# SCIENCE:

*A WEEKLY NEWSPAPER OF ALL THE ARTS AND SCIENCES*

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## UNIVERSITY EXTENSION AND THE UNIVERSITY OF THE FUTURE.[1]

I AM requested to furnish information with reference to the university extension movement in England. It will be desirable that side by side with the facts I should put the ideas of the movement, for, in matters like these, the ideas are the inspiration of the work; the ideas, moreover, are the same for all, whereas the detailed methods must vary with different localities. The idea of the movement is its soul: the practical working is no more than the body. But body and soul alike are subject to growth, and so it has been in the present case. The English university extension movement was in no sense a carefully planned scheme, put forward as a feat of institutional symmetry: it was the product of a simple purpose, pursued through many years, amid varying external conditions, in which each modification was suggested by circumstances, and tested by experience. And with the complexity of our operations our animating ideas have been striking deeper and growing bolder. Speaking, then, up to date, I would define the root idea of "university extension" in the following simple formula: university education for the whole nation organized on a basis of itinerant teachers.

But every clause in this defining formula will need explanation and defence.

The term "university extension" has no doubt grown up from the circumstance that the movement in England was started and directed by the universities, which have controlled its operations by precisely the same machinery by which they manage every other department of university business. I do not know that this is an essential feature of the movement. The London branch presents an example of a flourishing organization directed by a committee formed for the purpose, though this committee at present acts in concert with three universities. I can conceive the new type of education managed apart from any university superintendence, only I should look upon such severance as a far more serious evil for the universities than for the popular movement.

[1] The substances of addresses delivered before the Johns Hopkins and other university audiences, by Richard G. Moulton, A.M., of Cambridge University, England.

But I use the term "university education" for the further purpose of defining the type of instruction offered. It is thus distinguished from school education, being moulded to meet the wants of adults. It is distinguished from the technical training necessary for the higher handicrafts or for the learned professions. It is no doubt to the busy classes that the movement addresses itself; but we make no secret of the fact that our education will not help them in their business, except that, the mind not being built in water-tight compartments, it is impossible to stimulate one set of faculties without the stimulus re-acting upon all the rest. The education that is properly associated with universities is not to be regarded as leading up to any thing beyond, but is an end in itself, and applies to life as a whole. And the foundation for university extension is a change, subtle but clear, that may be seen to be coming over the attitude of the public mind to higher education, varying in intensity in different localities, but capable of being encouraged where it is least perceptible,—a change by which education is ceasing to be regarded as a thing proper to particular classes of society or particular periods of life, and is coming to be recognized as one of the permanent interests of life, side by side with such universal interests as religion and politics. For persons of leisure and means, such growing demand can be met by increased activity of the universities. University extension is to be the university of the busy.

My definition puts the hope of extending university education in this sense to the whole nation without exception. I am aware that to some minds such indiscriminate extension will seem like an educational communism, on a par with benevolent schemes for redistributing the wealth of society so as to give everybody a comfortable income all round; but it surely ought not to be necessary to explain that in proposing a universal system of education we are not meaning that what each individual draws from the system will be the same in all cases. In this, as in every other public benefit, that which each person draws from it must depend upon that which he brings to it. University extension may be conceived as a stream flowing from the high ground of universities through the length and breadth of the country. From this stream each individual helps himself according to his means and his needs: one takes but a cupful, another uses a bucket, a third claims to have a cistern to himself. Every one suits his own capacity, while our duty is to see that the stream is pure, and that it is kept running.

The truth is, that the wide-reaching purpose of university extension will seem visionary or practicable according to the conception formed of education, as to what in education is essential and what accidental. If I am asked whether I think of shop-assistants, porters, factory-hands, miners, dock or agricultural laborers, women with families and constant home duties, as classes of people who can be turned into economists, physicists, literary critics, art connoisseurs, I admit that I have no such idea; but I do believe, or rather, from my experience in England I know, that all such classes can be interested in economic, scientific, literary, and artistic questions; and I say boldly that to interest in intellectual pursuits is the essential of education, in comparison with which all other educational purposes must be called secondary. I do not consider that a child has been taught to read unless he has been made to like reading. I find it difficult to think of a man as having received a classical education if the man, however scholarly, leaves college with no interest in classical literature such as will lead him to go on reading for himself. In education the interest is the life.

If a system of instruction gives discipline, method, and even originating power, without rousing a lasting love for the subject studied, the whole process is but a mental galvanism, generating a delusive activity that ceases when the connection between instructor and pupil is broken off; but if a teacher makes it his first business to stir up an interest in the matter of study, the education becomes self-continuing when teacher and pupil have parted, and the subject becomes its own educator. If, then, it be conceded that the essence of education is to interest, does it not seem a soberly practical purpose that we should open up to the whole nation without exception an interest in intellectual pursuits?

I take my stand on the broad moral ground that every human being, from the highest to the lowest, has two sides to his life,— his work and his leisure. To be without work in life is selfishness and sloth; but, if a man or woman is so entangled in routine duties as never to command leisure, we have a right to say to such persons that they are leading an immoral life. Such an individual has no claim to the title of a working-man: he is a slave. It may be cruel circumstances that have thus absorbed him in business, but that does not alter the fact: slavery was a misfortune rather than a fault to those who suffered it; but, in any case, to be content with slavery is a crime. Once get society to recognize the duty of leisure, and there is immediately a scope for such institutions as university extension that exist for the purpose of giving intellectual interests for such leisure time. The movement is thus one of the greatest movements for the "raising of the masses." With a large section of the people there is, at the present moment, no conception of "rising" in life, except that of rising out of one social rank into another. This last is of course a perfectly legitimate ambition, but it is outside the present discussion. University extension knows nothing of social distinctions. It has to do with a far more important mode of "rising" in life,— that of rising in the rank to which a man happens to belong at the moment, whether it be the rank in which he started or any other. There is a saying that all men are equal after dinner; and it is true, that while, in the material wealth we seek in our working hours, equality is a chimera, yet in the intellectual pursuits that belong to leisure there is no bar to the equality of all, except the difference of individual capacity and desire. Macaulay tells of the Dutch farmers who worked in the fields all day, and at night read the Georgics in the original. Scotch and American universities are largely attended by students who have had to engage in menial duties all the summer in order to gain funds for their high education during the winter. And every university extension lecturer, highly trained specialist as he is, will testify how his work has continually brought him into contact with persons of the humblest social condition, whom a moment's conversation has made him recognize as his intellectual equals. No one has any difficulty in understanding that in religious intercourse and experience all classes stand upon an equality; and I have spoken of the foundation for the university extension movement as being the growing recognition of education as a permanent human interest akin to religion. The experience of a few years has sufficiently demonstrated the possibility of arousing such interest: to make it universal is no more than a practical question of time, money, and methods.

But no doubt when we come to *modus operandi* the main difficulty of the movement is the diversity of the classes it seeks to approach,— diversity in individual capacity, in leisure, means, and previous training. Opposite policies have been urged upon us. Some have said, "Whatever you do, you must never lower the standard. Let the extension movement present outside the universities precisely the same education as the universities themselves are giving, however long you may have to wait for its acceptance." On the other hand, it has been urged, "You must go first where you are most needed. Be content with a makeshift education until the people are ready for something better." The movement has accepted neither of these policies, but has made a distinction between two elements of university training,— method and curriculum. So far as method is concerned, we have considered that we are bound to be not less thorough, but more thorough, if possible, than the universities themselves, in proportion as our clients work under peculiar difficulties. But in the matter of curriculum we have felt it our first duty to be elastic, and to offer little or much, as may in each case be desired. Accordingly, we have elaborated an educational unit,— the three-months' course of instruction in a single subject. This unit course we have used all the resources we could command for making as thorough in method as possible. Where more than this is desired, we arrange that more in a combination or series of such unit courses. The instruction can thus be taken by retail or wholesale, but in all cases it must be administered on the same rigorous method.

The key to the whole system is thus the unit course of three months' instruction in a single subject. The method of such a course is conveyed by the technical terms "lecture," "syllabus," "exercises," "class." The lectures are addressed to audiences as miscellaneous as the congregation of a church or the people in a street car; and it is the duty of the teacher to attract such miscellaneous audiences, as well as to hold and instruct them. Those who do nothing more than simply attend the lectures will at least have gained the education of continuous interest. It is something to have one's attention kept upon the same subject for three months together. But it may be assumed that in every such audience there will be a nucleus of students, by which term we simply mean persons willing to do some work between one lecture and another. The lectures are delivered no oftener than once a week; for the idea is not that the lectures convey the actual instruction, a great part of which is better obtained from books, but the office of the lecture is to throw into prominence the salient points of the study, and rouse the hearers to read for themselves. The course of instruction is laid down in the syllabus,— a document of perhaps thirty or forty pages, sold for a trifling sum. By referring for details to the pages of books, this pamphlet can be made to serve as a text-book for the whole course, making the teacher independent in his order of exposition of any other text-book. The syllabus assists the general audience in following the lectures without the distraction of taking notes, and guides the reading and thinking of the students during the week. The syllabus contains a set of "exercises" on each lecture. These exercises, unlike examination questions or "quizzes," are not tests of memory, but are intended to train the student to work for himself. They are thus to be done under the freest conditions,— at home, with full leisure, and all possible access to books, notes, or help from other persons. The written answers are sent to the lecturer for marginal comment, and returned by him at the "class." This class is a second meeting for students and others, at which no formal lecture is given; but there is free talk on points suggested to the teacher by the exercises he has received. The usual experience is that it is more interesting than the lecture. This weekly

routine of lecture, syllabus-reading, exercise, and class goes on for a period of twelve weeks. There is then an "examination" in the work of the course held for students who desire to take it. Certificates are given by the university, but it is an important arrangement that these certificates are awarded jointly on the result of the weekly exercises and the final examination.

The subjects treated have been determined by the demand. Literature stands at the head in popularity; history, with economy, is but little behind. All the physical sciences have been freely asked for. Art constitutes a department of work; but it is art-appreciation, not art-production. The movement has no function to train artists, but to make audiences and visitors to art-galleries more intelligent. It will be observed that the great study known as "classics" is not mentioned in this list; but it is an instructive fact that a considerable number of the courses in literature have been on subjects of Greek and Latin literature treated in English, and some of these have been at once the most successful in numbers and the most technical in treatment. I am not without hope that our English university extension may re act upon our English universities, and correct the vicious conception of classical studies which gives to the great mass of university men a more or less scholarly hold upon ancient languages, without any interest whatever in ancient literatures.

This university extension method claims to be an advance on existing systems, partly because under no circumstances does it ever give lectures unaccompanied by a regular plan of reading and exercises for students. These exercises, moreover, are designed, not for mental drill, but for stimulus to original work. The association of students with a general audience is a gain to both parties. Many persons follow regularly the instruction of the class who have not participated in the exercises. Moreover, the students, by their connection with the popular audience, are saved from the academic bias which is the besetting sin of teachers: more human interest is drawn into the study. The same effect follows from the miscellaneous character of the students who contribute exercises. High university graduates, experts in special pursuits, deeply cultured individuals who have never before had any field in which to exhibit the fruits of their culture, as well as persons whose spelling and writing would pass muster nowhere else, or casual visitors from the world of business, or young men and women fresh from school, or even children writing in round text,— all these classes may be represented in a single week's work; and the papers sent in will vary in elaborateness from a scrawl on a post-card to a magazine article or treatise. I have received an exercise of such a character that the student considerately furnished me with an index. I remember one longer still, but, as this hailed from a lunatic-asylum, I will quote it only for illustrating the diversity of the spheres reached by the movement. Study participated in by such diverse classes cannot but have an all-roundness, which is to teachers and students one of the main attractions of the movement.

But we shall be expected to judge our system by results; and, so far as the unit courses are concerned, we have every reason to be satisfied. Very few persons fail in our final examinations; and yet examiners report that the standard in university extension is substantially the same as that in the universities, our pass students being on a par with pass men in the universities, our students of "distinction" reaching the standard of honors schools. Personally I attach high importance to results which can never be expressed in statistics. We are in a position to assert that a successful course perceptibly influences the tone of a locality for the period it lasts. Librarians volunteer reports of an entirely changed demand for books, and we have even assurances that the character of conversation at "five o'clock teas" has undergone marked alteration. I may be permitted an anecdote illustrating the impression made upon the universities themselves. I once heard a brilliant university lecturer, who had had occasional experience of extension teaching, describe a course of investigation which had interested him. With an eye to business, I asked him if he would not give it in an extension course. He became grave. "Well, no," he replied, "I have not thought it out sufficiently for that;" and when he saw my look of surprise, he added, "You know, any thing goes down in college; but when I have to face your mature classes, I must know my ground well." I believe the impression thus suggested is not uncommon among experts who really know the movement.

Our results are much less satisfactory when we turn to the other side of our system, and inquire as to curriculum. It must be admitted that the larger part of our local centres can only take unit courses. There may be often a considerable interval between one course and another; or, where courses are taken regularly, the necessity of meeting popular interest involves a distracting variety of subjects; while an appreciable portion of our energies have to be taken up with preliminary half-courses, rather intended to illustrate the working of the movement than as possessing any high educational value. The most important advance from the unit course is the affiliation system of Cambridge University. By this a town that becomes regularly affiliated has arranged for it a series of unit courses, put together upon proper sequence of educational topics, and covering some three or four years. Students satisfying the lecturers and examiners in this extended course are recognized as "students affiliated" (S.A.), and can at any time enter the university with the status of second year's men, the local work being accepted in place of one year's residence and study. Apart from this, the steps in our educational ladder other than the first are still in the stage of prophecy. But it is universally recognized that this drawback is a matter solely of funds. Once let the movement command endowment, and the localities will certainly demand the wider curriculum that the universities are only too anxious to supply.

The third point in our definition was that the movement was to be organized on a basis of itinerant teachers. This differentiates university extension from local colleges, from correspondence teaching, and from the systems of which Chautauqua is the type. The chief function of a university is to teach, and university extension must stand or fall with its teachers. It may or may not be desirable on other grounds to multiply universities; but there is no necessity for it on grounds of popular education, the itinerancy being a sufficient means of bringing any university into touch with the people as a whole. And the adoption of such a system seems to be a natural step in the evolution of universities. In the middle ages the whole body of those who sought a liberal education were to be found crowded into the limits of university towns, where alone were teachers to listen to, and manuscripts to copy. The population of such university centres then numbered hundreds where to-day it numbers tens. The first university extension was the invention of printing, which sent the books itinerating through the country, and reduced to a fraction the actual attendance at the university, while it vastly increased the circle of the educated. The time has now come to send teachers to follow the

books, the ideas of the university being circulated through the country as a whole, while residence at a university is reserved as the apex only of the university system.

An itinerancy implies central and local management, and travelling lecturers who connect the two. The central management is a university, or its equivalent. This is responsible for the educational side of the movement, and negotiates for the supply of its courses of instruction at a fixed price per course.[1] The local management may be in the hands of a committee formed for the purpose, or of some local institution — such as a scientific or literary club or institute — which may care to connect itself with the universities. On the local management devolves the raising funds for the university fee and for local expenses, as well as the duty of putting the advantages of the course offered before the local community. The widest diversity of practice prevails in reference to modes of raising funds. A considerable part of the cost will be met by the tickets of those attending the lectures, the prices of which I have known to vary from a shilling to a guinea for the unit course, while admission to single lectures has varied from a penny to half a crown. But all experience goes to show that only a part of this cost can be met in this way. Individual courses may bring in a handsome profit, but, taking account over various terms and various districts, we find that not more than two-thirds of the total cost will be covered by ticket-money. And even this is estimated on the assumption that no more than the unit course is aimed at; while even for this the choice of subjects, and the chance of continuity of subject from term to term, are seriously limited by the consideration of meeting cost as far as possible from fees. University extension is a system of higher education; and higher education has no market value, but needs the help of endowment. But the present age is no way behind past ages in the number of generous citizens it exhibits as ready to help good causes. The millionnaire who will take up university extension will leave a greater mark on the history of his country than even the pious founder of university scholarships and chairs; and, even if individuals fail us, we have the common purse of the public or the nation to fall back upon.

The itinerant lecturers, not less than the university and the local management, have responsibility for the progress of the cause. An extension lecturer must be something more than a good teacher, something more even than an attractive lecturer: he must be imbued with the ideas of the movement, and ever on the watch for opportunities of putting them forward. It is only the lecturer who can maintain in audiences the feeling that they are not simply receiving entertainment or instruction which they have paid for, but that they are taking part in a public work, and are responsible for giving their locality a worthy place in a national scheme of university education. The lecturer, again, must mediate between the local and the central management, always ready to assist local committees with suggestions from the experience of other places, and equally attentive to bringing the special wants of different centres before the university authorities. The movement is essentially a teaching movement, and it is to the body of teachers I look for the discovery of the further steps in the development of popular education. For such a purpose lecturers and directors alike must be imbued with the missionary spirit, for university extension is a missionary university, not content with supplying culture, but seeking to stimulate the demand for it. This is just the point in which education in the past has shown badly in comparison with religion or politics. When a man is touched with religious ideas, he seeks to make converts; when he has views on political questions, he agitates to make his views prevail. Culture, on the other hand, has been only too often cherished as a badge of exclusiveness, instead of the very consciousness of superior education being felt as a responsibility which could only be satisfied by efforts to educate others. To infuse a missionary spirit into culture is not the least purpose of university extension.

I cannot resist the temptation to carry forward this thought from the present into the future. In university extension so described, may we not see a germ for the university of the future? I have made the foundation of our movement the growing conception of education as a permanent interest of adult life side by side with religion and politics. The change is at best only beginning: it tasks the imagination to conceive all it will imply when it is complete. To me it appears that this expanding view of education is the third of the three great waves of change the succession of which has made up our modern history. There was a time when religion itself was identified with a particular class, the clergy alone thinking out what the rest of the nation simply accepted; then came the series of revolutions popularly summed up as the Reformation, by which the whole adult nation claimed to think for itself in matters of religion, and the special profession of the clergy became no more than a single element in the religious life of the nation. Again, there has been in the past a distinct governing class, to which the rest of society submitted, until a series of political revolutions lifted the whole adult population into self-government, using the services of political experts, but making public progress the interest of all. Before the more quiet changes of the present age, the conception of an isolated learned class is giving way before the ideal of a national culture, in which universities will still be centres for educational experts; while university extension offers liberal education to all, until educationally the whole adult population will be just as much within the university as politically the adult population is within the constitution. It would appear, then, that the university of such a future would be by no means a repetition of existing types, such as Oxford or Cambridge, Harvard or Johns Hopkins. These institutions would exist, and be more flourishing than ever, but they would all be merged in a wider "University of England," or "University of America;" and just as the state means the whole nation, acting in its political capacity through municipal or national institutions, so the university would mean the whole adult nation, acting in its educational capacity through whatever institutions might be found desirable. Such a university would never be chartered; no building could ever house it; no royal personage or President of the United States would ever be asked to inaugurate it. The very attempt to found it would imply misconception of its essential character. It would be no more than a floating aggregation of voluntary associations. Like the companies of which a nation's commerce is made up, such associations would not be organized, but would simply tend to co-operate because of their common object. Each association would have its local and its central side, formed for the purpose of mediating between the wants of a locality and the educational supply offered by universities or similar central institutions. No doubt such a scheme is widely different from the ideal education of European countries, so highly organized from above that the minister of education can look at his watch and know at any moment all that is being done

[1] The Cambridge fee is £45 per course of three months.

throughout the country. On the contrary, the genius of the Anglo-Saxon race leans towards self-help. It has been the mission of the race in the past to develop self-government in religion and politics: it remains to crown this work with the application of the voluntary system to liberal education.

In indulging this piece of speculation I have had a practical purpose before me. If what I have described be a reasonable forecast for the university of the future, does it not follow that university extension, as the germ of it, presents a field for the very highest academic ambition? To my mind, it appears that existing types of university have reached a point where further development in the same direction would mean decline. In English universities the ideal is "scholarship." Scholarship is a good thing, and we produce it. But the system which turns out a few good scholars every year passes over the heads of the great mass of university students without having awakened them to any intellectual life: the universities are scholarship-factories, producing good articles, but with a terrible waste of raw material. The other main type of university enthrones "research" as its *summum bonum*. Possibly research is as good a purpose as a man can set before him, but it is not the sole aim in life. And when one contemplates the band of recruits added each year to the army of investigators, and the choice of ever minuter fields — not to say lanes and alleys — of research, one is led to doubt whether research is not one of the disintegrating forces of society, and whether ever-increasing specialization must not mean a perpetual narrowing of human sympathies in the intellectual leaders of mankind. Both types of university appear to me to present the phenomena of a country suffering from the effects of over-production, where the energies of workers had been concentrated upon adding to the sum of wealth, and all too little attention had been given to the distribution of that wealth through the different ranks of the community. Just at this point the university extension movement appears to recall academic energy from production to distribution, suggesting that devotion to physics, economics, art, can be just as truly shown by raising new classes of the people to an interest in physical and economic and æsthetic pursuits as by adding to the discoveries of science, or increasing the mass of art products. To the young graduate, conscious that he has fairly mastered the teaching of the past, and that he has within him powers to make advances, I would suggest the question whether, even for the highest powers, there is any worthier field than to work through university extension towards the university of the future.

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## LETTERS TO THE EDITOR.

*** Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.*

*The editor will be glad to publish any queries consonant with the character of the journal.*

*On request, twenty copies of the number containing his communication will be furnished free to any correspondent.*

### The Souring of Milk during Thunder-Storms.

IN *Science* of Sept. 19, 1890, appeared a short note on some work recently done in Italy by Professor Tolomei on the souring of milk during thunder-storms. Professor Tolomei concludes that there is a sufficient amount of ozone generated at such times to coagulate milk by a process of direct oxidation, and a consequent production of lactic acid.[1]

Similar results have been obtained by other experimenters, and some have even gone so far as to say that free oxygen, when in contact with milk, will generate enough lactic acid to coagulate its caseine.

These results are very different from some obtained in this laboratory. While working on the bacteria in milk, the idea occurred to us to find out, if possible, the truth of the somewhat widely accepted theory that milk will sour with extreme rapidity during thunder-storms. Although the statement that this is an oxidizing action had been frequently made, a Mr. Iles of Baltimore was the first, so far as I know, to perform any experiments in this direction.[1] His method was to subject milk to the action of ozone, generated by an electric spark passed through oxygen, above the milk. He found a rapid coagulation produced, which he attributed to the direct oxidizing action of the ozone.

Our method was similar to that of Mr. Iles's. A Wolff bottle was filled about one-third full of milk, and the air in the bottle displaced by pure oxygen. Through the opposite necks wires leading from a Holtz induction machine were passed into the interior, and the necks plugged tightly with cotton to prevent any escape of oxygen; ozone was then generated by passing a spark across through the oxygen from one pole to the other. In some cases, instead of the spark, a "silent discharge" of electricity from the two poles was used to generate ozone.

In all cases a second bottle was partially filled with milk, and kept as a "control;" i.e., one in which the milk is left in its normal condition.

For some of our experiments three bottles were used, — one left as a control; a second filled with milk and oxygen; while a third was filled, like the second, with milk and oxygen, and then treated with the electricity. We thus had milk under three conditions: 1. In its normal state; 2. Under the influence of free oxygen; 3. Under the influence of free oxygen plus a certain amount of ozone. The electricity, in all cases, was passed through the oxygen for at least half an hour. That a considerable quantity of ozone was generated, was shown by its odor, and strong action on starch-iodine paper. Our results were very different from those given by Iles and Tolomei. The milk treated with ozone, or simply pure oxygen, soured a little, but only a little, faster than normal milk. If the milk in the control coagulated in thirty-six hours, the milk experimented on coagulated only an hour or two earlier.

This result was very constant. In a considerable number of experiments, using milk of all degrees of sweetness, from that just from the cow to that a day or more old, the same result followed, — a slight hastening of the time of coagulation in milk treated with ozone or oxygen. Between the time of coagulation of milk treated simply with oxygen, and that treated with oxygen plus ozone, no perceptible difference could be noticed.

We had, then, in our experiments, produced a slight hastening of the time of coagulation. Was this a direct oxidation? From the fact that it required over a day to act, it seemed likely that it could not be. If, however, it were an oxidation, it ought to act as well on sterilized milk — i.e., milk in which all bacteria have been killed by heat — as on ordinary milk. We therefore, before introducing the oxygen, sterilized the milk. In this case no coagulation occurred. Milk that had been treated at two separate times, a week apart, with oxygen and ozone, was kept for over two months without the appearance of the least sign of coagulation.

Briefly summed up, then, our results were as follows :—

1. Milk, under the influence of oxygen, or oxygen and ozone, coagulates somewhat earlier than when left in its normal condition.

2. This action does not take place if the milk has been sterilized, and is kept from contact with unfiltered air.

3. It is probably, therefore, not an oxidation. The conclusion drawn from this is that the souring was simply produced by an unusually rapid growth of bacteria. The bacteria of milk are mostly aerobic, and would undoubtedly be stimulated to rapid growth by free oxygen or ozone.

If in a thunder-storm ozone is set free, as some observers claim, its action on bacteria would perhaps explain the effects produced

[1] A more extended account of Professor Tolomei's experiments is given in *Biedermann's Central-Blatt für Agriculturchemie*, 1890, p. 538.

[1] Chemical News, vol. xxxvi. p. 237.