and sodium nitrate 100 pounds per acre. For soil 3, superphosphate 300 pounds per acre.

In the place of superphosphate a like amount of fine bone-meal was recommended for fall crops, like fall wheat and rye. In making the tests of soils in this manner it is not necessary to bring the plants to maturity, if time will not permit. Observations made on the growth of the plots during five or six weeks, will give sufficient data to interpret the needs of the soil.

The tests thus carried out are much less laborious than an analysis of the soil would be, and the chemist, who occupies a position, where the demands for soil analyses are frequently made by persons not properly informed in the matter, may often find this method of use in imparting that knowledge to the farmer, which will enable him to apply commercial fertilizers to his soil in a rational manner.

ON THE UNIVERSAL DISTRIBUTION OF TITANIUM.

BY CHARLES BASKERVILLE.

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THE universal distribution of titanium in the mineral and plant world is practically acknowledged. V. Roussel[1] found it in basalt; Aleksiejew[2] in certain clays. Holland[3] found it in certain igneous rocks. Dunnington[4] observed its occurrence in the soil of Albemarle County, Va.; later the same writer with McCaleb[5] found it in sixteen specimens of soil collected from different sections of the United States. Subsequently after having examined a large number of samples of soil collected from all parts of the globe Professor Dunnington[6] asserted its universal occurrence in the soils of the world.

W. A. Noyes[7] found it in a number of Arkansas minerals. Hillebrand has shown its presence in a large number of rocks and minerals collected by the United States Geological Survey. Wait[8] found it in the ashes of several plants and different kinds

1 *Ber. d. chem. Ges.*, 6, 1417, *b*.
2 *Chem. Ztschr.*, Rep. 1896, 261.
3 *Chem. News*, 59, 27.
4 *Proc. A. A. A. S.*, 34, 132.
5 *Am. Chem. J.*, 10, 36.
6 *Am. J. Sci.*, Dec. 1891; *Chem. News*, 65, 65.
7 *J. Anal. Appl. Chem.*, 5, 39.
8 This Journal, 18, 402.

of wood, also in coals, bituminous and anthracite. Haywood[1] found traces in domestic strawberries and 0.1088 per cent. in the ash of wild strawberries (*Fragaria Virigiana*). Langenbeck speaks frequently of its occurrence in clays. It has been found by the writer rather widely distributed in the clays of this state.[2] While Roscoe and Schorlemmer state that "It does not appear to form part of the animal and vegetable kingdom," Wait[3] assumes that it is assimilated by plants. The writer[4] shows its presence in the ashes of peat. As the clay substance therein is comparatively small its presence can scarcely be attributed to that. F. Garrigon found traces in mineral waters.

No statement in the literature has been found of its presence being noted in the ashes obtained from the animal kingdom. The ash from incinerated fresh beef, beef bone, human flesh, and bone free from dirt, have been examined in this laboratory with the following results: Beef bone 0.0195 per cent., beef flesh 0.013 per cent., human bone[5] a trace, human flesh[6] 0.0325 per cent. titanic oxide.

A private communication from Dr. J. L. Howe concerning the work of some of his students states that "Toole found titanium in abundance in dead bones, but only traces in fresh bone and muscular tissue, though traces were undoubtedly there." Dr. C. E. Wait in a letter of recent date writes: "Since my note on titanium was published a year or so ago, I have made an examination of a large number of bodies and I believe that element was found in nearly all of them. I have made a large number of estimations of titanium in vegetable bodies, and later took up the examination of animal flesh and bone, and the last piece of work along that line was the examination of human excretory products."

The universal distribution of titanium in all forms of living and dead matter may now be regarded as settled. While no opinion is hazarded by the writer upon the rôle played by

1 This laboratory. Work unpublished.

2 See "Clay Deposits and Clay Industry in N. C." Bulletin 13, N. C. Geological Survey, by Dr. H. Ries.

3 *Vide supra*.

4 This Journal, 21, 706.

5 A true rib and clavicle.

6 Pectoral muscles, *latissimus dorsi* and *gluteus maximus*. I am indebted to Dr. C. S. Mangum, of this University, for kindly dissecting out these samples.

titanium in animal and vegetable growth, it is hoped that Dr. Wait's work will throw some light upon the subject. Doubtless had we as delicate and covenient tests for the other less common elements we should find their occurrence as widespread. Thus the asseverated belief of Hillebrand in the universal occurrence of all the elements in the earth's crust is extended.

Titanium was determined by Weller's well-known method as modified by W. A. Noyes, Dunnington, and Hillebrand.

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THE RELATION OF PHYSICAL CHEMISTRY TO TECHNICAL CHEMISTRY.[1]

BY WILDER D. BANCROFT.

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STUDENTS ask me often what use physical chemistry can be to them if they are going into technical work and, once or twice, a manufacturer has said to me that "of course, physical chemistry has no practical usefulness." It is this idea, that physical chemistry is not a necessary part of the technical chemist's equipment, which I wish to combat. Let me warn you in advance, however, not to take anything that I shall say as an argument in favor of substituting a study of physical chemistry for a study of organic or inorganic chemistry. Nothing is farther from my thoughts. A good working knowledge of inorganic and organic chemistry is absolutely essential to the man who is going to use his physical chemistry either for purely scientific purposes or for technical purposes.

To understand the usefulness of physical chemistry to the manufacturer, it is necessary to ask what the manufacturer needs. He is interested in the discovery of new and useful compounds, and in the improvement of methods for making compounds already known. The discovery of new and useful compounds may be left, for the present, to the man who is an inorganic or an organic chemist, pure and simple: it is his especial province. What I wish to emphasize is that this is, as a rule, a matter of secondary importance. There are very few manufacturers who make their profits entirely from the sale of a compound which they alone have the right to make. The

[1] Revised from a paper read before the American Chemical Society at Columbus, September 21, 1899.