Scientific American.

ESTABLISHED 1846.

MUNN & CO., Editors and Proprietors.

PUBLISHED WEEKLY AT
NO. 37 PARK ROW, NEW YORK.

O. D. MUNN. A. E. BEACH.

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VOLUME XXXV., No. 8. [NEW SERIES.] *Thirty-first Year.*

NEW YORK, SATURDAY, AUGUST 19, 1876.

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THE SCIENTIFIC AMERICAN SUPPLEMENT.
Vol. II., No. 34.
For the Week ending August 19, 1876.
With 71 Illustrations.

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BERTHELOT'S NEW ELECTRO-CHEMICAL DISCOVERIES.

M. Berthelot, the distinguished French chemist, has lately brought before the French Academy of Sciences a series of remarkable experiments, which, in addition to affording other results, point to an important and brilliant discovery relative to the reactions which occur between the gaseous elements of the air and the organic compounds of the earth. The nature and effect of these reactions on vegetation constitute no small portion of the science of agricultural chemistry. And regarding the question of the source of the supply of nitrogen to plants, it is well known that none is more closely enlisting the attention of chemists who find, in the doubt encircling present accepted theories, the stimulus for further and deeper investigation.

We know that, for the support of vegetation, carbon, hydrogen, oxygen, and nitrogen are needed, and that the source of carbon is the carbonic acid which exists in the atmosphere in the proportion of $\frac{1}{2500}$ of its volume. Similarly, the water always present in the air supplies hydrogen and oxygen necessary. It is not so easy to trace whence the nitrogen is derived, and here opinions have fiercely conflicted. Previous to Liebig's time, it was supposed that organic matter (humus) supplied the chief nutriment of plants; but this the great German chemist denounced as "baseless and absurd;" and after detailing his own experimental researches and those of others, he affirms that nitrogen "is derived either from the air, whence it is conveyed to the earth in rain or dew, or from organic substances accumulated from a series of generations of dead or decayed plants, or else from animal remains contained in the earth or incorporated with it by man in the form of excrements. * * * The remains of extinct animal life, which are embedded to an enormous extent in sedimentary strata, or which of themselves constitute whole masses of rock, attest the extraordinary distribution of organic life in the former ages of the earth: and it is the nitrogenous constituents of these animal bodies, passing over into ammonia and nitric acid, which still play an important part in the economy of the vegetable and animal world." Such is the present theory. It is difficult to conceive of its more complete reversal than must follow the acceptance of the facts which M. Berthelot now places before us—facts which the clearest of subsequent investigation must substantiate before they will prevail over Liebig's conclusions—facts which lead to the assertion that free atmospheric nitrogen is fixed in organic nature, unchanged in form by atmospheric electricity.

It has long been known that the silent electric discharge is capable of producing special chemical reactions. In order to study these, M. Berthelot devised a simple little apparatus, composed, first, of a bell-mouthed test tube about which a ribbon of platinum was coiled; and second, a V tube of glass closed at one extremity. The test tube filled with the gas or liquid to be tested was inserted over a mercury bath, and the closed end of the V tube was inserted in it. One pole of a Ruhmkorff coil was attached to the platinum ribbon, the other communicated with a conducting liquid (acidulated water) in the V tube. The current then passed through the then annular space comprised between the vertical leg of the V tube and the inner periphery of the test tube, which space was of course filled with the material under examination. By this instrument he found that organic compounds, at ordinary temperatures, absorb free nitrogen, while under the influence of the current. In a few hours, 15·4 grains absorbed from 0·24 to 0·3 cubic inch of nitrogen, the greater part remaining unaltered; a solid resinous polymeric product was generated, which, on being heated, decomposed with evolution of ammonia. Turpentine and marsh gas acted similarly. Taking the constituent principle of vegetable tissues—in the shape of a piece of white filtering paper, which is none other than cellulose or ligneous principle—after having slightly wet it, he submitted it to the action of the current in presence of pure nitrogen. In eight or ten hours, a notable quantity of gas had been absorbed, and subsequently the nitrogen, combined with the paper, was extracted in the state of ammonia.

The presence of oxygen does not hinder the absorption of nitrogen. By causing the discharge to act on atmospheric air in contact with a sirupy solution of dextrin, M. Berthelot observed that a certain quantity of nitrogen and oxygen combined with the organic matter. Furthermore, hydrogen is absorbed in the same manner and even more rapidly than nitrogen; 0·06 cubic inch of benzine took up 15 cubic inches of hydrogen, or about 2 equivalents, and the result of the combination was a resinous substance analogous to a dried varnish, possessing a very strong and disagreeable odor.

The reaction produced by the silent discharge appears to be much greater than when the electric spark is used. With the current the proportion of ammoniac gas reaches about 0·03 in the normal mixture of nitrogen and hydrogen; with the spark, but a few hundred-thousandths. The decomposition of ammoniac gas by the current tends to the same limit. This identity of the two limits produced by the inverse action of the current is remarkable, and is as important to be noted as that of the diversity which exists between the action of the silent discharge and that of the spark. Protoxide and binoxide of nitrogen, sulphuretted and phosphuretted hydrogen, sulphurous acid, etc., are all more or less profoundly decomposed; and in brief, the action of the silent discharge, like that of the spark, tends to resolve compound gases into their elements, with the production of phenomena of equilibrium due to the inverse tendency of recombination. Only, in the case of the discharge, a portion of the isolated elements unites with the compound itself to form condensed products, to the formation of which, however, are opposed the longer duration of the spark, and especially the heating effect thereof.

"It is not doubtful," says M. Berthelot, turning to the practical results of his discovery, "that analogous phenomena (accompanied by an absorption of oxygen) manifest themselves during storms, and even when the air is electrified or presents a different potential in its upper strata and in those exposed to the sun, which is, after all, its normal state. Under these conditions, the organic matters in contact with the air very probably absorb nitrogen and oxygen. This absorption may be revoked at the moment of lightning discharges, which correspond to the differences of tension analogous to and greater than those of the Ruhmkoff apparatus; and the same is likewise probable for weaker differences that are incessantly produced. Perhaps even this absorption of nitrogen and oxygen, joined to the molecular condensations and other chemical changes developed in the tissues under the influence of the electric discharge, causes corresponding physiological modifications which play a certain part in the singular ailments manifested in the human organism during storms."

Without stopping to dwell on these points, however, the discovery may be regarded, as we stated in the beginning, as showing a new cause for the fixing of atmospheric nitrogen in Nature. It engenders condensed nitric products, of the order of the humic principles so widely extended over the earth's surface; and however limited the effects may be, at each instant or at each point of the terrestrial superficies, they may evidently become considerable by reason of the extent and the continuity of the reaction universally and perpetually taking place.

IS THE UNIVERSE COMPOSED ENTIRELY OF HYDROGEN?

There are many eminent chemists, Professor Cooke among the number, who believe that, instead of there being 64 elements, there is but one. That this one universal element assumes more than 60 different forms (according to the velocity with which the atom moves), which constitute the molecules, or their arrangement, or number, is not more wonderful than the changes which some of our so-called elementary bodies suffer in their allotropic modifications. Sulphur, phosphorus, and carbon are, to a certain extent, protean; but they are distanced in the allotropic race by isomorphous hydrocarbons. Dr. Wurz defines organic chemistry as the chemistry of the hydrogen compounds, for he believes that it is protean hydrogen, with its ever-changing atomic volume that makes organic chemistry so complex. If we combine the two theories, that all matter is but various forms of one simple body, and that hydrogen is the most protean of our so-called elements, we have an affirmative answer to the query which forms the title of this article.

What force we shall employ to dissociate the elements and convert them into that primitive form, we are at a loss, as yet, to say; but the spectroscope leads us to think that heat, if sufficiently intense, may accomplish it. Lockyer, the great English spectroscopist, has recently been studying the spectrum of calcium, and says that when this metal is heated above a certain temperature the hydrogen line appears, as though, at that temperature, a partial dissociation took place. This fact alone is a feeble basis for the grand hypothesis that all things are hydrogen, and so too is the coincidence of the blue indium line with one of the hydrogen lines; but we shall wait for farther research, thankful that Professor Lockyer has directed our attention to that direction. The hottest known body is the sun, and about it play enormous lambient flames of hydrogen; and perhaps this unlimited supply of hydrogen is due to dissociation. Will spectroscopic astronomers tell us?

OCULAR COLOR SPECTRA AND THEIR CAUSATION.

It is a well known fact that by certain simple combinations of lines the eye can be so completely deceived as to make it altogether unreliable as a means of estimating distance and direction. Similarly, by certain grouping of masses of light and shade, the organ can be misled into recognizing apparently tangible and solid objects from mere pictorial representations. These deceptions, however, are independent of color. When that element is added a remarkable group of optical phenomena is engendered, by which the eye is led even more completely, and with less obvious reason, into error.

The reader will gain an idea of these appearances by the performance of a few simple experiments which we will indicate. On a black background, place a disk of white paper about the size of a half dollar piece. Gaze at the disk fixedly for a couple of minutes, then suddenly regard a blank white wall: when a dark spot, having the outline of the disk, will be beheld on the white surface. If a dark body on a white ground be first looked at, then, on lifting the eyes to the wall, a brilliant white figure of corresponding shape will appear, To these appearances the name negative spectra has been given; they may be considered, in fact, as genuine specters, ghosts, of the solid objects gazed on. Next, prepare from brilliantly colored paper, red, blue, yellow, and green circles. After gazing fixedly at the red circle and transferring the eyes to the wall, a green circle will appear thereon, the blue will cause a yellow specter, the yellow a blue one, the green a red, and so on, each color producing a specter of complementary hue. These are termed complementary color specter, and they may be produced in a variety of ways. Near sunset, the rays of the sun passing through an orange colored cloud cast blue shadows; the shadows of objects seen behind red curtains are green. If the sunlight be transmitted through colored glass so as to fall on white ground, the shadow of an object, placed so as to intercept the light, will have a shadow of the color complementary to that of the transmitting pane. And yet, if we look at the shadows so thrown through a tube, so as to shut