P (1110

voted himself to the automobile torpedo. Abandoning Capt. Lupuis's plans, he succeeded, in 1867, in perfecting the delicate machine which bears his name, with the assistance only of his son, a mere boy, and one trusted workman. As a result of that success, every navy has its fleet of torpedo boats and torpedo-boat destroyers, and almost every cruiser and battleship has its torpedo-launching tubes. In order to combat this terrible weapon, there was introduced first the torpedo netting, now discarded, and then the quick-firing guns, intended to protect a warship by an incessant hail of projectiles. Incidentally, the weight of armor on all protected vessels was greatly increased, and finally the submarine was undoubtedly hastened by the Whitehead invention. Indeed, the torpedo has probably had a greater influence than any other factor, save the comfort of men and officers, in developing the modern topheavy, high-sided fighting vessel, as the standard type of battleship, instead of the Ericsson monitor.

Whitehead's first torpedo was of steel, 14 inches in diameter, weighing 300 pounds, and carrying as its explosive 18 pounds of dynamite. Its speed was low—only six knots—and the right to manufacture was purchased by the English Government in 1871 for the trifling sum of $15,000. As now developed, the Whitehead, whose motive power is compressed air, has attained a speed of 26 knots an hour, with a range of 4,000 yards. It can be regulated to explode by impact or after a definite time; it may be set to travel at a uniform speed and depth the whole of its range, or both depth and speed may be varied. So remarkable is its mechanism that it may be made to rise to the surface or sink to the bottom after missing its mark. Its "war head" being detachable, it can be used again and again during practice with perfect safety. In length, the Whiteheads used by the United States navy vary from thirteen to eighteen feet. Whitehead himself re-designed his torpedo in 1876, 1884, and 1889. By 1885 and 1886, torpedo boats for the discharge of these weapons were constructed by Austria, Chili, China, Greece, Italy, Portugal, Russia, Spain, Sweden, Turkey, Germany, France, and Great Britain. To-day, England alone has 142 torpedo-boat destroyers, 117 first-class torpedo boats, and 72 of the second class, in addition to 39 submarines built or building. In addition to this, automobile torpedoes are part of the coast defence of several nations.

So far as the effect of Whitehead's invention upon general naval tactics is concerned, the battle of the Sea of Japan affords the best illustration, although full and accurate reports of the part played by the Japanese torpedo boats are not yet at hand. It is believed, however, that some of the Russian vessels were directly sunk by torpedoes, and that others received the *coup de grâce* from torpedo boats after they had been wrecked and put out of action by gunfire. Moreover, the repeated Japanese torpedo attacks, even when successfully repelled, as at the beginning of the battle, kept the Russian crews in a high state of tension and excitement, just as the Spanish destroyers at Santiago made our American naval officers nervous and set them to seeing spectres and firing at phantoms. As long as torpedo boats are in the vicinity of a fleet, its crews will be nervously wrought up. For many years to come the success of the Japanese torpedo attacks at Port Arthur on February 28 and the destruction of the *Sebastopol* should be the classic examples of the damage which can be wrought by daring torpedo officers. One lesson of the late war is that torpedoes are of little value on board large ships, while the torpedo tubes on them are sources of structural weakness; but this had already been foreshadowed. It must not be forgotten, however, that floating mines were even more destructive than torpedoes. Three big battleships foundered at once on striking mines, while not one was totally destroyed by a single torpedo.

In this connection it is interesting to note that, as the United States was the last country to build torpedo boats, so its naval officers, by their own admission, have paid far less attention to this mode of warfare than have foreign navies. Not until 1900 was the first torpedo with a war charge fired by an American torpedo boat. This indifference is distinctly regrettable, because the United States is the country, above all others, which can be well defended by a torpedo flotilla. Unfortunately, our naval experts are now far more concerned with heavy offensive squadrons than with the defensive measures long urged by the founders of this Government. But if our navy were to devote itself to developing torpedoes and torpedo boats, it might demonstrate that the country needs fewer battleships than it has to-day—and this, from the point of view of many officers, would never do.

THE NATIONAL ACADEMY OF SCIENCES AT NEW HAVEN.

NOVEMBER 18, 1905.

The meeting of the National Academy of Sciences in New Haven on November 14 and 15 was perhaps not as full as might have been expected; no quorum of the Council was present, and the number of papers by members was not large, but it may be doubted whether there ever was a meeting in which so much was brought forward that had a flavor of great scientific novelty, inasmuch as the new conception of matter which has resulted from the study of various kinds of radiation is now taking on the aspect of a greater revolution in science than did the advent of the doctrine of energy or that of natural selection, and therefore of the greatest since Newton, if not since Copernicus.

The most astounding surprise, though the matter had been rather skeptically heard of before, was the demonstration shown in photographs brought home from South Africa by Prof. W. M. Davis, of the ancient glaciation in that country. Prof. Davis reported that, as far as he heard, all the geologists at the Cape Town meeting of the British Association were fully convinced that the scratches on the rocks and other apparent vestiges of a great glacier sheet were veritably what they had seemed to South African geologists to be. Yet, in addition to some minor difficulties, such as the total absence of terminal moraines, this South African glacier sheet presents two features wholly unprecedented, one of them truly astounding. The former is that this glacier belonged to the Permian epoch, though it has hitherto been supposed that the glacial ages were all, geologically speaking, recent, and indeed have not yet quite come to an end. One is hardly prepared to say why there might not have been glaciers in Permian times; but belief is almost staggered when we learn that this sheet, starting well within the tropics, moved due south toward the Cape. We are reminded, however, that the newly discovered source of energy by radio-active decomposition of elements of high atomic weight is so tremendous that the age of the sun, and consequently the length of geological eras, must probably be far greater than those who have listened to Kelvin and the physicists have been accustomed to think. Moreover, the present view is that the planets generally have performed a half-somersault under tidal action, so as to rotate now from south to east, though at first they turned from south to west. But such a change, by dynamical necessity, must have been accompanied by a vast shifting of the axis of each planet. We are, therefore, tempted to think that there might have been a time when South Africa was warm than the parts that are now in latitude 20° S. Somebody ought to examine into this. It illustrates, at any rate, how limitless is the field of consequences which may result from Madame Curie's discovery.

We cannot be surprised at finding that young men are the most alert in assimilating the new conceptions which old and young are now driven to admit, but the old with some not very definite reserve. Dr. B. B. Boltwood, who was introduced by Prof. H. L. Wells, exhibited a curious table showing calculated ages of certain minerals in millions of years. Here, again, we have to remember that there is no longer any solid reason for refusing to acknowledge the lengths of geological time upon which the geologists have always insisted, nor, indeed, if the affirmative reasons are sufficient, the still vaster durations demanded by the palæontologists. It now appears that helium is set free in all radio-active decomposition, and in point of fact the atomic weight of uranium exceeds that of thorium, as nearly as we know, by twice the atomic weight of helium, and exceeds the atomic weight of radium by three times the same amount, as if U=Th He_2=Rd He_3; and radium, which undergoes five successive radio-active decompositions, has an atomic weight exceeding that of lead by five times the atomic weight of helium, as if Rd=Pb He_5. For this and another weighty reason, Dr. Boltwood suggested last spring that the final product of the decomposition of radium is lead, an idea which has been received with favor. The other reason to which we allude is, that the proportions of lead and helium in the radio-active minerals are correct if we suppose that they were all pure thorium minerals at first; and in point of fact all do contain thorium. It is singular that the rate of each kind of radio-active decomposition remains absolutely constant at all pressures, and at temperatures ranging from that of liquid air to the highest temperatures that have been tried. Nothing seems to disturb its march. On this basis, then, Dr. Boltwood has determined, from the amounts of lead and of helium per gramme of the mineral, the length of time required to produce that amount for all the minerals for which the calculation is possible—a long list from various parts of the world; and the truth of the calculated times seems to be decidedly confirmed by the calculations turning out to give all the minerals from any one region, however different they may be in composition, pretty nearly the same age, although minerals from different regions show decidedly, and sometimes vastly, different calculated ages. Thus, the calculated ages of five minerals of Connecticut range from 92 to 98 millions of years, those of North Carolina 119 to 127 millions of years, and those of Norway from 290 to 383 millions of years.

Stupendous as these periods of time are, it does not appear that the physicist can any longer deny them, and they appear to receive some support from the southward motion of the glacier sheet of South Africa. There is, however, one point of serious doubt. Many chemical reactions proceed with extreme slowness at ordinary and lower temperatures, but, when the substances are heated to a certain point, they suddenly advance with great rapidity. Now experiments upon radio-active decomposition have never been made above 200 degrees C, which is below the heat of a good baker's oven. It is, therefore, quite possible that at some higher temperature this decomposition should proceed very fast, especially if certain other conditions that might be pointed out should be realized. For the present, this consideration must throw a not inconsiderable doubt over Dr. Boltwood's calculations.

Dr. H. A. Bumstead, who was introduced by Professor Hastings, is a Yale graduate, already favorably known to the scientific world, who has been working for a year under the guidance of Prof. J. J. Thomson, the chief promoter of electrons and all these ideas, in the Cavendish Laboratory. His paper greatly impressed the physicists by its refinement and cautious attention to every source of error, although it is impossible here, in short compass and without drawings, to give any idea of its merits. When the Röntgen rays strike upon metals they liberate a quantity of energy considerably in excess of that which went to their production. This excess of energy can be due only to the radio-active decomposition of the metal, although it would be quite impossible to detect, by chemical analysis, that any change had taken place. We have been accustomed to think of the liberation of energy in combustion as very great; but that which is liberated in radio-active decomposition is millions of times greater. Dr. Bumstead has taken a pair of elements, zinc and lead, the one of low atomic weight, the other of high, and, by measuring the difference of energy resulting from the action upon them of the Röntgen rays, studied the radio-active decomposition.

Another young man, known for excellent work in collaboration with Dr. Bumstead, Dr. L. P. Wheeler, introduced by Professor Hastings, gave an excellent paper and one very convincing of the value both of Professor Hastings's leadership and of the influence of Willard Gibbs. It was a mixed mathematical and experimental research, admirable in both directions, into metallic reflexion, the polarization-effects of films and of scratches, etc.

Another paper connected with the new conception of matter, and indeed opening a rich field of suggestion concerning electrons, was by one of the leaders in physics, Professor Trowbridge. He described, and illustrated by photographs thrown upon the screen, the singular effects which he had produced in large tubes traversed by a current from a battery of twenty thousand cells of great resistance. When sparks are used, we get only instantaneous effects, but, with such a continuous source of high-tension electricity, slow alterations are observed, occupying minutes in their performance. A volume-ionization is manifest, which slowly increases, and also an ionization-lag. There is a decided unipolar discharge. With some arrangements, rotating brushes are seen, together with phenomena which decidedly resemble the shifting of the Northern lights.

A paper, perhaps indicating an unrecognized state of matter, was by the veteran Professor Brewer. He had formerly given some account of his observations upon the deposition of sediment from water in which clay had been stirred up. But, the vessels not being transportable without disturbance, it was not until the Academy came to New Haven that he could actually exhibit his results. He had several two-gallon bottles with vertical sides, containing clay and pure water, which had not been shaken for fourteen and for twenty-two years. Yet an opalescence was still visible in them, and Professor Brewer was of opinion that the clay never would completely settle. It seemed to be in a colloidal condition, in semi-chemical union with the water, and diffusing through it. But Professor Brewer informed the Academy that if a minute quantity of salt water were to be added, the water would completely clear itself in a few days. To this paper Professor Brewer appended another with specimens demonstrating that wood will never rot under the influence of pure air and moisture, even if considerably heated. If, however, the smallest particle of rotten wood be introduced into the vessel, the rot will soon spread through all the wood present.

There was one exceedingly interesting paper upon mineral chemistry by Professor Penfield, the well-known mineralogist. It seems that some time ago he received from a correspondent a package of small crystals found at Borax Lake in California, the sender remarking that they contained magnesium and sodium in the form of carbonates and chlorides. One crystal, being taken at random for analysis, was found to have the described composition, with the singular difference that, instead of chloride, it contained sulphate. Now every student of chemistry knows that a sulphate cannot replace a chloride without a complete change in crystalline form; yet all the crystals were alike. It was, therefore, at first supposed that some blunder must explain their having been described as containing chloride. However, further examination showed that of the crystals which remained after taking away that one, some seven thousand in number, not one contained any sulphate at all. After that, one other crystal was met with which contained sulphate and no chloride. The formula of the first and last was

$$2MgCO_3,\ 2Na_2CO_3;\ Na_2SO_4;$$

That of the other seven thousand was

$$2MgCO_3,\ 2NA_2CO_3;\ 2NaCl.$$

The crystals containing chloride were somewhat soluble; those containing sulphate were insoluble. Moved by a rule of old-time chemistry about the precipitation of insoluble salts, Professor Penfield imagined that though the sulphate crystals were so rare in nature, it might be easy to crystallize them from a mixed solution of their ingredients. It proved to be far from easy, but was accomplished by five days' digestion over a *bain-marie*. There were, then, two independent phenomena to be explained: (1) the isomorphism of the sulphate and chloride compounds; and (2), the difficulty of formation of the sulphate salt, with its consequent infrequency in nature.

We now pass to the physiological and anatomical papers. The very first memoir read was an elaborate piece of work by Dr. L. B. Mendel, who was introduced by Professor Chittenden. It related to the presence of Sucrase, Maltase, and Lactase in the tissues and liquids of pigs and dogs in several embryonic stages and in the breathing animal. The details, though interesting, would require too much explanation to be given here. The differences found at different stages of development doubtless depend upon such facts as that the embryo-muscle has no work to perform, and that the embryo does not so readily get rid of substances which it can neither absorb nor transform, as the adult does.

Dr. F. E. Beach, introduced by Professor Hastings, dealt with the errors of eccentricity and collimation of the human eye. He corrected certain errors of Helmholtz, and showed how they had arisen. The axis of distinct vision is inclined some 3° or 4° from the axis of the cornea, which has not the form of a portion of a spherical surface. A person looking into an eye which looks straight into his will see three reflections—one from the cornea, and two from the two surfaces of the crystalline lens. It was to the departures from the character of an ideal optical instrument which are betrayed by the locations of these reflections that Mr. Beach's measures and calculations related.

The paper of the session was unquestionably that of Prof. Edmund B. Wilson, who attacked one of the great traditional mysteries, the problem of sex-determination, and distinctly brought it one long march nearer to elucidation. His admirably clear

diagrams, drawings from microphotographs of wonderfully prepared specimens, showed groups of bodies known as chromosomes, which are found not only in the cells immediately concerned in fertilization, but also in the cells from which *these* cells are formed by reduction. The animals from which they were taken belonged to six different genera of bugs. Three of these genera have, in each cell of the ovarian follicles from which the egg-cells are formed, a fixed number of chromosomes. This number is even without being divisible by four (such as 14 or 22), consisting of an odd number of pairs, the chromosomes of each pair being alike in size and general appearance, while the different pairs differ more or less in these respects. In particular, two chromosomes, in every case, are vastly larger than any of the others. These two have hitherto been called the "accessory" chromosomes; but Professor Wilson, having proved the gross impropriety of this designation, renames them the "heterotropic" chromosomes. Exclusive of these two, the number of chromosomes is divisible by four (as 12 or 20). The corresponding cells in the male contain each one chromosome fewer (as 13 or 21), since they possess but one of the heterotropic kind. The ordinary chromosomes in the male correspond exactly, one to one, to those of the female. From each of the cells of which we have been speaking, is formed, in each sex, two cells of the kinds directly concerned in fertilization. In this process of division the two members of each matched pair of chromosomes separate and go, the one to one of the new cells, the other to the other. But since the cells of the male contain but one heterotropic chromosome, half of the new male cells contain one, and the other half none at all. In the act of fertilization, one male cell is absorbed in a female one, which thus comes to contain the chromosomes of both; namely, a number of ordinary chromosomes divisible by four, and either only one heterotropic chromosome, which is the characteristic of the male, or two of these, which is the characteristic of the female.

This is what happens in three of the genera examined. In the other three there is a slight difference, in that the original cells of the male, instead of containing ordinary chromosomes equal in number to those of the male together with a single chromosome which is a good deal larger, contain, beside all those, an additional chromosome which is a good deal smaller than the ordinary ones. This little chromosome acts like the mate to the big one, in that, in the division of the cell, it always goes to the opposite one of the new cells; that is, to that one of the new cells which the big one does not enter. If we leave the little chromosome out of account, the phenomena of these genera are just like those first described. Professor Wilson entertains no doubt that it is this second arrangement that is the primitive one. These facts seem to show that the determination of sex takes place at fertilization, wherein a signal addition is made to our knowledge of the subject. Still, Professor Wilson does not believe that the chromosomes are the direct determinants of sex, but rather that they are concomitants of that determination, which he thinks may be a matter of metabolism, perhaps of growth.

Mr. Agassiz, the President of the Academy, as usual wound up the session with one of his delightful papers, which are always followed without difficulty, and are always full of interest. It treated to the various forms and functions assumed by the spines of sea-urchins. We have not mentioned three mathematical papers by Dr. Franz Boaz, Mr. C. S. Peirce, and Prof. Asaph Hall. Professor Hall's paper related to the calculation of the anomaly of Halley's, or any similar, comet.

The meeting was an exceptionally enjoyable one; and the New Haven members gave the Academy such a dinner as is not often offered to mere scientists.

THE BRITISH ASSOCIATION IN SOUTH AFRICA.—II.

HARVARD UNIVERSITY,
November 4, 1905.

The stay in Johannesburg was so actively employed that it was something of a relief to start away on the further journey. The main party made a brief stop at Bloemfontein, and then a long southward détour by rail to Kimberley, and there spent two days. A number of others "trekked" across the plains in slow wagons from Pretoria to Mafeking, to learn something of the open country far from the railway. A small geological party again separated from the others and went a day's journey northeastward to the Duivel's Kantoor (the Devil's Shop), a great promontory in the escarpment by which the interior highland breaks down toward the coast, affording "one of the finest views in South Africa." It was curious to find at this isolated spot a comfortable little hotel kept by a German (who shouted for joy when Penck changed from English to his own language in the second half of his after-dinner speech), and some small summer houses, refuges for those who can leave their homes on the coastal lower lands during the hot season. Returning to Johannesburg, we followed the main party around to Kimberley.

The railway journeys gave us abundant views of the broad, treeless, apparently unoccupied Veld in the Transvaal and the Orange River Colony. We had been told in Cape Town that this ride was monotonous and tiring, and so it truly might have been to travellers not interested in land forms; but, in the sympathetic company of our geological party, there was study and discussion of the plains all day long, for their origin seemed to involve curious changes in continental altitude or in climatic conditions, yet to be worked out. Moreover, on this and other railway journeys, we saw the broad country that the Boers had wrested from the natives, and that they had learned to occupy in somewhat patriarchal fashion. Each isolated homestead was usually determined by some convenient source of water supply; hence the frequent recurrence of names ending in *fontein* (spring), *spruit* (stream), *vlei* (hollow), *poort* (gap), and so on. There were small gardens near the houses, occasional small fields of "mealies" (maize) which supply a staple article of food for Boer and Kaffir, and plantations of gums (eucalyptus) and wattles (acacias) from Australia, for South Africa has been unsuccessful in the development of trees suitable to its dry climate; but the greater part of each estate was a vast uncultivated cattle range, where the herds and flocks are tended by natives, who live like serfs near their master's house. Here, dwelling in isolated and contented independence, rather indifferent to what outsiders call progress, and accustomed to a political system in which the local government of cities by their citizens had practically no place, the scattered Boers saw the rapid growth of the concentrated and aggressive mining population on the Rand, and a prolonged conflict was the natural, if not the inevitable, result. In what degree the Boer rulers were to blame for precipitating the conflict, I shall not presume to say; but it was a matter of regret to see that unsympathetic antagonism still exists between the scattered farmers and the crowded miners. We passed many battlefields and saw many traces of the war; blockhouses and rifle pits in various stages of obliteration, barbed-wire entanglements along parts of the railway line, ruined or rebuilt houses; and we heard much of the efforts made by the British to reëstablish the Boers on their farms. Vast sums of money have been spent under British control, chiefly on the reconstruction of railways and public works, but also on the repatriation of the farmers and on the restocking of their cattle ranges, the latter effort being greatly hindered by rinderpest and other diseases. Some of the money has been spent on the *Beiwohner* or hangers-on, the houseless Boers who, by misfortune, lack of thrift, or otherwise, have become a sort of "poor whites" in a country where the whites insist that they must dominate the blacks. As if in dread of the growth of such a class, great effort is made to give them means of becoming landlords.

Another problem that took our attention in the interior was the question of British immigration. Shall the stalwart young English farmer be encouraged to go out and plant his small capital and his small family in the Veld, in the hope of bettering the narrow condition that he leaves at home, and of opening up a wider future for his children? The opinion of the Association party was on the whole adverse to recommending such a venture; and this advice judgment was supported by experts in agriculture and economics as well as by the "intelligent travellers." The mechanic may do well in the mining centres, and the man of larger means may succeed in the Veld, especially if he first learns to live at least as well as the Boers do, and does not insist on carrying out his home ideas in a dry country; but the small farmer must wait until irrigation is introduced on a large scale under Government control, and this has not thus far been shown to be feasible; until a kind of wheat can be developed that will be immune to rust during the summer rains, and no wheat of that kind is to be had at present; and until the many diseases of cattle and sheep can be controlled, and that happy day is not as yet. Until these difficult problems are solved, the young British farmer had better stop in the Cape Colony, near the coast, or go to Canada or New Zealand, and leave the Veld to the Boers and its vast emptiness.

It must be borne in mind that an important factor in the future of South Africa is the principle, widely proclaimed by Briton and Boer alike, that the white man must work only with his head, and leave manual labor to the natives. I do not believe that