day his greatest rivals in the control of nature. They threaten his life daily; they shorten his food supplies, both in his crops while they are growing and in such supplies after they are harvested and stored, in his meat animals, in his comfort, in his clothing, in his habitations, and in countless other ways. In many ways they are better fitted for existence on this earth than he is. They constitute a much older geological type, and it is a type which had persisted for countless years before he made his appearance, and this persistence has been due to characteristics which he does not possess and can not acquire—rapidity of multiplication, power of concealment, a defensive armor, and many other factors contribute to this persistence. With all this in view, it will be necessary for the human species to bring this great group of insects under control, and to do this will demand the services of skilled biologists—thousands of them. We have ignored these creatures to a certain extent on account of their small size, but their small size is one of the great elements of danger, is one of the great elements of success in existence and multiplication.

Let all the departments of biology in all of our universities and colleges consider this plain statement of the situation, and let them begin a concerted movement to train the men who are needed in this defensive and offensive campaign.

In closing, I can not refrain from quoting a remarkable paragraph from Maeterlinck:

> The insect does not belong to our world. The other animals, even the plants, in spite of their mute existence and the great secrets which they nourish, do not seem wholly strangers to us. In spite of all, we feel with them a certain sense of terrestrial fraternity. They surprise us, even make us marvel, but they fail to overthrow our basic concepts. The insect, on the other hand, brings with him something that does not seem to belong to the customs, the morale, the psychology of our globe. One would say that it comes from another planet, more monstrous, more energetic, more insensate, more atrocious, more infernal than ours. . . . It seizes upon life with an authority and a fecundity which nothing equals here below; we can not grasp the idea that it is a thought of that Nature of which we flatter ourselves that we are the favorite children. . . . There is, without doubt, with this amazement and this incomprehension, an I know not what of instinctive and profound inquietude inspired by these creatures, so incomparably better armed, better equipped than ourselves, these compressions of energy and activity which are our most mysterious enemies, our rivals in these latter hours, and perhaps our successors.

L. O. HOWARD
U. S. DEPARTMENT OF AGRICULTURE

ADDRESS AT THE LAYING OF THE CORNER STONE OF THE CHEMICAL LABORATORY OF THE CORNELL UNIVERSITY

THE great chemical laboratory, the cornerstone of which we lay to-day, will not be without its effect upon the life of the university. Its influence may be good or it may be bad. It is sure to be profound.

Chemistry has many aspects. Sordidly treated, as a mere bread and butter subject, it might conceivably tend to degrade our teaching to a low, materialistic level. Idealistically treated, as becomes a great fundamental science, it will promote the noblest purposes in education.

Are we out of touch with life? Chemistry has the most varied and intimate contacts with life of any of the sciences.

Do we wish to inspire, in our teaching, a passion for truth? The pursuit of science is an unending quest for truth.

Are we inclined to shun specialization lest we lose a certain breadth of training for our students? Let us remember that to really know something of any one of the many branches of a science like chemistry one must use several languages, must be something of a mathematician and physicist and must be acquainted with many allied subjects.

There are few things so broad as a " narrow specialty "—if you follow it down to the ends of its wide spreading roots!

As for the training of the imagination and the building of character, is it not inspiring to turn from the pitiful struggles of the human race as depicted in a world's history whose every page drips with blood and filth, to the contemplation of the intimate structure of God's universe, perfect, complete; equally majestic whether we view it as a whole or in its minutest parts. It is indeed healthful for the imagination and for the character to delve, now and then into those unseen realms of nature through which wanders in speculative mood the spirit of modern science.

All of these things: the keeping in touch with life, the love of truth, the breadth of culture, the training of the imagination, the building of character are pedagogical considerations. But they are so important that the favorable influence of the new laboratory upon them would in itself make that great gift well worth while. Its real purpose, however, is much more momentous.

The new laboratory will be a center of research from the start. Of that we may be sure, knowing who are to occupy it. By its very completeness and adequacy, assured by years of careful and intelligent planning, it will challenge our chemists to redoubled activity. Enthusiasm and the true spirit of investigation are sure to prevail and notable results may be counted upon.

If the chemists and students of chemistry who are to work in this building attain only an average output as measured by the performance of university laboratories in the past, the donor may count on returns from his investment such as no commercial enterprise has ever paid. Nearly every fundamental discovery has originated in the universities and these discoveries have literally transformed the conditions of life upon our planet. In this transformation chemistry has had a great part.

The cost in money of these first essential steps towards progress has been but trifling.

The price of a single battleship would build twenty such great laboratories: that of a modern battle fleet, destined to the scrap heap within ten years, would amply endow all the universities in the land.

We can not remind ourselves too often of all this because these basic things which must precede all invention and industrial development are not ushered into the world with acclamation. Yesterday, so to speak, a quiet, shy little man in a university laboratory studied the emission of electrons from a hot body, described the phenomenon, wrote out the equations and went his way. To-day, as a consequence, you or I may speak to a friend in San Francisco. To-morrow, perhaps, we may be able to call up a man in any part of the world *and hear his living voice*: and very, very few will realize that *Richardson* made that miracle possible!

This is but one instance, and not from the domain of chemistry; were I a chemist and did time permit I could doubtless cite a hundred equally striking cases.

It is obviously difficult to estimate just what credit in the development of modern civilization is to be assigned to the workers in pure science but theirs is clearly an essential part. But for the new knowledge furnished by them modern civilization could not have come into being.

It may be thought that this is an evil day in which to boast of the triumphs of our civilization and that it were well if we could return to the primitive conditions of ancient Greece. I prefer, however, to regard the terrible upheaval which the human race has gone through as a violent attack of indigestion, due to having taken too rapidly into an unaccustomed system the rich new diet proffered by science. Let us hope for the ultimate recovery of the patient.

Measured according to that ultimate standard, which does not fluctuate with the abundance or scarcity of gold, *i.e.*, the happiness of the human race, I believe that the research man, academic trifler, theorist, dreamer, dabbler in things trivial as he seems to the man of affairs, will be found, like that other idle ne'er-do-well, the artist, to be among the most supremely productive of all the world's workers.

Speaking more intimately and personally, we may expect that the renewed activity of our chemists will react upon other departments. There will be joint projects for carrying on extended researches made possible by the new equipment. Thus we may soon hope to enter upon what is perhaps the most promising next step in the development of the sciences: namely cooperative undertakings on a large scale involving chemistry-physics, chemistry-engineering, chemistry-geology, chemistry-biology, and the like. Many of the pressing problems of the immediate future are too large for any individual or for any single department. In this way, on its scientific side, the university may best serve the community. Thus it may better perform the prime function of every true university—the *advancement of knowledge*.

EDWARD L. NICHOLS
CORNELL UNIVERSITY

THE ORIGIN OF SOIL COLLOIDS AND THE REASON FOR THE EXISTENCE OF THIS STATE OF MATTERS

IN the mechanical analysis of hundreds of samples of soil by the beaker method, the microscopical control of the subsidence of the clay group indicated that the smallest diameter of a clay particle is about 0.0001 mm. while the water from which the sediment subsided was clear and transparent.

At first thought it would appear that in a soil which has weathered under many agencies, such as the grinding of glacial ice, the abrasion of flood waters, the pounding of ocean waves, and other agencies of attrition due to soil movements operating through untold ages, material of every degree of fineness would accumulate, passing down below the limit of microscopic vision. Practically however this does not appear to be the case as the finest material of the soil, called the clay group, excluding the colloidal material, to be discussed later, ranges in diameter from .005 to .0001 mm. The question naturally arises as to what has become of the material of smaller size.

My present view is that particles of matter derived from silicate rocks and other soil-forming minerals when they approach a diameter of .0001 mm. contain relatively so few molecules that the bombardment of the water molecules in which the particle is immersed shatters the particle beyond the ability of the molecules in the solid to hold together as a solid mass. The atoms of calcium, magnesium, potassium and sodium in the molecule of the silicate would go for the most part into true solution, while the atoms of silicon, aluminum, and iron would go chiefly into colloidal solution forming the basis of the colloidal matter or the ultra clay of the soil. It should be possible for the mathematical physical chemist, from physical constants now known, to determine empirically the relative size of the particle of matter which could withstand such bombardment without complete disintegration. This is a problem which has not yet been worked out.[1]

There appears to be a certain equilibrium established between the colloidal state and the truly soluble state as there is always a small proportion of silicon, aluminum, and iron which seem to be in real solution, as they pass through a Pasteur-Chamberland filter and separate out on evaporating the solution not as a colloid but as an amorphous mass of hard scale-like material, like a boiler scale, without absorptive properties.

It is that portion of the silicon, aluminum, and iron which collects on the outside of the Pasteur-Chamberland filter in a truly colloidal condition which is recognized as the ultra clay.

This colloidal matter is very absorptive and takes into itself a considerable quantity of salts of calcium, magnesium, potassium, and

[1] Another way of looking at this is from the point of view of the internal energy of the system. The molecular attraction between the molecules of the solid and the molecular attraction between water molecules themselves and between the molecules of the solid and of the water must come to equilibrium. If the solid particle becomes relatively small in diameter there will be relatively few molecules in the solid to hold together against the attraction of the increasing number of water molecules surrounding them as the size of the solid particle diminishes. The attraction of water molecules for solids which it wets, as, for instance, glass, is seen in the relatively high temperatures and therefore high energies required to remove the *last traces* of water from the solid.