the information of the Commissioner of Patents are assigned to the chief of the Bureau of Plant Industry to carry out. "A plant patent," according to Dr. W. A. Taylor, chief of the Bureau of Plant Industry, "grants to the patentee the exclusive right to use, vend and asexually reproduce the new variety covered by the patent throughout the United States and Territories for seventeen years. Naturally, under the limitations prescribed in the statute, most of the alleged new varieties thus far considered are in the horticultural field, relatively few general field crops other than tubers being capable of asexual propagation on a commercial scale in temperate climates. The granting of a patent on a new variety in no way passes on its adaptability to climatic conditions or for special uses or on its economic value, nor does it determine the validity or otherwise of any varietal name which may be applied to the variety by the originator or disseminator.

THE London correspondent of the *Journal* of the American Medical Association writes: "It is striking that in the present period of industrial depression and unemployment, unprecedented both in intensity and in duration, the general health of the population has been remarkably good and has even improved. The registrar-general's statistical review for 1931, which has just been published, shows a death rate of 12.3 per thousand persons living, 0.9 above that for 1930. That rate, however, was the lowest ever recorded, largely because of the exceptionally mild weather in the early part of the year, when the greatest number of deaths occur. The higher rate for 1931 is a reflection of the more severe weather of the early part of the year. Infant mortality was similarly affected, the deaths of children under 1 year being 66 per thousand live births, against 60 in 1930. That year and 1928, however, are the only years that have shown a lower mortality than 1931. The death rate for cancer was 1,484 per million persons living, against 1,454 in 1930. But if allowance is made for the difference in the age constitution of the population (which is constantly becoming greater) the increase in the cancer rate becomes much smaller. Tuberculosis again furnished a new low record, 896 deaths per million living. Road accidents due to mechanical vehicles caused 5,892 deaths. The figures for the preceding four years were 4,452, 5,196, 5,752 and 6,342. The decrease in 1931 is the first that has occurred since 1921, the figures having steadily increased previously. The birth rate was 15.8 per thousand persons living, the lowest on record and 0.5 below that for 1929 and 1930."

DISCUSSION

UNIVERSITY PATENTS

NOTHING seems at first sight more reasonable and effective to provide funds for research work in colleges, universities and research institutions than the exploitation, under the protection of patent laws, of the results of research work. Apparently in increasing numbers the universities in this country are resorting to patenting—directly or through approved agencies—for the stated purpose of obtaining money to support research work done by members of their staffs.

Arguments in favor of such a policy seem to have been published rather more fully than other types of comment. Experience, however, is proving that this policy of patenting, so attractive when first contemplated, involves more numerous and more serious difficulties than were at first foreseen, even by those who opposed the policy on ethical grounds. It is not with the ethical or moral validity of universities exploiting patents for revenue that the present communication deals. I wish to call attention only to some of the problems entailed by the policy, at present spreading among universities in the United States and Canada, of taking or being party to the taking of patents for the purpose of obtaining revenue for research work to be done by their students or staff. If explicit definition can obviate misunderstanding it may be well to observe that it is patenting for revenue and not patenting to prevent exploitation by others which is under consideration. I bring forward the matter because, now that the advantages of this policy have been published, it seems reasonable to point out some of the disadvantages.

A professor in one of our large state universities visited not long ago a university whose declared policy it is to take out patents where possible for the research work of its personnel. The professor talked with a young staff member about his research work. It became apparent that what the professor had learned from his own research work would lead, if pieced together with what the young man had found out, to a distinct advance in knowledge, an advance very probably capable of being patented. Although the young man would have been delighted to have had an honorable part in an advance of knowledge and might have received a merited recognition for his share therein, and although science might have been advanced, the professor kept his mouth shut because he couldn't see why his work should be an integral part of a patent controlled for the exclusive benefit of another university. Perhaps it would be better if both universities went in for the patent business. Then the professor wouldn't have felt so resentful or

so much at a disadvantage. He would have magnanimously given the young man his big chance by telling him what he needed to know. But of course there is just the possibility that another man would have kept silence, gone back to his own laboratory to confirm the young man's findings and purloined the patent not for his personal advantage of course but for his university. In such a case the young man, if he were as intelligent as he is educated, would learn to keep his mouth shut. I cite this little story from real life because it is such a nice illustration of what patenting for money has done in this instance to the advance of knowledge—for which, incidentally, the two states' funds are being in part devoted.

Some time ago in a well-known medical school a certain synthetic antiseptic was on trial clinically. The first reports were almost as brilliant as the color of the substance itself. The opportunity to patent the antiseptic would have meant an income for research of perhaps $100,000 a year. This entrancing possibility was not seized. Instead of that the clinicians of that school, devoid of proprietary interest, maintained a critical attitude and pursued their investigations, during which the earlier (and honest) enthusiasms paled because the stuff wasn't as good as they thought at first. As the dean remarked to me later, "Would we have cared to examine it as critically if it might mean the loss of a big income for our research work?" For politeness' sake one should quench such doubt by assurances that of course they would, or at least they wouldn't have taken out the patent until they knew that further investigation could not qualify their confidence.

In the dairy state of Ubique I know of an owner of a large milk products company. He is angry because the University of Ubique Research Associates, Incorporated, has taken out a patent for a process that could improve the nutritional value of certain milk products. He says: "I pay taxes to support the State University and its research workers, and as soon as they find something of use to me I have to pay them again for being successful. I'll be ——ed if they can have it coming and going. I'll bring counter suit if they try to sue me."

It is obvious that obtaining a patent is not complete protection. Some money has to be set aside to put teeth in it, *i.e.*, to punish infringements. Without the aid of newspaper files many medical scientists can recall a trial which is reported to have cost the defendants $80,000. Duly skeptical of such a figure, I should, however, assume that the patentees did not use all their takings that year for research. Shortly after the trial they were told by a spirited chief of one city health service that he was going to use their process anyhow and on a large scale, for which he proposed to pay them just one dollar and if they wanted to refuse this offer and bring suit, maybe they'd win, but the city was rich and had good lawyers.

When the patentees set aside large sums for the prosecution of infringements instead of the prosecution of research, there is no assurance of good feeling in the scientific or academic worlds. A well-known American patent for the treatment of an important infectious disease is protected in one country abroad by a clause which forbids its use in research directed to its improvement. An entirely honorable research organization in that country on consulting legal advice as to the probable consequences of using the material for research purposes was told that they would probably be supported by the courts but that the trial would cost upwards of $15,000. Having no funds to fight for the legal right to do research work they have left that field where the patentee desires it to be left. The only consolation that could be offered to them is that their research staff will be spared the waste of time upon the witness stand—a waste of time which has disgusted at least one scientist in this country to the point of deserting a field in which lawsuits may require his time.

The dean of one of our larger medical schools complains that one of his teachers is so busy controlling the product made under a patent held by the university that there is no time left for research or teaching. As a university interest it can't be disregarded, since there may be some money in it, so a competent investigator is now busy testing a commercial product. As long as there is a chance of the product being improved by some one else, he is likely to be tied down for some time to this one subject.

In justice to the universities now in the patent business, it should be admitted that no case has yet come to common knowledge of an appointment or promotion being accorded to a man because his mind runs to patentable and consequently profitable research. Surprise at such an event would, however, be a trifle naïve when the universities intentionally and officially encourage patents for revenue to support the research expenses they so badly need.

One neither moralizes nor speculates in restating the present tendency as being an assertion on the part of certain universities that they are disposed to encourage the means to extract legally and certainly from the public in this and other countries a contribution to their own research work, which is as they believe inadequately supported. They invoke the patent law to supplement what public appreciation fails to provide: they insist on a general and immediate contribution to maintain research which they can not guarantee will be of value equal to its cost. An

excuse is provided for the first time for the public to leave research in the universities to "look out for itself."

I am not interested in discussing here the ethics or morality of the matter. The way it is working out is proving dangerous: it tends to shut off unselfish exchange of ideas and information, it tends to kill a critical and impartial attitude, it tends to introduce quarrels and bitterness and to consume time and funds in lawsuits. It may quite naturally influence the choice of university personnel and the choice of research problems. If, in addition, the policy of taking out patents for revenue be interpreted as a declaration of independence the public may quite cheerfully acquiesce and leave research work to earn its own way. Why should gifts intended for the general welfare play the rôle of capitalizing a business? And what becomes of the peculiar function of university research as contrasted with that of the shrewdly administered business enterprise?

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THE COEFFICIENT OF CORRELATION

IN a recent article describing a least-square curve fitting machine[1] the authors make use of the Pearson product-moment coefficient of correlation to test the agreement of the parameters obtained by use of this device with those obtained by an algebraic method. This use of the correlation coefficient to test the agreement of two methods of measuring the same quantity is frequently seen in the literature, but the soundness of the procedure is open to question.

The idea of correlation as conceived by Galton implies that there is such a measurable quantity as *degree of relationship,* and the coefficient developed by Pearson is taken to give this measure. In keeping with this idea it is argued that if two methods of measurement agree well, their results will be "closely related" and *vice versa;* hence the use of the coefficient. As a matter of fact, the correlation coefficient is more correctly understood, specifically as a particular parameter obtained in a least-square fit of a straight line to the data correlated, and its significance is not general, but varies with the character of the data to which the fit applies.

In the case at hand, it can easily be shown that the coefficient measures, in large part, something quite different from what is intended. The method of procedure when two instruments or methods of measurements are to be compared is as follows: A series of determinations over the entire range of instrument or method x is made, and upon the same data determinations are made with instrument y. The corresponding measurements are then correlated. The coefficient may be given by

$$r=\sqrt{1-\frac{\sigma_{x.y}^2}{\sigma_x^2}}$$

Where r is the coefficient, σ_x is the standard deviation of the x measurements, $\sigma_{x.y}$ is the partial standard deviation of x, for a fixed value of y. Now, in instances of this kind, the distribution of x is not generally normal, but rectangular, *i.e.,* about the same number of measurements is made at each value of x. Under these circumstances σ_x depends on the range of x, being given by $\sigma_x^2=\frac{R_x^2}{12}$ where R_x is the range of x. Consequently, r is greater the greater the range of the measurements made. That the method can easily lead to paradoxical results may be seen as follows. Suppose two instruments to be uniformly comparable over their entire ranges, one with the other. A series of measurements is made over the lower half of the range and correlated, yielding a particular value of r. The same procedure is repeated for the upper half and the same value of r is obtained, appearing to give a good check of the measure of how well the two methods agree. But if now all the data are put together as a single series, the correlation will be greater. For instance, if r was 0.5 in the first case, it would be 0.9 in the second.

This fallaciousness in the use and interpretation of the correlation coefficient creeps in in other instances than where methods of measurement are compared. For instance, it is present when a physical trait like height is correlated with age, and the age range is arbitrary. It also vitiates not a little of the use made of the coefficient by psychologists.

In passing, referring to the main topic of the article first mentioned, it may be noted that the idea of obtaining a least-square fit of a line on the principle of elastic bands stretched from the points to be fitted was mentioned at least as early as 1921 by L. J. Reed.[2]

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ATTEMPT TO CONFIRM THE EXISTENCE OF A FILTRABLE CYCLE OF BACTERIA BY THE USE OF "K" MEDIUM[1]

AN attempt has been made to confirm the results of Kendall reported in the *Northwestern University Bulletin* (xxxii, 5, 1931). Complete failure with 'K' medium made by us according to his directions, was

[1] Gains and Palfrey, "A Least-Square Curve Fitting Machine," SCIENCE, 76: 472, November 18, 1932.

[2] Lowell J. Reed, "Fitting of Straight Lines," *Metron,* Vol. 1, p. 3, 1921.

[1] A detailed account of the work appears in the *Journal of Infectious Diseases,* 52: 20. 1933.