

poison is cyanide of potassium, yet they use chlorate of potash and sulfate of iron "to give the trees chlorine, sulfur, iron and potash." They make wonderful claims for the destruction of the scale and invigoration of trees, and commenced by charging fifty cents per tree for the so-called "vaccination." The price is now reduced to fifteen cents, but they are taking thousands of dollars from the confiding public.

The important scientific point is that I have examined hundreds of trees treated by them, and have in some instances found no evidences that scale insects were ever present, while in others I have found the San José scale alive on the trees some time after treatment. What is much worse is that I have found it is true that some one or more of these chemicals is evidently taken up in the sap of the tree, and that to a considerable extent. While the material was placed under the bark about three feet from the ground, it blackened the cambium layer as high as I could reach and remove the bark, and started blight or death of tissue at the place where inserted. I have the names of scores of persons whose trees or orchards were finally killed by this treatment. One man, whose name and address I can give, thought that it benefited his trees, and had it applied the second year, and the trees then died quickly. He is now disgusted with the treatment.

In company with Professor I. C. Williams, Deputy Forestry Commissioner of Pennsylvania, I visited an orchard in Lebanon County that had been treated a few weeks previously. The San José scale was found alive on the trees, but blight or death of tissue had commenced at the place of treatment and had worked downward slightly and upward considerably, and in fact, as high as one could reach. During the present week I have learned of another orchard, in Cumberland County, Pennsylvania, that was blighted and destroyed by the cyanide treatment. Therefore, while it is evident that some chemicals may be taken up in the trees and may even destroy some insects, it is further evident that they may be

injurious to the trees, and should be applied with great care and only after considerable experimentation, and should be recommended by scientists only after great deliberation. I shall send to interested persons printed articles on this subject from the office of the State Zoologist, Harrisburg, giving names and addresses of persons whose trees have been killed by the cyanide "vaccination," as the fakirs call it. These may be published.

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QUOTATIONS

RESEARCH AND TEACHING

THERE are at least three different conceptions of a university. To some men it means a group of technical schools which prepare for many distinct vocations; a place of universal study, as contrasted with one that pursues a single line only. To some men it means a place which is widely known for its teachers of science and literature and the discoveries that they are making; a school of universal reputation, as distinct from one whose fame is merely local. Still others think of it as a place where students can get wide range of knowledge and fit themselves for their duties as citizens of a self-governing community; a school with ideals of universal culture, rather than of narrow specialization.

The German university emphasizes the first and second of these conceptions; the French, the first and third; the English, the second and third. The American college in its early days devoted itself almost exclusively to the third. In attempting to become universities instead of colleges, our schools of higher learning in America have in recent years tried to combine all three aims; but often under such adverse conditions or with such inadequate resources that they have failed of actually attaining any one of them.

Under these circumstances a widespread belief has arisen that the three things should be separated rather than combined; that we

ought to have country colleges to give the students general culture, city technical schools to train them for their several callings, and research foundations, apart from college or technical school, to promote scientific discovery and other forms of intellectual achievement, by relieving the man who does creative work from the necessity of teaching.

Let us first examine the arguments of those who say that research ought to be separated from teaching.

The qualities of the investigator and the qualities of the teacher are quite different. A man may be good in one of these lines and bad in another. If investigators and teachers are associated in a university under the common title of professor, the tendency is to require every man who seeks a position at the head of his department to do something in both lines. The college is so largely dependent upon teaching for its revenue that it can not make any adequate payment to the investigator who does not teach. It is at the same time so dependent upon investigations for its outside reputation that it can not give the highest recognition and promotion to the teacher who does not investigate. Under these circumstances we get no proper division of labor. The man who ought to be making discoveries is compelled to waste his time in teaching students who can not appreciate and understand him. The man who ought to be teaching classes inspiringly and effectively feels himself compelled to do second-rate work of investigation which is of no inspiration to him or to anybody else. What is true of science is true of letters. The man who should be a creative author is made to do bad teaching. The man who should be an effective teacher is encouraged to write bad prose or worse poetry. To secure the advantages which the community can derive from proper division of labor—advantages which the community secures in every line of productive work except science and letters—we ought to have foundations which, by relieving our universities of the responsibility for progress in science and letters, will enable them to spend their money in paying adequate salaries to

men who can teach. Such are the views of those who argue for the extrusion of research from our universities.

These arguments are plausible; to a certain extent, they are sound. Foundations to promote scientific discovery or literary production are admirable things. There are some men who can work more effectively without a university connection than with one; and it is most important to provide such men with opportunities. But if this idea were carried to the extreme, and it were understood that the universities were places for teaching and not for investigation, the result would certainly be bad for the universities themselves, and would probably be bad for the progress of science and letters as a whole.

For while it is true that the work of the investigator and the work of the teacher are different, it is not true that they are habitually separate or antagonistic. There are some productive scholars that can not teach at all; but the majority of them can teach remarkably well if you give them the opportunity to do it in the right way. On this point I may be permitted to quote a paragraph from my report of eight years ago:

We are not dealing with an ordinary case of division of labor. The chief argument for division of labor is that it makes each man more expert and more efficient in his own field of work. In university work, however, the man who tries to investigate without teaching is apt to become sterile, while the man who attempts to teach without investigating becomes a worse teacher instead of a better one. We want the opportunities for research and investigation distributed as widely as possible throughout the teaching force and the student body. We want to impress upon every man that teaching and discovery are both done at their best when done in combination. Not that every man should be compelled to lecture to classes, whether he is able to do so or not. There is a great deal of valuable teaching which is not done in the class-room, or even in the laboratory. There are some men who teach best by their writings, their conversations, their intelligent suggestions for the work of others; but they should understand that they are part of the teaching force, and are simply doing their teaching in a dif-

ferent way from other men. Instead of setting such a man apart as a research professor, we should let him understand that withdrawal from the lecture room and relief from the duties of supervising elementary students carry with them a larger obligation to publish as fully as possible the results of all discoveries, to organize departments intelligently, to train up young men who can teach; and to make liberal room for such men, instead of trying to get in their way when their work becomes popular.

The routine work of teaching, if done under favorable conditions, is often a positive help to a scientific or literary man in keeping his nerves steady. Very few scholars, however productive, can write well all the time. Very few investigators, however well qualified, can make a continuous series of discoveries. If a man has nothing to occupy him in his less fertile intervals he will be tempted either to remain wholly idle or to publish second-rate books and pseudo-discoveries. A teaching position enables him to fill his time with work sufficiently close to his lines of productive activity to be stimulating and yet with enough of routine in it to make it healthful. And to most men this combination of teaching with research gives positive enjoyment of a high order. We may well remember the words of Lord Kelvin in connection with his receipt of the degree of Doctor of Laws from Yale in 1902:

There is one point on which I specially desire to speak. College professors should be permitted and given the means to do research work. On this matter of research I feel deeply. At the same time I do not believe it wise to have a research laboratory without teaching. It is a pleasure for a professor to meet students and to tell them what he can, and a greater pleasure if he can make them understand, and the greatest pleasure if he can widen the borders of their knowledge. To combine research work with teaching is most valuable both for student and teacher.

This is not intended as an argument against the establishment of institutions for research. There is room outside of the universities for all the endowments which we now have for productive work in science and letters, and for many more. There is as much difference of

temperament among investigators as there is among men of any other kind. Some do better research work when they are relieved of the necessity of teaching. For these we should have independent foundations. Others, whom I believe to be a decided majority, do better research work in connection with university positions. I regard it as a most fortunate circumstance that we are able to make provision for men of both kinds.

Nor is this intended as an argument against appointing men to professorial positions who are inspiring teachers rather than productive scholars. Our colleges need all the good teachers that we now have, whether they are productive scholars or not. But with a large number of men good teaching and productive scholarship ought to be conjoined; and it would be most unfortunate for such men themselves, for our universities, and for America's progress in science and letters, if we attempted to dissociate things that so generally belong together.—From the annual report of President Arthur T. Hadley, Yale University.

SCIENTIFIC BOOKS

List of Prime Numbers from 1 to 10,006,721.

By DERRICK NORMAN LEHMER. Carnegie Institution of Washington, Publication No. 165, 1914. Pp. xv + 133.

By the publication of his factor table for the first ten million natural numbers (Publication 105, Carnegie Institution of Washington, 1909) Professor Lehmer offered to the public a monumental work which will probably remain a model of its kind for centuries in view of its accuracy. The present work is based upon this factor table and was prepared with equal care. The pages are of the same size in these two publications, but the present volume is not quite one third as large as its predecessor.

Since the natural numbers are fundamental in many mathematical theories, it is not infrequently useful to know whether a given number is prime. The direct determination of this property is generally very laborious when the number is large. Hence a reliable table may save an enormous amount of labor.