

fix ammonia in the same manner as arable land, and acted towards ammonia in the same manner as animal charcoal or bone black.

5. Brustlein's experiments also proved the important fact, that whilst these substances fix ammonia in its pure or caustic state, they have no such effect upon any of its salts, such as carbonate, sulphate or muriate. He verified this by dissolving out carefully with muriatic acid all the lime from a calcareous soil, which still retained the power of fixing pure ammonia, *but entirely lost its power of absorbing it from any of its salts.* This important discovery will be again referred to when we treat of the use of lime as a manure.

It is an established fact, that the presence of phosphoric acid in a soil is essential to the growth of plants, and yet, until within a few years, it was rarely detected by analysis. The great improvements, however, in analytic processes now enable chemists to detect it in all fertile soils, yet the proportion is usually so small as to render it impossible to determine the exact quantity. Under these circumstances it is, in my opinion, unsafe to rely upon the results of chemical analysis in determining whether a soil requires phosphates or not. This may be determined more certainly by means which will be stated in another place.

With the exception of a few localities of the native phosphate of lime, or apatite, in which it occurs in small quantities, we find phosphates very sparingly distributed in the mineral kingdom. It was an interesting question in science for a long time to account for the fact that the phosphates so essential to the existence of both vegetable and animal life should be so extremely rare in the mineral kingdom. The advance of science has solved the problem, by proving that they are most extensively distributed throughout the world but in very minute proportions, which were not appreciable by the older analytic processes.

Bischoff, Delesse, Fowne and other eminent chemists have detected traces of phosphates in granite, hornblende rock and limestone, and also in talcose, chloritic and mica slates and other rocks and minerals. They have also proven its existence in sea water, which might have been inferred from the abundance of organic life therein.

These interesting investigations indicate the source of the phosphates in all unmanured soils, and they satisfy us also from the minute proportion in the rocks, that when the supplies in the virgin soils become exhausted they are too slowly supplied from natural sources for the wants of man. Hence the necessity for phosphates for all impoverished soils.

Nitrogen (which, united to hydrogen forms ammonia, or with oxygen forming nitric acid) is equally essential to vegetable and animal life. It exists to an extremely limited