perplexing questions, most of which we hope to have solved in satisfactory manner. The cataloguing is progressing rapidly, and we hope to see it completed during the ensuing year.

As heretofore we recommend that this Committee be continued for another year, and that it be allowed for use in its work such amounts from the Academy's funds as may to the Executive Committee seem wise; and that it be further allowed to use such sums as may be realized from the sale of duplicate material.

Respectfully submitted,

GEORGE WAGNER,
WALTER M. SMITH,
EDWARD KREMERS.

FORTY-SECOND ANNUAL MEETING.

The meeting was held jointly with the Wisconsin Archeological Society, the Wisconsin Mycological Society, and the Wisconsin Natural History Society, in Madison, on April 4 and 5, 1912.

The morning sessions were held in the Lecture Room of the State Historical Library, and the afternoon sessions in Room 42, Science Hall. The following progamme was presented:

THURSDAY, APRIL 4.

Morning Session, 10:00 o'clock.

D. C. Munro presided, as President Plantz was delayed:
Preliminary Business.
Presentation of Papers.

1. Efforts to Prevent the Introduction and Dissemination of Injurious Insects. J. G. Sanders. (By title.)
2. The Oscillations of the Lower Water in Green Lake. E. A. Birge. Twenty minutes.
3. Notes on Lake Michigan Swarms of Chironomids. A. C. Burrill. Ten minutes.

4. Some Points in the Anatomy of the Four-Spotted Dragon-fly, Libellula 4-maculata. William S. Marshall. (By title.)
5. Economic and Biologic Notes on the Giant Midge (*Chironomus plumosus*, Meyen.) A. C. Burrill. Twenty minutes.
6. Palmer's Organ and its Function. J. E. Wodsedalek. Ten minutes.
7. The Behavior of Leucocytes. N. Fasten. Ten minutes.
8. On the Distribution of two Wisconsin Mammals. George Wagner. Five minutes.
9. The Boreal Life Zone in Wisconsin. Sigmund Graenicher. Fifteen minutes.
10. Doubts and Progress. H. M. Kallen. Twenty minutes.
11. The *Lebertia* of Wisconsin. Ruth Marshall. (By title.)
12. A Contribution to the Natural History of the Amphipod *Hyalella knickerbockeri* (Bate). Hartley H. T. Jackson. (By title).

Afternoon Session, 2:00 o'clock.

President Samuel Plantz called the meeting to order.

13. The Nuclear Behavior in the Basidium of Auricularia. E. M. Gilbert. Ten minutes.
14. A New Method of Fertilization in Lichens. Freda M. Bachman. Ten minutes. (Illustrated.)
15. A Comparison of Plant and Animal Spermatogenesis. C. E. Allen. Ten minutes. (Illustrated.)
16. The Development of Melanospora. J. B. Overton. Ten minutes. (By title.)
17. A Comparison of the Botany of the Galapagos and Cocos Islands. Alban Stewart. Ten minutes. (Illustrated.)
18. Apogamy, Apospory, and Related Phenomena in the Purple Cliff Brake. W. N. Steil. Ten minutes. (Illustrated.)
19. The Tapetal Cells of *Lycopodium Selago* and *L. Annotinum*. R. H. Denniston. Ten minutes. (Illustrated.)
20. Colony Formation and Development in Certain Coenobic Algae. Gilbert M. Smith. Ten minutes. (Illustrated.)
21. Modern Pottery-Making among the Hopi and Tewa Indians of Northern Arizona. Samuel A. Barrett. Twenty minutes. (Illustrated.)
22. The Niman Katcina of the Hopi Indians. Samuel A. Barrett. Thirty minutes. (Illustrated.)
23. A Provisional List of Parasitic Fungi of Wisconsin. J. J. Davis. (By title.)
24. A preliminary Report on the Hepaticae of the Duluth-Superior Region. George H. Conklin. (By title.)
25. Species of Pholiota and Stropharia in the Region of the Great Lakes. E. T. Harper. (By title.)

Evening Session, 6:30 o'clock.

An informal dinner was given to the visiting members of the Societies at the University Club.

The retiring President of the Wisconsin Academy of Sciences, Arts, and Letters, President Samuel Plantz, delivered the Triennial Address.

FRIDAY, APRIL 5.

Morning Session, 9 o'clock.

26. John Thelwall, a Forgotten Revolutionary Poet. Arthur Beatty. Fifteen minutes.
27. Hamann—A German Sidelight on English Literature. H. A. Watt. Fifteen minutes.
28. Hagbard's Beard (Kormakssage Chapter III.) Lee M. Hollander. Fifteen minutes.
29. Luther Parker: New Hampshire and Wisconsin Pioneer. Grant Showerman. Twenty minutes.
30. Social Conditions in Southern Bavaria in the Thirteenth Century as shown in Meier Helmbrecht. Martin H. Haertel. Fifteen minutes. (Read by B. Q. Morgan.)
31. The Requirements for the Degrees at the University of Paris in Thirteenth Century. Sumner H. Slichter. Ten minutes.
32. Relations between the Ecclesiastical and the Educational Policy of the First Napoleon. Victor Coffin. (By title.)
33. A Theological Treatise by Dr. Hunnius on the Question whether it is Permissible to Take Interest on Money Loaned. 1622. Ernst Voss. (By title.)
34. *Officium Pastorum:* A Study of the Dramatic Development within the Liturgy of Christmas. Karl Young. (By title.)
35. Some Veridical Relations between Certain Celtic Tales and Certain Alleged Experiences. Arthur Beatty and Fritz Kunz. (By title.)

At the end of the session, the following business was transacted:

The chair appointed as a committee on the nomination of officers for the next three years E. A. Birge (chairman), J. J. Davis, E. B. Skinner, C. E. Allen, and R. H. Denniston.

The Exchange Committee made the following report, which was adopted:

Madison, April 1, 1912.

To the Wisconsin Academy of Sciences, Arts and Letters:

Your Exchange Committee herewith presents its sixth annual report. The chief activity of the Committee, this year as last, has been to give aid in various ways during the cataloguing of the Academy Library by

the University Library staff, and the correlation of our Library with the others in the building. This work is now substantially finished. It involved many difficult problems, not a little compromise, and much patience. We hope, however, that those who have followed its progress or examined its results will see the great improvement in usefulness of all parts of the scientific libraries thus brought together. We owe much to the willingness and skill especially of Miss Coddington and Miss McCulloch of the University cataloguing force.

The work of securing missing parts and new exchanges has had to take a subordinate place this year. By correspondence with Societies the following have been secured:

Missing volumes received	2
Missing parts received	3
Volumes completed	3
Sets completed	0
New exchanges	4

Again a sum of $40.00 has been at our disposal, which was expended, securing 13 volumes and two parts, completing one volume previously incomplete.

Of the Academy funds we have expended about $95:00 (the Treasurer's report will show the exact amount) of which $92.67 was paid for 18 volumes of the Abhandlungen der K. Sächsischen Gesellschaft der Wissenschaften, a great addition to our material.

The new exchanges are as follows:

'sRyks Herbarium, Leiden.
Svenska Botaniska Förening.
Philosophical Society, University of Virginia.
Société d'Histoire Naturelle, Autun.

The present relations and condition of our Library make it desirable that the work of the Library Committee and Exchange Committee be consolidated. We therefore recommend:

1. That the Exchange Committee be discharged, and its duties turned over to the Library Committee.

2. That the Library Committee be allowed for use in its work such amounts from the Academy's funds as may to the Executive Committee seem wise; and that it be given authority to dispose of the duplicates of the Library in such manner as it may deem fit.

Respectfully submitted,

GEORGE WAGNER,
WALTER M. SMITH,
EDWARD KREMERS.

The Treasurer, R. H. Denniston, acting for W. G. Marquette, resigned, presented his report, and the Chairman appointed as an auditing committee D. C. Munro and George Wagner.

TREASURER'S STATEMENT.

1911	RECEIPTS.		
Feb. 18, balance		$114.85	
Dues		280.94	
Transactions sold		2.50	
Bonds matured		400.00	
Interest on bonds		124.75	
			$923.04
	DISBURSEMENTS.		
5 City Street Improvement bonds, voucher 2		$520.00	
Stationery and envelopes, vouchers 1, 4, 5, 7, 8, 9		30.26	
Printing, voucher 3		18.50	
Secretary's allowance, voucher 6		100.00	
Shipping and wrapping Trans., vouchers 10, 12		28.00	
Journals purchased (Wagner), voucher 13		92.76	
			794.52
April 4, 1912, balance on hand			$128.52

R. H. DENNISTON,
Treasurer.

Certified correct,
D. C. MUNRO,
GEORGE WAGNER.

SECRETARY'S REPORT.

The Secretary presented his report, as follows. It was adopted.

Members at last report		302
Dropped for non-payment of dues	12	
Resigned	18	
Deceased	10	
		40
		262
New members, 1911	13	
New members, 1912	25	
		38
		300

ARTHUR BEATTY,
Secretary.

The Committee on Nominations recommended the following persons for membership in the Academy. The report was adopted.

Rufus M. Bagg, 466 Alton St.....Appleton.
Oscar James Campbell, Jr., 205 Prospect Ave.....Madison.
Muriel B. Carr, 616 Lake St.....Madison.
William Hunt Eisenman, Racine College.....Racine, Wis.
H. W. Griggs, 2421 Sycamore St.....Milwaukee, Wis.
Michael F. Guyer.....Madison.
Chester Lloyd Jones, 412 Carroll St.....Madison.
Eric Rexford Miller, 84 North Hall.....Madison.
Ralph Woodward Owen, 627 Mendota Court.....Madison.
John J. Pettijohn.....Madison.
Edward Bunker Schlatter, 1619 Jefferson St.....Madison.
Matthew Lyle Spencer.....Appleton, Wis.

Afternoon Session, 2:00 o'clock.

The session was presided over by President Plautz.

36. Studies in the Manufacture of Flint Implements. H. L. Skavlem. Ten minutes.
37. Notes on Outagamie County Antiquities. Geo. R. Fox. (By title.)
38. The Grooved Stone Axes of Wisconsin. Charles E. Brown. Ten minutes.
39. The Effect of Off-Shore Deepening on Coast Deposits. Rufus M. Bagg, Jr. Twenty minutes. (Illustrated.)
40. Notes on an Unusual Type of Foraminifera as a Limestone Builder off the Coast of Venezuela. Rufus M. Bagg, Jr. Five minutes.
41. The Former Higher Levels of the Yahara Lakes. Samuel Weidman. Fifteen minutes.
42. An Italian Drug Store of the Quattrocento. Edward Kremers. Ten minutes.
43. The Use of Potassium Iodide in Studying the History of a Water Supply. Albert F. Gilman. Fifteen minutes.
44. Some Incongruities in Chemical Nomenclature. Andrew F. McLeod. Fifteen minutes.
45. A Mechanical Analogy of the Electron. (With a Demonstration.) L. R. Ingersoll. Five minutes.
46. On the Bending of the Waves of Wireless Telegraphy around the Earth. H. W. March. Fifteen minutes.
47. The Banner Stone Ceremonials of Wisconsin. Charles E. Brown. (By title.)

The Nominating Committee brought in the following report, which was adopted.

President, D. C. MUNRO, Madison.
Vice-President of Sciences, I. N. MITCHELL, Milwaukee.

Vice-President of Arts, A. C. CLAS, Milwaukee.
Vice-President of Letters, F. M. ERICKSON, Ripon.
Secretary, ARTHUR BEATTY, Madison.
Treasurer, ARTHUR BEATTY, Madison.
Curator, C. E. BROWN, Madison.

Committee on Publication.

D. C. MUNRO, Madison, President (ex-officio.)
ARTHUR BEATTY, Madison, Secretary (ex-officio.)
C. E. ALLEN, Madison.

Committee on Library.

W. M. SMITH, Madison, Librarian. (ex-officio.)
R. H. DERNEHL, Milwaukee.
R. G. THWAITES, Madison.
GEORGE WAGNER, Madison.
C. A. YOUTZ, Appleton.

Committee on Membership.

ARTHUR BEATTY, Madison, Secretary (ex-officio.)
H. L. WARD, Milwaukee.
A. F. MCLEOD, Beloit.
HELEN SHERMAN, Milwaukee.
L. R. INGERSOLL, Madison.

MEETING OF THE COUNCIL.

On April 5 a meeting of the Council was held at which the following business was transacted.

Samuel Plantz was nominated a Life Member of the Academy.

R. A. Harper, F. J. Turner, O. G. Libby, and Edgar W. Olive were made corresponding members.

It was moved that the Council be authorized to appropriate for the uses of the Library Committee not more than $100. Carried.

It was moved and carried that the allowance for the Secretary and Treasurer be $200.

ARTHUR BEATTY,
Secretary.

FORTY-THIRD ANNUAL MEETING

The meeting was held jointly with the Wisconsin Archeological Society, the Wisconsin Mycological Society, and the Wisconsin Natural History Society, in Milwaukee on March 20 and 21, 1913. The sessions were held in the Public Museum.

THURSDAY, MARCH 20.

Afternoon Session, 2:00 o'clock.

President D. C. Munro presiding.

Forty persons present.

In the absence of Secretary Arthur Beatty, Mr. Charles E. Brown was chosen to act as secretary of the joint meetings.

Dr. G. G. Davis and Mr. Henry L. Ward we reappointed a committee to audit the treasurer's accounts.

Presentation of Papers.

1. Progress of Archaeological Researches in Wisconsin during 1912. Charles E. Brown. Fifteen minutes.
2. Indian Earthworks and Camp Sites on Turtle Creek, Rock County. Robert H. Becker. By title.
3. The value of Local Collection to Archaeological Study. H. L. Skavlem. Twenty minutes.
4. An Archaeological Surface Survey of the West Shore of Green Bay in Wisconsin. George R. Fox. By title.
5. Indian Miniature Axes and Celts. H. M. Whelpley. (By title.)
6. An Indian Pipestone Quarry in Barron County. Charles E. Brown. Ten minutes.
7. Archaeological Survey of Trempealeau and Adjoining Counties. George H. Squier. (By title.)
8. Joseph Reynolds and the Diamond Jo Line of Upper Mississippi River Steamers. George Byron Merrick. Ten minutes.
9. The Habits of Fiddler Crabs. A. S. Pearse. Twenty-five minutes. (Illustrated.)
10. A consideration of the Habits of Some Solitary Wasps. George P. Barth. Twenty minutes.
11. On the Structure and Habits of the Larvae of Certain Parasitic Diptera and Hymenoptera. Sigmund Graenicher. Fifteen minutes.
12. American Water-mites of the Genus *Oxus*. Ruth Marshall. (By title.)
13. An account of some Phototropic and Starvation Experiments on the Museum Pest (Trogoderma tarsale.). E. J. Wodsedalek and R. A. Muttkowski. Fifteen minutes.
14. The Development of the Wings of a Caddis-fly. W. S. Marshall. (By title.)

15. Mammal Bones of the Los Angeles Brea Beds and their Geologic Relations. Ira M. Buell. Twenty minutes.

On the motion of H. L. Ward the following new members were regularly elected to membership in the Academy.

Harley W. Barber	Ripon
George P. Barth	Milwaukee
Welz E. Boren	Milwaukee
M. A. Bussewitz	Milwaukee
Muriel B. Carr	Madison
Chester Lloyd Jones	Madison
Frank J. Kelley	Madison
Rachel M. Kelsey	Milwaukee
Louise W. Mears	Milwaukee
Samuel Moore	Madison
Alexander Mueller	Milwaukee
V. E. McCaskill	Superior
J. J. Pettijohn	Madison
E. C. L. C. Roedder	Madison
L. L. Ruschhaupt	Milwaukee
H. A. Watt	Madison
W. T. Stephens	Milwaukee
R. E. Vaughn	Madison

Evening Session, 7:00 o'clock.

A dinner was given at the Hotel Gilpatrick for members. Closer affiliation between the various scientific societies of the state was discussed.

FRIDAY, MARCH 21.

Morning Session, 9:30 o'clock.

The annual reports of the Secretary and Treasurer were read, and the Auditing Committee reported that the accounts of the Treasurer were found correct.

TREASURER'S STATEMENT, 1912–1913.

To balance on hand April 16, 1912	$293.52
Total receipts April 16, 1912, to March 17, 1913	105.35
	398.87
Total expenses	250.00
Net balance	148.00
Invested in Madison City Bond	100.00
Cash balance	$48.87

ARTHUR BEATTY,
Treasurer.

Your auditing committee has compared the records of the receipts and expenditures of the Academy since the previous meeting and finds that the Treasurer's statement is correct.

J. J. DAVIS,
HENRY L. WARD.
Auditing Committee.

Milwaukee, March 21, 1913.

SECRETARY'S REPORT, 1912–1913.

Honorary Members	6
Life Members	12
Active Members	229
Corresponding Members	40
	287
Deceased, resigned and dropped	31
New Members	16
Total	287

ARTHUR BEATTY,
Secretary.

It was moved by George P. Barth that a committee consisting of two members of each of the four participating societies be appointed by the president to consider plans for a closer coöperation between Wisconsin scientific societies. Seconded by G. G. Davis. Carried.

Moved by Mr. A. S. Pearse that the sum of $20.00 be allowed to the committee by the Academy to cover necessary expenses of postage, typewriting and other expenses. Seconded. Carried.

The President called Dr. Lewis Sherman, president of the Wisconsin Mycological Society, to the chair.

Presentation of Papers.

16. The Migration of the Germ Cells in *Ameiurus nebulosus*. Freda M. Bachman. Fifteen minutes.
17. A New Species of Diaptomus. Chancey Juday. (By title.)
18. A List of Fungi from Kewaunee County, Wisconsin. B. O. Dodge. (By title.)
19. The Effect of Pressure on the Development of the Lateral Roots of Herbaceous Plants. J. B. Overton. Fifteen minutes.
20. Cell Structure and Zoöspore Formation in Characium. Gilbert M. Smith. Ten minutes.
21. The Preservation of Green Algae in their Natural Color. Gilbert M. Smith. Ten minutes.
22. Cytology of the Convallariceae. Frederick McAllister. (By title.)
23. Oögenesis in Sphaeroplea annulina. E. M. Gilbert. Ten minutes.
24. Preliminary Report on a Collection of Hepaticae from the Duluth-Superior District. George H. Conklin. (By title.)

25. An August Survey of the Hydrophytes of Lake Mendota. R. H. Denniston. (By title.)
26. Notes on Parasitic Fungi of Wisconsin. J. J. Davis. (By title.)
27. Field Record of the Wisconsin Mycological Society for the Season of 1912. W. C. Schier. (By title.)
28. Some Recent Researches on Cellulose. A. F. Gilman. Fifteen minutes.
29. John C. Gilman, Pioneer. A. F. Gilman. (By title.)
30. Wisconsin Mushrooms. Lewis Sherman. Twenty minutes.
31. The Stimulus which Causes the Leaf-Ovipositing Tachinidae to Hatch. Henry H. P. Severin. Five minutes.
32. Insect-Catching Grasses of Hawaii. Henry H. P. Severin. Five minutes.
33. The Behavior of the Mediterranean Fruit Fly (Ceratitis capitata Wied) Towards Kerosene. Henry H. P. Severin. Ten minutes.
34. Kerosene Traps as a Means of Checking up the Efficiency of a Poisoned Bait Spray to Control the Mediterranean Fruit Fly. Henry H. P. Severin. Ten minutes.
35. Parasites of the Walking Stick, Diapheromera femorata Say. Henry H. P. Severin. Five minutes.

Afternoon Session, 2:00 o'clock.

36. Results of the Measurements of Sunshine at Madison, Wisconsin, during 1910, 1911, and 1912. Eric R. Miller. (By title.)
37. The Climatic Influence of the Great Lakes, Especially in Wisconsin. Eric R. Miller. (By title.)
38. The Congressional Elections of 1844 and 1848. C. R. Fish. (By title.)
39. General Aspects of Literary Patronage in the Middle Ages. Samuel Moore. Twenty minutes.
40. The Attitude of Goethe to Shakespeare. M. E. Speare. Thirty minutes.
41. The Development of the Vowel of the Unaccented Syllable in Italian. Edward B. Schlatter. (By title.)
42. The Aesthetic Purpose of Tennyson in The Palace of Art. Arthur Beatty. (By title.)
43. The Influence of Tertiary Derivative conjugations in Hebrew. Louis B. Wolfenson. Ten minutes.

President Munro appointed as committee to consider closer affiliation between the Scientific Societies of Wisconsin, the following:

Dr. J. J. Davis (chairman), Prof. W. S. Marshall..Wisconsin Academy
Dr. Geo. P. Barth, Mr. Henry L. Ward.....
.....Wisconsin Natural History Society
Dr. Lewis Sherman, Mr. W. H. Ellsworth.....
.....Wisconsin Mycological Society
Mr. H. L. Skavlem, Mr. C. E. Brown.....
.....Wisconsin Archeological Society

By invitation of the chair Director Henry L. Ward of the Public Museum, gave a talk on the improvements to be made in the Milwaukee Public Museum.

EXTRACTS FROM THE CHARTER.

AN ACT to incorporate the Wisconsin Academy of Sciences, Arts, and Letters.

The people of the state of Wisconsin, represented in senate and assembly, do enact as follows:

SECTION 1. Lucius Fairchild, Nelson Dewey, John W. Hoyt, Increase A. Lapham, * * *[1] at present being members and officers of an association known as "The Wisconsin Academy of Sciences, Arts, and Letters," located at the city of Madison, together with their future associates and successors forever, are hereby created a body corporate by the name and style of the "Wisconsin Academy of Sciences, Arts, and Letters," and by that name shall have perpetual succession; shall be capable in law of contracting and being contracted with, of suing and being sued, of pleading and being impleaded in all courts of competent jurisdiction; and may do and perform such acts as are usually performed by like corporate bodies.

SECTION 2. The general objects of the Academy shall be to encourage investigation and disseminate correct views in the various departments of science, literature, and the arts. Among the specific objects of the Academy shall be embraced the following:

1. Researches and investigations in the various departments of the material, metaphysical, ethical, ethnological, and social sciences.
2. A progressive and thorough scientific survey of the state with a view of determining its mineral, agricultural, and other resources.
3. The advancement of the useful arts, through the applications of science, and by the encouragement of original invention.
4. The encouragement of the fine arts, by means of honors and prizes awarded to artists for original works of superior merit.
5. The formation of scientific, economic, and art museums.
6. The encouragement of philogical and historical research, the collection and preservation of historic records, and the formation of a general library.
7. The diffusion of knowledge by the publication of original contributions to science, literature, and the arts.

SECTION 3. Said Academy may have a common seal and alter the same at pleasure; may ordain and enforce such constitution, regulations, and by-laws as may be necessary, and alter the same at pleasure; may receive and hold real and personal property, and may use and dis-

[1] Here follow the names of forty others. Sections 5, 6, 8 and 9 are omitted here as of no present interest. For the charter in full see *Transactions*, vol. viii, p. xi, or earlier volumes.

pose of the same at pleasure; provided, that it shall not divert any donation or bequest from the uses and objects proposed by the donor, and that none of the property acquired by it shall, in any manner, be alienated other than in the way of exchange of duplicate specimens, books, and other effects, with similar institutions and in the manner specified in the next section of this act, without the consent of the legislature.

SECTION 4. It shall be the duty of the said Academy, so far as the same may be done without detriment to its own collections, to furnish, at the discretion of its officers, duplicate typical specimens of objects in natural history to the University of Wisconsin, and to the other schools and colleges of the state.

SECTION 7. Any existing society or institution having like objects embraced by said Academy, may be constituted a department thereof, or be otherwise connected therewith, on terms mutually satisfactory to the governing bodies of the said Academy and such other society or institution.

Approved March 16, 1870.

STATUTES OF 1898.

TRANSACTIONS OF THE ACADEMY.

SECTION 341. There shall be printed by the state printer biennially in pamphlet form two thousand copies of the transactions of the Wisconsin Academy of Sciences, Arts, and Letters, uniform in style with the volumes heretofore printed for said society.

Note.—Under a ruling of the printing commissioners of the state of Wisconsin, made in response to a presentation by a committee of the Academy appointed December 29, 1897, each volume of the Transactions may be issued in two consecutive parts; so that a publication may thus be issued each year covering the papers accepted after the previous annual meeting. The Academy allows each author one hundred separate reprints of his paper from the Transactions without expense, except a small charge for printed covers when desired. Additional copies are charged for at the actual cost of printing and binding.

OF THE DISTRIBUTION OF PUBLIC DOCUMENTS.

SECTION 365. The transactions of the Wisconsin Academy of Sciences, Arts, and Letters shall be distributed as follows: One copy to each member of the legislature, one copy to the librarian of each state institution; one hundred copies to the State Agricultural Society; one hundred copies to the State Historical Society; one hundred copies to the State University, and the remainder to said Academy.

SECTION 366. In the distribution of books or other packages, if such packages are too large or would cost too much to be sent by mail, they shall be sent by express or freight, and the accounts for such express or freight charges, properly certified to, shall be paid out of the state treasury.

STATUTES OF 1901.

CHAPTER 447.

BINDING OF EXCHANGES.

SECTION 1. Section 341 of the revised statutes of 1898 is hereby amended by adding thereto the following: The secretary of state may authorize the state printer to bind in suitable binding all periodicals and other exchanges which the Society shall hereafter receive, at a cost not exceeding one hundred and fifty dollars per annum. The secretary of state shall audit the accounts for such binding.

STATUTES OF 1913.

CHAPTER 771.

SECTION 19. That part of section 20.31 of the statutes relating to printing for the Wisconsin academy of sciences, arts and letters is amended to read: "not more than two thousand copies * * * *of each number as issued*, of the transactions of the Wisconsin academy of sciences, arts and letters * * * *together with* suitable binding at a cost not exceeding one hundred and fifty dollars per annum of all periodicals and other exchanges which said academy shall hereafter receive."

CONSTITUTION

OF THE WISCONSIN ACADEMY OF SCIENCES, ARTS, AND LETTERS.

[As amended at various regular meetings.]

ARTICLE I.—*Name and Location.*

This association shall be known as the Wisconsin Academy of Sciences, Arts, and Letters, and shall be located at the city of Madison.

ARTICLE II.—*Object.*

The object of the Academy shall be the promotion of sciences, arts, and letters in the state of Wisconsin. Among the special objects shall be the publication of the results of investigation and the formation of a library.

ARTICLE III.—*Membership.*

The Academy shall include four classes of members, viz.: life members, honorary members, corresponding members, and active members, to be elected by ballot.
obtained by the payment of one hundred dollars and election by the Academy. Life members shall be allowed to vote and to hold office.

2. Honorary members shall be elected by the Academy and shall be men who have rendered conspicuous services to science, arts, or letters.

3. Corresponding members shall be elected from those who have been active members of the Academy, but have removed from the state. By special vote of the Academy men of attainments in science or letters may be elected corresponding members. They shall have no vote in the meetings of the Academy.

4. Active members shall be elected by the Academy or the council and shall enter upon membership on the payment of an initiation fee of two dollars which shall include the first annual assessment of one dollar. The annual assessment shall be omitted for the president, secretary, treasurer, and librarian during their term of office.

ARTICLE IV.—*Officers.*

The officers of the Academy shall be a president, a vice-president for each of the three departments, sciences, arts, and letters, a secretary, a librarian, a treasurer, and a custodian. These officers shall be chosen by ballot, on recommendation of the committee on nomination of officers, by the Academy at an annual meeting and shall hold office for three years. Their duties shall be those usually performed by officers thus named in scientific societies. It shall be one of the duties of the president to prepare an address which shall be delivered before the Academy at the annual meeting at which his term of office expires.

ARTICLE V.—*Council.*

The council of the Academy shall be entrusted with the management of its affairs during the intervals between regular meetings, and shall consist of the president, the three vice-presidents, the secretary, the treasurer, the librarian, and the past presidents who retain their residence in Wisconsin. Three members of the council shall constitute a quorum for the transaction of business, provided the secretary and one of the presiding officers be included in the number.

ARTICLE VI.—*Committees.*

The standing committees of the Academy shall be a committee on publication, a library committee, and a committee on the nomination of members. These committees shall be elected at the annual meeting of the Academy in the same manner as the other officers of the Academy, and shall hold office for the same term.

1. The committee on publication shall consist of the president and secretary and a third member elected by the Academy. They shall determine the matter which shall be printed in the publications of the Academy. They may at their discretion refer papers of a doubtful character to specialists for their opinion as to scientific value and relevancy.

2. The library committee shall consist of five members, of which the librarian shall be *ex officio* chairman, and of which a majority shall not be from the same city.

3. The committee on nomination of members shall consist of five members, one of whom shall be the secretary of the Academy.

Article VII.—*Meetings.*

The annual meeting of the Academy shall be held at such time and place as the council may designate; but all regular meetings for the election of the board of officers shall be held at Madison. Summer field meetings shall be held at such times and places as the Academy or the council may decide. Special meetings may be called by the council.

Article VIII.—*Publications.*

The regular publication of the Academy shall be known as its Transactions, and shall include suitable papers, a record of its proceedings, and any other matter pertaining to the Academy. This shall be printed by the state as provided in the statutes of Wisconsin. All members of the Academy shall receive gratis the current issues of its Transactions.

Article IX.—*Amendments.*

Amendments to this constitution may be made at any annual meeting by a vote of three-fourths of all the members present; *provided*, that the amendment has been proposed by five members, and that notice has been sent to all the members at least one month before the meeting.

RESOLUTIONS

REGULATIVE OF THE PROCEEDINGS OF THE ACADEMY.

THE TRANSACTIONS OF THE ACADEMY.

[*By the Academy, December* 28, 1882.]

2. The secretary of the Academy shall be charged with the special duty of overseeing and editing the publication of future volumes of the Transactions.

3. The Transactions of the Academy hereafter published shall contain: (a) a list of officers and members of the Academy; (b) the charter, by-laws and constitution of the Academy as amended to date; (c) the proceedings of the meetings; and (d) such papers as are duly certified in writing to the secretary as accepted for publication in accordance with the following regulations, and no other.

6. In deciding as to the papers to be selected for publication, the committee shall have special regard to their value as genuine, original contributions to the knowledge of the subject discussed.

9. The sub-committee on publication shall be charged with insisting upon the correction of errors in grammar, phraseology, etc., on the part of authors, and shall call the attention of authors to any other points in their papers which in their judgment appear to need revision.

[*By the Academy, June* 2, 1892.]

The secretary was given authority to allow as much as ten dollars for the illustrations of a paper when the contribution was of sufficient value to warrant it. A larger amount than this might be allowed by the committee on publication.

[*By the Academy, December* 29, 1896.]

The secretary was directed to add to the date of publication as printed on the outside of author's separates the words, "Issued in advance of general publication."

FEES OF LIFE MEMBERS.

[*By the Academy, July* 19, 1870.]

Resolved, That the fees from members for life be set apart as a permanent endowment fund to be invested in Wisconsin state bonds, or other equally safe securities, and that the proceeds of said fund, only, be used for the general purposes of the Academy.

ANNUAL DUES.

[*By the Academy, December* 29, 1892.]

Resolved, That the secretary and treasurer be instructed to strike from the list of active members of the Academy the names of all who are in arrears in the payment of annual dues, except in those cases where, in their judgment, it is desirable to retain such members for a longer time.

ARREARS OF ANNUAL DUES.

[*By the Council, December* 29, 1897.]

Resolved, That the treasurer be requested to send out the notices of annual dues as soon as possible after each annual meeting and to extend the notice to the second or third time within a period of four months where required.

SECRETARY'S ALLOWANCE.

[*By the Academy, December* 27, 1902.]

Resolved, That the Academy hereby appropriates the sum of seventy-five dollars per annum as an allowance for secretary's expenses, for which a single voucher shall be required.

SECRETARY'S ALLOWANCE.

[*By the Council, April* 5, 1912.]

Resolved, That the Academy appropriates the sum of two hundred dollars per annum for the secretary-treasurer's allowance.