friends of his. A scientist in New York has not only grossly offended a number of his colleagues by refusing to accept certain good old traditions, but during one of his joyrides actually threw mud at the image of God. Such unnecessary occurrences are of course regretted by all, and should be avoided because they are likely to give science a bad name.

Witmer[6] says: "Intelligence is the ability to solve new problems . . . Education is the device of civilization to keep from encountering new problems." A scientist lives largely on ideas. The late John O. Reed once said of one of his colleagues: "I do not particularly mind him, because I know that he really does not think. He only thinks that he thinks." Any one who reads scientific journals soon learns that a certain proportion of the scientific world belongs in the same class with Dean Reed's friend. But, after all, one of the fine things about the scientific attitude of mind is that those who have it think what they please, without fear or prejudice or self-interest. Facts are facts. They require no apologies. Scientific spirit is bound at times to lead those who possess it into conflict with authority and established institutions. But it can not be suppressed. Science is always right because it seeks only for truth, and truth hurts no one. Unfortunately, scientists are not always right.

A scientist has his circulating medium in problems. He deals in and develops problems as a broker deals in stocks and bonds. When his problems are completed he "sells" them to the scientific world by publication, usually at his own expense. For a scientist there is no joy like that of working in his chosen field. Holmes said: "What have we to do with time but fill it up with labor?" To work, to know, to discover and create—for a scientist there is nothing beyond this!

A "real" or "pure" scientist can have little pleasure from life if he begins his career by craftily seeking out the best "field" or "opportunity." Modern genetics tells us that we are preordained to be osteocephs or geniuses. If one works and worries day and night for forty years on what he loves most, he may amount to something, and he may not. Genetics alone knows and it won't tell. At least we can enjoy ourselves. The greatest thing any man can do for science is to respect himself, love his work—and keep working. I wish you scientists a long and happy life—adventurous and romantic.

A. S. PEARSE

UNIVERSITY OF WISCONSIN

[6] *Sci. Mo.*, 15: 57.

THE MAINTENANCE OF ORGANIC MATTER IN SOILS

NONE of the hypotheses for the origin of the earth make any provision for the presence of combined nitrogen in the lithosphere. All productive soils, however, contain this element in some form generally closely related to the organic matter present, and nitrogen is one of the plant food elements essential to the development of all higher forms of plant life. The atmosphere must, therefore, be the primary source of all soil nitrogen, and its incorporation in the soil is dependent upon precipitation, free fixation and the fixation power of legumes. Such incorporation has had an opportunity to continue for long geological periods with the result that there has been a gradual accumulation. Under conditions where there have been no losses through leaching, this accumulation is not only directly proportional to the precipitation received, but naturally also to the amount of vegetative growth produced on the soil. The tendency has been in nature to convert this nitrogen into an organic form and it is in this form that practically all of the soil nitrogen exists. Results from various soil investigators working in widely different climatic sections have shown that the ratio between the nitrogen and the organic matter and also between the carbon and the organic matter is practically a constant. This constancy is so well established by experimental data that the approved methods for determining soil organic matter are based on the carbon and nitrogen content of the soil.

$$\text{Organic matter} = \text{Carbon} \times 1.724$$
$$\text{or Organic matter} = \text{Carbon dioxide} \times .471$$
$$\text{or Organic matter} = \text{Nitrogen} \times 20$$
$$\text{then } \frac{\text{carbon}}{\text{nitrogen}} = \frac{20}{1.724}$$
$$\text{or Nitrogen} : \text{Carbon} :: 1 : 11.6$$

This ratio of practically 1:12 is established by nature at a point where it has a very pronounced relationship to productivity. It is found that where organic matter composed largely of low nitrogen-carrying material is applied to a soil, nitrate accumulation is inhibited to the extent that crop development is retarded. This effect on nitrate accumulation is felt until sufficient carbon has been eliminated as carbon dioxide in the process of decomposition to establish a nitrogen-carbon ratio of about 1:12 in the remaining material.

Under natural conditions where no special effort is made to encourage nitrification and where all vegetative growth reverts to the soil, plant development

will take place about as rapidly as nitrogen becomes available, so that all possibilities of nitrogen losses through leaching are largely eliminated and a gradual increase in the organic matter proportional to the increase in nitrogen must and does follow and the 1:12 nitrogen-carbon ratio is maintained. It is only under conditions of intensive tillage where excessive amounts of nitrogen are removed regularly by cropping or leaching that there can be any very pronounced loss of organic matter. In this process of organic decomposition the carbon is lost more rapidly than nitrogen with the result that the nitrogen-carbon ratio is always slightly narrower in cropped than in virgin soil. The close relationship between nitrogen and carbon makes it impossible to increase or maintain organic matter in the soil unless nitrogen is increased or maintained in like proportion, and, conversely, it is impossible to increase the organic nitrogen without a proportional increase in the total organic matter.

Because of the fact that the benefits of soil organic matter in its relation to available plant food and to physical condition are thoroughly appreciated, attempts have been made to increase this material in the soil, but nearly always with disappointing results. To effect such increase in a measurable degree during the short periods over which records have been kept would require what in reality amounts to a change in climatic conditions. Under irrigated conditions, where the introduction of water on a soil well adapted to legume culture and decidedly deficient in nitrogen meant a heavy production of vegetation and a rapid fixation of nitrogen, it has been possible to increase the organic matter in the soil over and above that in the virgin state. This is practically the only condition under which increases are possible. Under other climatic conditions all attempts at even maintenance have been confronted with many difficulties and disappointments.

In the humid sections liberal annual applications of manure for long periods have had little or no permanent effect, while in the arid regions the return of straw to the soil can not be justified on the basis of improved physical condition of the soil resulting from an increase of soil organic matter. These results are readily explainable when it is realized that manure contains only about ten pounds of nitrogen per ton, and when applied at the rate of ten tons per acre will not more than supply the nitrogen removed by leaching and cropping. In the case of straw, which also contains about ten pounds of nitrogen per ton, and which is recommended for application at the rate of about one ton per acre, practically no influence is felt and little should be expected, because, true to the constant nitrogen-carbon ratio, these ten pounds of nitrogen can fix only about 120 pounds of carbon or a total of about 200 pounds of organic matter, a smaller amount than needs to be decomposed to supply the nitrogen required for one crop.

To maintain soil organic matter, emphasis should be placed on the nitrogen, and if this element is maintained sufficient carbon will be fixed. Nitrogen can be maintained, in part at least, through the use of fertilizers and the growth of legume crops. Even where inorganic fertilizers like sodium nitrate or ammonium sulphate are applied in connection with straw or other low nitrogen-carrying residues much of the nitrogen will be fixed with the carbon in an organic form in the process of decomposition. In the case of maintenance with legumes, worn-out soils can be decidedly influenced, as is evidenced by the pronounced improvement in the physical condition following immediately after the legume sod is broken up. When manure or strawy crop residues are applied this effect is not nearly as pronounced. In one case there is not sufficient carbon to fix all the nitrogen and large amounts are made available either to be lost by leaching or to cause a lodging or burning effect on the succeeding crop, while in the other case there is too much carbon for the nitrogen and in the process of decomposition much carbon is lost and little nitrogen is made available. This also results in decreased yields.

In sections where climatic conditions make it necessary to follow a legume sod with small grain, a crop that does not require excessive amounts of nitrogen, but nevertheless is decidedly dependent on small amounts of available nitrogen early in the season, difficulty is experienced in maintaining the organic matter supply.

The ill effects of legumes or straw used singly can be overcome by introducing the straw as a surface dressing on the legume sod before it is broken up. Besides this, it is reasonable to assume, consistent with the constancy of the nitrogen-carbon ratio, that much of the nitrogen and carbon that would be lost in the process of decomposition where the materials are used singly is now fixed, thus resulting in the more rapid accumulation of desirable soil organic matter.

F. J. SIEVERS
WASHINGTON AGRICULTURAL EXPERIMENT STATION

MEDICAL LICENSURE OF NON-MEDICAL DOCTORS

WHAT would result if most of our scientific laboratories were placed in charge of physicians? This question may be countered by saying that no one ever entertained such a thought; why raise needlessly a troublesome question? But House Bill No. 348 in the Pennsylvania legislature now in session provided