cal students, who, after taking the early part of their training in the colonial high schools and colleges, proceed to Edinburgh to complete their course, invariably give a very good account of themselves.

In matters of purely scientific interest there is but little to chronicle at present from the colony. The want of money seems to have paralyzed even much of the available energy of the colonists; many men who formerly thought themselves in possession of a competency for the rest of their lives, being under the necessity again of commencing the grim battle for bread. It must be borne in mind that there is practically no cultured class in the colony, outside of those who are compelled to work. The scientific research and work which have been put forth from these islands have been done usually in the course of, or in the intervals of, hard professional work, by settlers, surveyors, medical men, lawyers, and teachers. There is only one purely scientific association for the whole colony, — the New Zealand Institute; formed, however, of a number of affiliated societies, each having its own rules, office-bearers, funds, etc. The chief of these are the Auckland Institute, the Wellington Philosophical Society, the Philosophical Institute of Canterbury (meeting in Christchurch), and the Otago Institute (meeting in Dunedin). Besides these, there are smaller branches at Napier, Nelson, Hokitika, and Invercargill. The central body, termed the New Zealand Institute, is practically only an administrative board, partly elected by the affiliated societies, but chiefly nominated by the governor. This body is charged with the publication of the papers on scientific matters, which are read before the various affiliated societies; and these constitute a bulky octavo volume, containing last year nearly seven hundred pages. The management of the whole is in the hands of Sir James Hector, director of the Geological Survey, who indeed has been the central figure of the institute since its establishment in 1867. A government grant of £500 per annum meets the chief cost of publishing the annual volume of Transactions and Proceedings, but this is occasionally supplemented by small levies on the affiliated bodies. The total number of members of the various branches of the institute is about 1,250, — a most creditable number, when the population of the colony is considered, and when it is borne in mind that each of these is a voluntary member and subscriber to the extent of at least a guinea a year. The pages of the nineteen volumes of Transactions teem with valuable papers on many branches of natural science, zoölogy and botany having the largest number of votaries. The isolated position of the colony makes the study of its groups of plants and animals peculiarly complete from the point of view of geographical distribution. Hence many European specialists have devoted some of their time to working out all the New Zealand forms of one or other group. Thus at present Baron Osten-Sacken is engaged on the *Diptera*, — a group regarding which very little is known in the colony, but the members of which take a large share in the fertilization of its flowering plants. Mr. E. Meyrick has systematically studied many groups of the *Micro-lepidoptera*, and is still engaged on others. The New Zealand *Araneæ* were formerly only known from the Rev. O. Pickard-Cambridge's papers, in the London Zoölogical Society's Transactions. Now, however, they are being taken up by Messrs. Urquhart of Auckland, and Goyen of Dunedin, both of whom are doing very good work. At present, as has mostly been the case in the past, the chief work done in the colony has been systematic; and even this has been done under great difficulties, the principal one being the impossibility of consulting all the literature of any subject.

Some two years ago the Royal Society of England made a grant to Prof. T. J. Parker of Dunedin to aid him in working out the embryology of the Tuatera lizard (*Sphenodon*), and also of the Kiwi (*Apteryx*). Living specimens of the former were obtained and kept in confinement both by Professor Parker and by Professor Thomas of Auckland, but up to the present time no eggs have been laid. But the study of the embryological development of *Apteryx* has been prosecuted much more successfully, and zoölogists may shortly expect a communication on the subject to the Royal Society, which will contain many points of interest.

Matters geological, especially those relating to mining, bulk much more largely in people's minds here than any other questions of a scientific kind. It is felt that New Zealand must look in the future more to her mineral wealth for her prosperity than ever she has done in the past, and it is in this quarter that most of the available capital is being directed — or, one might say, misdirected. A great amount of money is sunk in unscientific ways of mining and of prospecting. The country teems with mineral wealth, but it wants more knowledge, and less blind working. Very many of the mining ventures have turned out, as indeed is the case everywhere, unsatisfactorily. Copper-mines have been opened in various parts, but none are now in operation. Antimony occurs abundantly, but has never been profitably worked. The enormous deposits of iron-sand on our sea-beaches are still practically unworked. An attempt is being made to work the oil-bearing beds of the east coast of the North Island, but it is impossible to see how the projectors can successfully compete against the cheap oils of Pennsylvania. The one great stand-by of the colony is gold, and the crying want of the miners is some method of saving the fine gold which at present is lost. When it is seen that the 'tailings' of the famous Blue Spur diggings, which have been washed over several times, are still being sluiced by Chinamen who are making from two dollars to three dollars a day, it is clear that the art of gold-saving is still in its infancy.

Within the last few months a number of Wellman's dredges have been constructed to attack the beaches of auriferous sand and the river-beds. As these come into use, the quantity of gold obtained will be increased, and the available extent of field much enlarged.

G. M. T.

Dunedin, Feb. 23.

GRÜNWALD'S THEORY OF SPECTRUM ANALYSIS.

THERE has lately been advanced by Professor Grünwald of Prague a theory of the change which the spectrum of a substance undergoes when that substance enters into combination with another, that is so extremely simple that it is difficult to see how it can possibly be true. But the number and exactness of the coincidences that Professor Grünwald has observed are such as to arrest attention, and give some interest to the theory which is based on them.

The discoverer states, that, by a mathematical investigation of the changes which the spectra of two gases undergo when brought into chemical combination, he has been able to establish a law, as simple as it is important, which may be the basis of a future mathematico-chemical analysis; and by the aid of this law he has been able not only to establish a very remarkable relation between the spectra of hydrogen and oxygen on the one hand, and that of water-vapor on the other, but also to discover the chemical composition and structure of hydrogen and oxygen, and bring out the facts of the dissociation of hydrogen in the atmosphere of the sun.

The fundamental theorem of this new mode of analysis is as follows. Suppose we have a chemical element a, which, when combined with some other elements, forms a gaseous substance A. When the gas A unites with some other substance, a chemical compound B is formed, in which the element a is also contained, but in a different condition from that in which it existed in A. Usually the atomic volume of the substance a, reckoned in the ordinary way in use among chemists, will be different in the last case from what it was in the first, and the ratio of the atomic volumes in the two cases will be expressed as a ratio of two simple whole numbers. The above being granted, the theorem asserts that those wave-lengths of light in the spectrum of the substance A that belong to the element a are to the wave-lengths due to that element in the spectrum of the substance B in the same ratio as the atomic volume of a in A is to its atomic volume in B.

It follows from the above, that, when the atomic volume is unchanged by the combination, the wave-lengths of the lines due to the substance will be the same in both cases. But great variation between the spectra may exist notwithstanding, because, as Professor Grünwald remarks, the amplitudes of some of its modes of vibration may well be very different in the one case from what they are in the other. This, of course, means that the intensities of lines may be so different in the two cases that stray lines in the one spectrum may be so faint as to seem entirely lacking in the other. Thus, when hydrogen combines with chlorine, bromine, or iodine, the resulting gases, HCl, HBr, and HI, are formed without change in atomic volume; and hence the spectrum of HCl, for example consists simply of the spectrum of hydrogen combined with that of chlorine, with certain changes in the intensity of some lines.

In comparing the spectra of hydrogen and water-vapor, it was found that wave-lengths of the lines of the so-called II^d or compound line-spectrum of hydrogen, which has been investigated by Hasselberg, were twice those of the corresponding lines in the water-vapor spectrum. This conclusion was arrived at by comparing with the comparatively few lines of the water-spectrum that were accessible at the time. To test the conclusion, however, a list of wave-lengths that should be in the water spectrum was drawn up and sent to Professor Liveing at Cambridge, and the wave-lengths compared with those obtained by Liveing and Dewar in their recent experiments. As the result of this comparison, the author publishes a list of nearly sixty lines between wave-length 2800 and 2450, in which to each estimated line there corresponds an observed one; the difference between the observed and calculated wave-lengths in no case amounting to more than one Angstrom unit, or 1 part in 2,500.

The author therefore concludes, on the basis of his theory, that hydrogen, in that condition in which it gives this second or compound line-spectrum, occupies twice the atomic volume which it has in water-vapor.

The primary or elementary line-spectrum of hydrogen, however, it was found might be divided into two groups of lines, in such a manner that the wave-lengths of the one group when multiplied by $\frac{19}{30}$, and of the other when multiplied by $\frac{4}{5}$, gave the wave-lengths of the corresponding lines in the H_2O spectrum. Whence the author, by means of his fundamental theorem, reasons thus: hydrogen is formed of two primary elements, which may be designated a and b, and which give rise to the two parts of the elementary hydrogen spectrum under each other's influence. Let a and b represent the volumes of these two substances respectively in unit-volume of hydrogen; then $a + b = 1$; and, since hydrogen occupies two-thirds the atomic volume in water-vapor that it does in the primary condition, from the fundamental theorem we have

$$\frac{19}{30}a + \frac{4}{5}b = \frac{2}{3}.$$

From these two equations,

$$a = \frac{4}{5}, \quad b = \frac{1}{5};$$

therefore hydrogen is a combination of the form $H = ba$, and is thus analogous to ammonium (NH_4), and, as Professor Grünwald asserts, will, on dissociation, expand in the ratio of 3 to 2.

The primary element a must be a gas many times lighter than hydrogen. The spectra of these two elements, a and b, in the free condition may be at once obtained from the hydrogen spectrum by the previous theorem, when it is granted that the gas, on dissociation, expands in the ratio of 3 to 2; for we have only to multiply the wave-lengths of the group a in the hydrogen spectrum by $\frac{3}{2}$ to obtain those of the substance a in the free condition; and in like manner the wave-lengths of the substance b may be obtained from the corresponding group b.

Professor Grünwald has tabulated five lines in the spectrum of a between wave-lengths 9842 and 5653, and about forty lines of the spectrum of b, and each is found to correspond with a line in the solar spectrum. He concludes, therefore, that hydrogen, in the dissociated condition, exists in the sun, and identifies one of the lines of b with the so-called Helium line, 5874.9 of Angstrom's scale, while reasons are given for believing the corona line (1,474 of Kirchoff's map) is one of those in the spectrum of a. These two component elements of hydrogen he therefore suggests might be named 'Coronium' and 'Helium.'

From similar considerations to those employed in the case of hydrogen, oxygen, in its simplest molecular condition, is found to consist of the modified hydrogen, which gives the secondary spectrum before mentioned, with an equal volume of a substance O′, with which it combines without change of volume. This O′ is a combination of four parts by volume of the same element (b) which was found in hydrogen, with five parts of another substance (O″), which is itself composed of four parts of b with five parts of an unknown primary substance c. The formula expressing the above is,

$$O = H' [b_4(b_4c_5)_5].$$

In a long paper published in December in the *Sitzungsberichte der Kais. Akad. der Wissenschaften* of Bohemia, Professor Grünwald has extended his work to the spectra of magnesium and carbon, employing the wave-lengths as determined by Liveing and Dewar, and Hartley and Adeney, with the result that the spectrum of magnesium may be separated into four groups. The first is due to 'Helium,' neither 'condensed nor dilated;' the second is that of the primary element c in the condition in which it exists in oxygen; the third is that of b in the state in which it exists in free hydrogen; while the fourth is caused by the same element b, but in the chemically more 'condensed' state in which it exists in water-vapor.

There are still a number of weak magnesium lines which fall naturally into these groups, but the corresponding lines to which in the hydrogen and oxygen spectra are not known to exist. Carbon has similarly been resolved into a certain compound of these elements b and c.

These speculations will require most thorough investigation and testing before they can be accepted; but the first point to be seriously examined is the basis on which they rest. If the coincidences reported by Professor Grünwald, when examined carefully, are found sufficiently close and numerous to prove that a large group of lines in the spectrum of one substance can be obtained by simple multiplication by a constant multiplier from a corresponding group in the spectrum of another substance, and if there is any other fact, such as the regular periodic arrangement of the lines, which would seem to connect that group of lines together, then it is one of the most important facts which have yet been developed in connection with spectra. But it is necessary that the agreement should be of the same order of accuracy as the errors in the determination of wave-lengths, and there should appear some other fact connecting a group of lines together. As to the 'condensation' theory, nothing need be said until the facts are more thoroughly worked up; but the remark of its author, that the intensity of the lines due to a substance will experience great differences in intensity in different combinations, while undoubtedly true, gives great elasticity to the theory, and admits of its adaptation to so wide a range of facts as to seriously weaken the evidence advanced in its favor.

HEALTH MATTERS.

Diphtheria in New York.

THE prevalence of diphtheria in New York and Brooklyn has awakened a renewed interest in the means for its prevention. A paper on this subject was recently read by Dr. A. Caillé before the New York Academy of Medicine, and is reported in the *New York Medical Journal*. It had been his experience, as it probably had that of many other physicians, that in certain families one or more members regularly had diphtheria in the spring or autumn. This was particularly true of children. It had occurred to him that such persons might harbor the microbes, or other essentials to the development of the disease, in the nasal and oral cavities. The germs of diphtheria would readily take hold of damaged mucous membrane.

In trying to establish the correctness or fallacy of this view of self-infection, he had selected eight cases, in all of which the patients had suffered from true diphtheria twice or more prior to October, 1885. The families were well known to him, and they had occupied the same houses or had the same surroundings for a number of years. The parents of the children were intelligent enough to carry out his instructions. All carious teeth were to be filled or extracted, the teeth to be examined from time to time; the mouth was to be thoroughly rinsed three times a day, after each meal, with either a three-per-cent solution of chlorate of potassium in water, a five-per-cent solution of *liquor sodæ chloratæ*, or a saturated solution of borax in water. Besides using it as a mouth wash and gargle, some of the solution was to be drawn into the nose. From October, 1885, to December, 1887, not one of the persons experimented upon suffered from diphtheria, although five of them had several attacks of acute pharyngitis and amygdalitis. There was diphtheria in the family of three of the number, but they did not contract the disease. While these cases were insufficient to furnish absolute proof of the benefit of such prophylactic measures, yet they went far to establish the belief, that, if the nasal and oral