nesium are capable of formation, one of which is unstable, and, as shown by Messrs. Jones and Taylor, is decomposed by water with evolution of a mixture of hydrogen and boron hydride, while the other is permanent both in the presence of water and acids. It is this stable boride, which M. Moissan has obtained in good crystals, which is so difficult to remove from the substance which has hitherto been considered as amorphous boron, and its formation should be avoided as much as possible. When magnesium and boric anhydride in the proportions above indicated—convenient quantities being 70 grams of the former and 210 grams of the latter—are heated to redness in a closed crucible, a somewhat violent reaction occurs, the crucible becoming vividly incandescent. Upon cooling, a reddish-brown mass is found, which is readily detached from the crucible, and is impregnated throughout with crystals of magnesium borate. The interior portion is then powdered, and successively treated with water and hydrochloric acid, alcoholic potash, hydrofluoric acid, and lastly with distilled water. This product, even after such exhaustive treatment, upon drying *in vacuo*, is found to contain only 95 per cent. of boron. In order to remove the 5 per cent. of the stable boride, the product is again heated to redness in the midst of a large excess of boric anhydride, and the extraction and washing repeated as before. The percentage of boron is by this means raised to 98·3 per cent., the remaining impurity being a mere trace of the boride and 1·3 per cent. of nitride of boron. These remaining impurities have finally been eliminated by employing a crucible rendered impenetrable to the furnace gases, the nitrogen of which rapidly causes the formation of nitride, by means of a mixture of titanic acid and charcoal. In addition to the laborious method above indicated, by which tolerably large quantities of pure boron may be obtained, M. Moissan further shows that it may be prepared in smaller quantities by the reduction of boric anhydride by magnesium in a stream of hydrogen, when, after extraction, a pure product necessarily free from nitride is obtained. And lastly, M. Moissan describes an electrolytical method of preparing it. Fused boric acid is rendered a good conductor of electricity by the addition of 20 per cent. of its weight of borax. Upon passing through the fused mixture a current of 35 amperes, a little sodium is liberated at the negative pole, and combines with the platinum electrode to form an alloy, while amorphous boron and oxygen are liberated at the positive pole. The greater portion of the boron, owing to the high temperature of the reaction, recombines with the oxygen with most brilliant incandescence, but a portion escapes combination, and may be isolated in the pure state as a chestnut-coloured powder.

The additions to the Zoological Society's Gardens during the past week include a Green Monkey (*Cercopithecus callitrichus* ♂) from West Africa, presented by Mr. George W. Bowles; a Toque Monkey (*Macacus pileatus*) from Ceylon, presented by Mr. Arthur Wallis; a Bauer's Parrakeet (*Platycercus zonarius*) from South Australia, presented by Mr. Edward F. Baillou; two Alpine Accentors (*Accentor collaris*), European, presented by Lord Lilford, F.Z.S.; four Coqui Francolins (*Francolinus coqui* 2 ♂ 2 ♀) from South Africa, presented by the Hon. F. Erskine; a Green Toad (*Bufo viridis*), six Painted Frogs (*Discoglossus pictus*), European, three Moorish Toads (*Bufo mauritanica*) from Tunis, purchased.

OUR ASTRONOMICAL COLUMN.

The Warner Observatory.—"The Warner Observatory is distinctively a private institution built for the purposes of original discovery rather than the ordinary routine work of most other Observatories." This sentence begins a recently-published history and work of the Warner Observatory, Rochester, N.Y., from 1883 to 1886. Under such favourable conditions as these, it is not wonderful that a considerable amount of work should be done. Mr. Lewis Swift is the Director of the Observatory, and, upon assuming command, he selected the discovery of new nebulæ as his principal field of labour. The first unrecorded nebula was found on July 9, 1883. Since then more than 400 others have been detected; and their positions and descriptions have been published from time to time in four catalogues. The observations are now brought together, and will therefore be more useful than heretofore. In the volume containing them are printed the Warner prize essays. One of these, by Prof. Lewis Boss, treats of "Comets: their Composition, Purpose, and Effect upon the Earth"; and there are several others on the coloured skies seen about the time of the Krakatão eruption. Mr. Henry Maine endeavours to show that a physical connection existed between these red sunsets and solar activity. The Rev. S. E. Bishop, of Honolulu, also describes the brilliant glows in question; ascribing them to the introduction of finely divided matter into the higher regions of the atmosphere.

Measurement of Solar Prominences.—In *Comptes rendus*, tome cxiii. p. 353 (1891), M. Fizeau pointed out that the velocities attained by solar prominences were comparable with the earth's orbital velocity, and remarked that, on account of this circumstance, prominences must suffer a displacement from their true position. If this were so, and the argument appeared to be sound, then the apparent heights reached would have to be increased or diminished according to the velocity with which the prominences were projected. Mr. Henry Crow has pointed out an apparent error in this reasoning (*Astronomy and Astro-Physics*, January, p. 90). He says:—"The author here neglects the fact that, at any given instant, each point of the solar disk and of the prominence, whether in motion or at rest, is sending to the observer rays, all of which are affected by the same correction for aberration. I say the 'same' correction, since the change in celestial longitude or latitude from one part of the sun's surface to another would affect the aberration quite inappreciably. If there be relative motion among the parts of the prominence, then, since at any instant aberration affects all these parts to the same extent, the prominence will be projected upon the slit of the spectroscope in its true proportions." So the study of the solar surface is apparently not to be complicated by the introduction of a new correction. In this connection it may be remarked that, in a letter dated February 12, Prof. Hale writes: "You may be interested to know that I have just succeeded in photographing all the prominences around the sun with a single exposure."

THE AUSTRALASIAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The Australasian Association for the Advancement of Science held its fourth annual meeting at Hobart, Tasmania, from January 7 to 14 inclusive. The meeting was in every way successful, and the proceedings afford ample and most satisfactory evidence that much excellent work is being done among our Australasian kinsfolk in every branch of science. The President was His Excellency Sir Robert Hamilton, Governor of Tasmania. The people of Hobart accorded to the members of the Association a most hearty welcome, and did everything in their power to make the occasion a pleasant and memorable one. Visitors from a distance had the advantage of being able to travel both by sea and land at greatly reduced fares, and everything of scientific interest in Tasmania was clearly explained for them in a capital hand-book issued from the Government Printing Office. Mr. Robert Giffen attended the meeting, and was cordially received. He delivered a lecture to the members of the Association on "The Rise and Growth of the British Empire."

Great credit is due to the Hobart *Mercury* and other local papers for the enterprise they displayed in reporting the proceedings.

At the meeting of the general Council on January 7, the chair was taken by Baron von Mueller, past President, as Sir James Hector, the retiring President, was prevented by ill health from being present. It was formally decided that the fifth annual meeting of the Association should be held at Adelaide, and practically decided that the sixth should be held at Brisbane. Prof. Tate will be President of the Adelaide meeting.

On the evening of the 7th Sir Robert Hamilton delivered his presidential address before a large audience in the Town Hall. He presented an interesting sketch of the history of the Royal Society of Tasmania, and suggested many sound reasons why all intelligent persons in Australasia should do their utmost "to hasten the advent of the time, which is undoubtedly approaching, when science will form a much more integral part of the life of the people than it does at present."

It is impossible for us to give a full account of the proceedings of the meeting; but the following notes may suffice to indicate the wide range of the work done in the various Sections.

SECTION A.

MATHEMATICS, PHYSICS, AND MECHANICS.

Prof. Bragg, Adelaide, was President of this Section. He chose as the subject of his presidential address, "Mathematical Analogies between various branches of Physics." About fifty years ago, he said, Sir William Thomson showed that there existed between several branches of physics a very close analogy—the analogy was so exact that the solution of any problem of any one theory was at the same time the solution of the problem in any other. The list of analogies might be still further increased by the addition of certain other theories, which were to some extent imaginary, yet important in that they were simple to realize, and therefore of great use in presenting to the mind the usual means of grasping the other problems. It was a matter of the greatest interest that so wide and so perfect an analogy should exist, and for that reason the analogy would be a fit subject for an address. There were other grounds for its fitness. It was of the greatest assistance in physics to follow up this analogy, and examine carefully its nature. It was a common remark that analogies were dangerous things, and the remark was often true enough. But the danger lay only in an imperfect knowledge of the extent to which calculations might be made upon the analogy, and could be avoided once and for all by amending the imperfection. Moreover, the student of electricity and magnetism could hardly avoid the use of some sort of analogy, for these theories deal with quantitative relations between things of the real nature of which we are completely ignorant, and most minds could not for long consider these relations in mere symbols, but must finally give them some sort of form. He then explained the nature of the problem, and proceeded to show the measure of analogy that exists between various theories of physical science.

A paper by Sir Robert Ball, on "The Astronomical Explanation of a Glacial Period," was read by Sir R. Hamilton, and a hearty vote of thanks was accorded to His Excellency and to the author. Mr. A. B. Biggs, Launceston, read a paper on "Tasmanian Earth Tremors." Mr. C. W. Adams, Dunedin, dealt with a graphic method of showing the relation between the temperature of the dew-point and the temperature of the air for any given climate. Mr. George Hogben, Timaru, N.Z., read the report of the Committee on "Seismological Phenomena in Australasia." This Committee had begun its work by making a compilation of the records of all previous earthquake shocks throughout Australasia, and these records were now nearly complete, except for Queensland and Western Australia. It had also provided for as accurate a system of observations in the future as was possible under the circumstances, by means of memoranda to be forwarded from various telegraph offices. The system adopted was, with the necessary modifications, that which had been in use with success in New Zealand for some time past. The Secretary explained what had been done in New Zealand by this means in the determination of earthquake origins, and of other facts about earthquakes, and pointed out that it was as part of a world system of observations that the observations in Australasia are likely to be most useful. With that aim in view the Committee proposed to extend their observations to the islands of the Pacific, and so to establish a connection, if possible, with what was being done in South America and in Japan. An important step was also taken in the adoption of a common standard of intensity—the Rossi-Forel scale, as used by Swiss and Italian seismologists, being that agreed upon. It was pointed out that the system now adopted throughout Australasia had led to the fixing of five of the chief origins of disturbance in or near New Zealand, among them (during the past year) of the origin of most of the Cook's Straits shocks.

Mr. A. McAuley, Ormond College, Melbourne, contributed a paper on "Quaternions as a Practical Instrument of Physical Research." He indicated the power of the method by six examples:—(1) A theorem in potentials illustrated by applying it to a general electrical problem. (2) Two examples in curvilinear co-ordinates. (3) A quaternion proof of a well-known theorem of Jacobi's of great utility in physics. (4) A generalization of one of the well-known equations of fluid solution. (5) The well-known particular system of the differential equation expressing the conditions of equilibrium of an isotropic elastic solid subject to arbitrary bodily forces. (6) A short criticism of Prof. Poynting's theory of the transference of energy through an electric field.

Papers were read by Mr. W. H. Steele on "The Conductivity of Solutions of Copper Sulphate"; by Mr. R. W. Chapman on "The Dodging Tide of South Australia," containing a summary of the work done by the Committee on Tidal Observations; and by Archbishop Murphy, Hobart, on "Solar Phenomena and their Effects."

Mr. H. C. Russell, F.R.S. (Government Astronomer, N.S.W.), read a paper on "The Grouping of Stars in the Southern Part of the Milky Way." He pointed out the advantages of the photographic method of studying star distribution, and discussed the evidence offered by a large number of photographs taken by himself. The results he had obtained tended to diminish the value of the rifts in the discussion of stellar distribution. The interest of this paper was much enhanced by the exhibition of a large collection of photographs.

Mr. R. L. J. Ellery, F.R.S. (Government Astronomer, V.), read a paper describing some of the difficulties occurring in the photographic charting of the heavens, more especially regarding the determination of stellar magnitude. He also spoke of the desirableness of establishing tidal observations in Tasmania. He drew attention to the incompleteness of the tidal records for Tasmania, and moved a resolution urging the Government to establish several more tide gauges, especially on the north coast. This resolution was seconded by Mr. H. C. Russell, and carried unanimously.

Mr. R. B. Lucas read a paper on the unification of standards of weights and measures, in which the condition of legislation in regard to this important matter, with suggestions for the unification of standards throughout the colonies, and recommendations for a central depot with central administration, was specially considered.

Captain Shortt (Meteorological Observer, Hobart) read a short paper advocating a particular method of determining longitude at sea from observations of the maximum altitude. The paper gave rise to a very interesting discussion.

The President of the Section moved "That the Section telegraph its congratulations to Sir W. Thomson on his elevation to the peerage." This was seconded by Mr. Ellery, supported by Mr. Russell, and carried unanimously.

SECTION B.

CHEMISTRY AND MINERALOGY.

Mr. W. M. Hamlet, Government Analyst, of New South Wales, presided over this Section. In his opening address he dealt with the progress of chemistry in Australasia. Having described the difficulties with which chemists in Australasia have to contend, he said that in spite of them work had been done. He mentioned the discovery of the alkaloids brucine and strychnine in the fruits of *Strychnos psilosperma*, by Prof. Rennie and Mr. Goyder, of Adelaide; also the work done by Mr. J. H. Maiden, of Sydney, in the examination of Australian kinos, gums, and barks. Chief amongst Mr. Maiden's researches was his work on wattle bark, which he found contained from 15 up to 46 per cent. of tannic acid. These barks were proved to be invaluable for tanning purposes, and their cultivation proved easily remunerative to the agriculturist. Mr. Kirkland's discovery of gallium and indium in some specimens of blende were referred to, as were the highly-interesting investigations of different minerals by the Rev. J. Milne Curran, of New South Wales. Reference was also made to researches being made by observers who were seeking to find out the actual state of combination in which elements occur in different ores. Much of this kind of work needed to be done, and if such questions were investigated by men who knew what they were doing, it would go a long way towards facilitating the operations attempted in the smelting works, where it is often expected that carbonates, sulphides, chlorides, and oxides should each and all yield to the same treatment.

The following papers were contributed by Mr. J. B. Kirkland, Assistant Lecturer and Demonstrator of Chemistry, University of Melbourne:—(1) "Notes on the Electrolysis of Fused Salts of Organic Basis"; (2) "Occurrence of the New Elements Gallium and Indium in a Blende from Peelwood, New South Wales"; (3) "Notes on the Volatility of Magnesium"; (4) "Lecture Experiment on Gaseous Diffusion." A paper on "The Analysis of the Cavendish banana (*Musa Cavendishii*) in Relation to its Value as a Food," by W. M. Doherty, was also read. Profs. Liversidge, Jackson, the President, Messrs. Clemes, Wilsmore, and Taylor took part in an interesting discussion that followed the reading of these papers.

Papers were contributed by Mr. W. M. Hamlet on "The Oleo-refractometer in Organic Analysis"; by Mr. A. H. Jackson on "The Analysis of Storage Battery Plates"; by Mr. A. J. Sachs on "The Jarvis Field Mineral Waters of Picton, New South Wales"; and by Mr. Mingaye on "Some Mineral Waters of New South Wales."

Mr. A. Liversidge, F.R.S., Professor of Chemistry, University of Sydney, read a paper on "The Rusting of Iron." It was usually stated in books upon chemistry, he said, that iron rust consisted of the hydrated sesquioxide of iron; but on examining a very large number of specimens of rust from very many different places, and from iron articles of various kinds, and formed under very varied conditions, he found that in almost every instance the rust contained more or less magnetic oxide; in fact, in some cases the rust, although presenting the usual "rust brown" colour and appearance, was, when powdered, practically wholly attracted by the magnet. The specimens which first drew his attention to the subject were some large scales of rust obtained from the rails of an old tramway at Clifden Springs, in Victoria, and he was led to collect and examine these on account of their resemblance to the crust so often present on metallic meteorites. On crushing this rust in a porcelain mortar and testing it with a magnet, it was found to be practically wholly attracted, the small quantity of iron magnetic oxide present being mechanically inclosed, lifted and removed by the magnetic particles (in consequence of the magnetic particles being joined end to end, parallel to the lines of magnetic force and forming a mesh-work inclosing the non-magnetic matter); but by repeatedly applying the magnet, and especially under water, the magnetic powder was fairly-well separated from the non-magnetic powder. Bright iron wire, plates, rods, nails, &c., were artificially rusted in many ways with free access of oxygen, and in almost every instance a large amount of magnetic oxide was formed.

Prof. Liversidge also read a paper on "The Presence of Magnetite in Certain Minerals."

Some notes on the analysis of water from Lake Corangamite were given by Mr. A. W. Craig and Mr. N. T. M. Wilsmore. Notes on a "Natural Bone Ash," from Narracoorte, South Australia, were given by Mr. N. T. M. Wilsmore (Melbourne University). This was an account of a fossil guano which might be successfully used for making cupels for silver assays, &c. Other papers read were "Minerals of East Gippsland," by Mr. Donald Clark; and "Notes on the Exudations yielded by some Australian species of Pittosporum," by Mr. J. Marden. A Committee was appointed to make a complete census of the minerals of Tasmania for the next meeting of the Association.

SECTION C.

GEOLOGY AND PALÆONTOLOGY.

Prof. T. W. E. David, of Sydney University, President of this Section, delivered an address on volcanic action in Eastern Australia and Tasmania, with special reference to the relation of volcanic activity to oscillations of the earth's crust, and to heavy sedimentation. The evidences of volcanic action in past geological time in East Australia and in Tasmania were reviewed historically, commencing with the oldest known lavas—the Snowy River porphyries—and concluding with the most recent—those of Tower Hill, near Warrnambool, in Victoria. The geological age of the former has been established as being lower Devonian, whereas the occurrence of the skeleton of a dingo under beds of volcanic tuff at the latter locality shows that those volcanic rocks are of recent geological age. Special reference was made to the vast development of contemporaneous lavas and tuffs in the Upper Palæozoic coal-fields of New South Wales, at Raymond Terrace, near Maitland, and at Kiama, in the Illawarra coal-field. Proofs were adduced to show that the lavas and tuffs at the latter locality were erupted prior to the deposition of the Bulli coal-measures, as marine fossil shells of Permo-Carboniferous age have been found in the volcanic tuffs of that series. The great plateau of diabasic greenstone, which occupies so large an area in the south-eastern portion of Tasmania, was considered by the author to be probably of later origin than the Mesozoic coal-measures of Fingal, Jerusalem, &c., and then the Palæozoic coal-measures of the Mersey coal-field. The greenstone forming the upper portion of Mount Wellington was, in the author's opinion, of later origin than the New Town coal-measures near Hobart. He considered the greenstone to be a variety probably of gabbro, which had burst through the marine mudstones and overlying coal-measures in the neighbourhood of Hobart in the shape of broad dykes and vosses, and which had spread over the top of the measures in the form of a thick broad capping. If this view were correct, there would be underneath the tiers of greenstone large areas of coal-measures which might contain workable seams of coal, undamaged by the overlying greenstone. A brief description having been given of the basaltic lavas of Tertiary age in Australia and Tasmania, the relation of the various manifestations of volcanic activity to oscillations of the earth's crust and to heavy sedimentation was next examined. The evidence collected by Australian and Tasmanian geologists showed that volcanic action had taken place most frequently after periods of prolonged subsidence had culminated in a compensating re-elevation of the land. Instances were cited to prove that in many cases the subsidence which preceded volcanic outbursts was directly due to the local loading of the earth's crust with thick masses of sediment, the weight of which bulged the earth's crust downwards, displacing in the process the lighter granitic magma which is considered to immediately underlie the earth's crust, and bringing the under surface of the crust in proximity to the heavier basic magma. This was suggested as an explanation of the fact that the products of volcanic action from such areas of subsidence were usually basalts rather than rhyolites or obsidians, both of which last are derived from the granitic magma.

Mr. W. J. Clunies Ross read a paper entitled "Remarks on Coral Reefs." Mr. W. J. C. Ross read a paper "On the Discovery of two Specimens of Fossil Lepidodendrons in the Neighbourhood of Bathurst, New South Wales, and the Inferences to be drawn from their Occurrence." One specimen was from the gravel of the Macquarie River, but its source was too uncertain to be of much value. The other specimen, although not actually found by the writer *in situ*, was received by him from the finder, who was able to point out the exact place from which it was obtained. This was about ten miles to the east of Bathurst, in some one of a series of beds of grit and quartzite forming the sides of a short valley, at the head of which there was a succession of three waterfalls over hard bands of quartzite, the uppermost fall being over a massive conglomerate. The grit bands contained abundant casts of Brachiopods, Spirifer, and Rhynconella, and the whole series of beds was coloured on the geological sketch map of the colony as Silurian. The late Mr. Wilkinson, however, classed the beds as Siluro-Devonian; and a very similar series at Rydal on the Western Railway Line was mapped by him as Devonian. Rydal was at least sixteen miles in a straight line from the locality at which the fossil was found. Near Rydal there were beds containing a Lepidodendron considered by Dr. Feistmantel and Mr. Carruthers as *Lepidodendron nothum*, and to be of Devonian age. Mr. R. Etheridge, Jun., however, questioned the identification of the species, and seemed to think it was *Lepidodendron australe*, McCoy, which was generally considered to be Lower Carboniferous. It was pointed out that the fossil now found was almost certainly derived from the grit beds containing Devonian Brachiopods, and was probably of that age. If it were taken as Carboniferous, then a rearrangement of the generally received geology of a large part of New South Wales would be necessary. As bearing on the probable Devonian age of the fossil, attention was called to the fact that in the Lower Carboniferous beds of Strand, N.S.W., there were two species of Lepidodendron, viz. *L. Veltheimianum* and *L. Volkmannianum*. The fossil in question did not resemble either of these forms, but appeared to be either *L. nothum* or *L. australe*, and, whichever it was, it was likely to be older than the Strand beds, and therefore can hardly be younger than Devonian. The specimens in question were exhibited, and the opinion of geologists desired on the questions raised.

Mr. J. H. Harvey discussed "The Application of Photography to Geological Work." He urged the desirability of having a photographer attached to every Geological Survey, and the importance of conducting the photography of the various surveys in a systematic and uniform manner. He submitted a scheme in connection with the same, which, without a great increase in the present expense, would, he considered, vastly increase the value of the survey.

Among the remaining papers were the following: "Sample of Cone-in-cone Structure found at Picton, New South Wales," by Mr. A. J. Sachs; "Notes on the Permo-Carboniferous Volcanic Rocks of New South Wales," by Prof. T. W. E. David; "Notes on the Advantages of a Federal School of Mines for Australasia," by Mr. J. Provis.

SECTION D.

BIOLOGY.

Prof. W. Baldwin Spencer, of the Melbourne University dealt in his presidential address with the fresh-water and terrestrial fauna of Tasmania. He described the various species found in Tasmania, and the distribution of these in other parts of Australia, showing that, in such forms as the fresh-water fish, reptiles, and amphibia, those found in Tasmania and some in Victoria were very closely allied. He dealt with the original introduction of the ancestors of the present animals of Australia, and the way in which the descendants of these had become distributed over the various parts, including Tasmania.

Prof. Hutton, of Christchurch, New Zealand, read a paper on "The Origin of the Struthious Birds of Australasia." The struthious birds—that was, the ostriches, emus, cassowaries, and kiwis—were confined to the southern hemisphere, except the African ostrich, which ranged into Arabia, and they were supposed to have originated in the northern hemisphere and migrated southwards. But by this hypothesis there were great difficulties in explaining how the struthious birds reached Australia and New Zealand without being accompanied by placental mammals. Also the struthious birds of New Zealand, including the lately extinct moas, were smaller, and make a nearer approach to the flying birds, from which the struthious birds were descended, than did any of the others, and they should expect to find the least altered forms near the place of origin. The tinamus of Central and South America, although flying birds, resembled the New Zealand struthious birds in several particulars; and as a former connection between New Zealand and South America was shown by the plants, the frogs, and the land shells, it seemed more probable that the struthious birds of Australasia originated in the neighbourhood of New Zealand from flying birds related to the tinamus, and that they spread from thence into Australia and New Guinea, rather than that they should have migrated southwards from Asia. Probably the ostriches of Africa and South America have a different line of descent from the struthious birds of Australasia, and might have originated from swimming birds in the northern hemisphere.

Prof. Spencer read a paper "On the Habits of Ceratodus, the Lung Fish of Queensland." This fish, he stated, lives only in the Burnett and Mary Rivers in Queensland, and belongs to a small group which may be regarded as intermediate between fishes on the one hand and amphibia on the other. The swimming bladder present in ordinary fishes has become modified so that it functions as a lung. In Africa, Protopterus, a form closely allied to Ceratodus, makes for itself a cocoon of mud, in which during the hot, dry season it lives and can breathe by means of its lung. The Ceratodus, however, does not appear to do this, and probably never leaves the water. It comes continually to the surface, and passes out and takes in air, making a faint spouting noise. The author suggested that the lung was of the greatest service to the animal, not during the hot, but during the wet season, when the rivers were flooded, and the water thick with the sand brought down from the surrounding country. With regard to its food, Ceratodus appeared to be herbivorous, feeding, at all events largely, on vegetable matter, such as the seeds of gum-trees which tumble into the water.

Papers were contributed by Mr. F. M. Bailey, Government Botanist of Queensland, on "Queensland Fungus Blights"; by Colonel W. V. Legge on "The Geographical Distribution of Australian Limicolæ"; by Mr. John Shirley on "A Rearrangement of the Queensland Lichens"; and by Mr. A. F. Robin on "The Preservation of Native Plants and Animals." Mr. W. A. Weymouth contributed a classified list of Tasmanian mosses, based on Hooker's "Flora of Tasmania" 1853–59), Mitten's "Australian Mosses" (1882), Bastow's "Mosses of Tasmania" (1886), and his own collections (1887–91), as determined by European specialists.

SECTION E.

GEOGRAPHY.

Captain Pasco, R.N., President of the Section, referred in his opening address to early discoveries in Australia. The exploration of the island of Tasmania, and the opening up of its varied resources, were begun by Sir John Franklin. He might be recognized as the founder of the Royal Society of Tasmania, and distinguished himself in 1842 by crossing the island from New Norfolk to Macquarie Harbour. Half a century ago Australia was considered to be a vast desert, containing possibly an inland sea, but Stuart, McDowall, Gregory, Forest, Giles, and others had dissipated that idea by exploring the continent from one side to the other. He further dealt with the tides and currents of the ocean, and their effects generally upon the earth, the temperature and saltness of sea-water, and the direction and force of the currents and times of high and low water. He concluded by saying there was still a considerable area of this globe to be subdued and peaceable dominion obtained within the Antarctic Circle. Though Sir James Ross unfurled the British banner on an island contiguous to the continent or extensive archipelago (as the case might be), yet almost a blank upon the map awaited the enterprise of the Anglo-Saxons located in the southern hemisphere to emulate their forefathers in the north by opening up the frozen zone.

Mr. James M. Clymont, Koonya, Tasmania, read a paper on "The Influence of Spanish and Portuguese Discoveries during the First Twenty Years of the Sixteenth Century on the Theory of an Antipodal Southern Continent." Mr. D. Murray gave an account of Mr. Lindsay's expedition in Western Australia under the auspices of Sir Thos. Elder, giving extracts from his despatches, narrating the journey from Fort Mueller to Queen Victoria Springs, and thence to the Frazer Ranges. Want of water had been a great and unexpected difficulty. There seemed to have been a complete drought for at least a year over this part of the continent. In the discussion ensuing, the question of artesian wells was raised, and Mr. Murray explained that while some of these wells in South Australia were unfit for irrigation purposes, owing to the superabundance of salts of soda, yet they were good enough for stock, &c., and that both further north and further east over large areas the wells gave water suitable for all purposes.

Papers were contributed by Dr. Frazer, on "Volcanic Phenomena in Samoa in 1886"; by the Rev. J. B. W. Woollnough, on "Iceland and the Icelander"; by Captain Moore, R.N., on "A Magnetic Shoal near Cossack, W.A."; and by Mr. A. C. Macdonald, on "The Life and Works of Sir John Franklin."

An elaborate and valuable paper on "Recent Explorations and Discoveries in British New Guinea," was read by Mr. J. P. Thomson. Referring to the natives, Mr. Thomson spoke of their numerous tribal divisions, and of the almost correspondingly different languages or dialects spoken by them. Even in localities separated by only a few miles, the dialects spoken differ the one from the other in some cases considerably. The Motu, which is the language spoken and taught by the missionaries at Port Moresby, is understood over a considerable area, both east and west of that place, but outside that neighbourhood changes and variations occur, so that at the head of the Great Papuan Gulf, and in the Fly Basin, the Motu language is a foreign tongue. The same applies to the eastern end, and to the islands adjacent thereto, where the philological variations are numerous and conflicting. While in the one case the people met with in the highland zones of the Owen Stanley Range spoke a dialect akin to that of the Papuan, those encountered on the Upper Fly River expressed themselves in a tongue, every word of which apparently differed from that spoken by the tribes of the lower regions, and from that spoken by any known coastal community, notwithstanding that the people themselves exhibited no evidence of possessing distinctive characteristics of race, the only marked contrast being in lightness of colour. In the western division the same diversity of speech is met with, where neighbouring tribes are unable to hold intercourse one with the other, even if friendly, by reason of incompatibility of language. No doubt this may in some measure be accounted for by local environment; constant civil intertribal war being the means of isolating communities, so that no friendly intercourse is held, by reason of which, together with other attendant causes, an incongruity of language may have unknowingly been established. With reference to geology, Mr. Thomson said it was somewhat remarkable that the general geological features of British Papua are in a very considerable degree identical in character with those of Australia, several specimens being coincident with those of the Silurian series from gold-fields in New South Wales, while some of the fossiliferous rocks were obtained from beds of clay similar to those at Geelong and Cape Otway in Victoria. Mineral areas of great value might yet await discovery by the penetrating eyes of British pluck and enterprise in Papua.

SECTION F.

ECONOMICS AND SOCIAL SCIENCE AND STATISTICS.

Mr. R. Teece, President, chose for the subject of his opening address, "The New Theory of the Relation of Profit and Wages." Papers were contributed by Mr. Alfred de Lissa, Sydney, on "The Organization of Industry"; by the Hon. N. J. Brown, Tasmania, on "The Incidence of Taxation"; by Mr. H. H. Hayter, Government Statistician, Victoria, on "Disturbance of Population Estimates by Defective Records"; by Mr. A. J. Ogilvy, on "Is Capital the Result of Abstinence?"; by Mrs. A. Morton, Tasmania, on "The Past Attitude of Capital towards Labour, and the Present Attitude of Labour towards Capital"; by Mr. T. A. Coghlan, Government Statistician, N.S.W., on "The Wealth of Australasia"; by Mr. A. J. Taylor, Hobart, on "The Value of Labour in relation to the Production of Wealth regarded from the Standpoint of a Physicist"; and by Mr. E. P. Nesbit, South Australia, on "Insanity and Crime."

SECTION G.

ANTHROPOLOGY.

The Rev. Lorimer Fison, President, said in the course of his opening address that in anthropological study the two main things required were first a patient continuance in collecting facts, and second the faculty of seeing in them what is seen by the natives themselves. But the natural tendency to form a theory as soon as a fact was seized, and looking at facts in savagery from the mental standpoint of civilized man, would lead investigators into fatal mistakes. The best way to gain information was to live with the natives, learn their language, and gain their confidence, or get information from the men living amongst them. References to aborigines, their manners and customs, in books, might be collected and classified by many readers, and thus facilitate investigation. In conclusion he dwelt upon the magnificent and all but untrodden field afforded by British New Guinea and its outlying groups of islands; and two extremely valuable books—the Rev. Dr. Codrington's on "The Melanesian Tribes," and "The Maori Polynesian Comparative Dictionary," by Mr. Edward Tregear, of New Zealand—were recommended for study.

The Rev. Dr. Gill, who has spent thirty-three years as a missionary in the Hervey Islands, read papers on "The Story of Tie and Rie" and "The Omens of Pregnancy," the latter having reference to superstitions still current in the island of Mangaia.

A paper on "New Britain and its People" was read by the Rev. B. Danks. According to the author, the bush people differ very much from the coast tribes, the latter being evidently invaders and conquerors.

Some interesting details as to "Sydney Natives Fifty Years ago," were given by the Rev. W. B. Clarke. Among other papers were the following: "Group Marriage and Relationship" and "The Nair Polyandry and the Dieri-Dieri Pirauru," by the Rev. L. Fison; "The Samoa and Loyalty Islands," by the Rev. S. Ella; "The Cave Paintings of Australia," by the Rev. J. Matthew; "The New Hebrides," by the Rev. D. Macdonald; "The Origin of the Sense of Duty," by Mr. Alex. Sutherland; "Notes on the Taunese," by the Rev. W. Gray.

SECTION H.

SANITARY SCIENCE AND HYGIENE.

Prof. W. H. Warren, of the University of Sydney, gave in his presidential address a sketch of sanitary engineering from its earliest days, and then proceeded to discuss the various schemes which have been proposed for disposing of the sewerage of towns.

Dr. James read a paper on "Cremation as a Step in Sanitary Reform." Papers were also contributed by Dr. E. O. Giblin, on "The Etiology of Typhoid"; by Miss Violet Mackenzie, on "Physical Education and Exercise in Schools"; by Dr. Barnard, on "Infection in Disease"; and by Dr. A. Moulton, on "Sewerage of a Seaside City."

SECTION I.

LITERATURE AND FINE ARTS.

This Section, although it assembled for the last time at the Hobart meeting, proved to be very popular. The President, Prof. Morris, of the University of Melbourne, referred in his opening address to the subject of Universities in Australia. He urged that it was not wise to multiply Universities. "In this matter," he said, "the law of supply and demand cannot be trusted, if it ever can be in the matter of education; and the Legislatures should be very careful not to permit the promiscuous conferring of degrees. Let them increase teaching facilities as much as generosity may make possible; do not lower the standard, as at least in the higher education competition does. In America there are five or six degree-giving Universities to every million inhabitants, and a degree by itself has no value. If Australia were one country, as it ought to be, two Universities would probably be quite enough, or, better still, even one, but it would need to be arranged somewhat on the pattern of the University of New Zealand, with teaching bodies in different places, but one uniform standard of examination for each degree. This would lead to emulation between the different teaching Colleges, and would surely have happy results. Unfortunately Australia is not one, and at present it looks as if, in spite of the wishes of the people, our absurd divisions were likely to continue. Yet it is worth consideration whether the Universities might not agree upon a common standard, and arrange that the courses in the Universities of the different colonies should be parallel and homogeneous. Educated men should be the first to show that the day of discord is over, and to welcome the arrival of unity and co-operation."

Among the contributions to the proceedings of this Section were papers on "Elementary Science in Primary Schools," by Mr. James Rule, senior inspector of schools, Tasmania; "Secondary Education in Australia," by Mr. Percy A. Robin; and "The Rationale of Examinations," by Mr. F. J. Young. A Committee was formed to establish a Home Reading Union for Australia.

SECTION J.

ENGINEERING AND ARCHITECTURE.

Mr. C. Napier Bell, President, referred in his opening address to sanitary engineering. In Australia, he said, the best attention of engineers should be devoted to sanitary engineering; first, to cleanse the towns, and second, to save the sewage to irrigate the land. On this subject Australian engineers should pause before copying the practice of Europe, which, enjoying an abundant rainfall, has never felt the same necessity for irrigation, and has had abundant stores of fossil manure to draw upon. Water irrigation was even more important, and he foresaw for engineers a noble task in providing irrigation for Australia. After dealing with the irrigation works of the older countries, he touched upon the importance of mining and electrical engineering. Then he remarked the neglect of warming and ventilation by architects and engineers, and argued that in the climate of Australia the art of cooling must certainly become as important as that of heating. In conclusion, he explained the necessity for sound theoretical and scientific knowledge in the engineer, and said that if the people of the colonies would entertain the honourable ambition, once more popular than now, of being remembered to the distant ages of the future, they must emulate those mighty peoples of the past who left imperishable records of their life in the ruins of their vast public works.

Among the papers read in this Section was one by Mr. Edward Dobson, on "The Evidence for the Prevalence of Human Habitations in Prehistoric Times." It was devoted to showing that, whilst rectangular forms prevailed in the early buildings of the East and in North America, the circular form had prevailed through Africa (with the exception of the Nile Valley) and through Switzerland and Northern Europe, in

Lapland and Greenland, and inquiry was raised as to the causes of these facts.

Mr. A. North read a paper on "The Truthful Treatment of Brickwork."

At the closing meeting of the Council, on February 14, the following general officers were appointed:—Treasurer, Mr. H. C. Russell, Sydney; Secretary for Tasmania, Mr. A. Morton; for New Zealand, Prof. Packer, Prof. Thomas, and Mr. D. B. Brandon; for Victoria, Mr. A. H. S. Lucas; for Queensland, Mr. J. Shirley.

THE DRAPER CATALOGUE OF STELLAR SPECTRA.

THE Observatory of Harvard College has played a prominent part in the development of astronomical photography. It was here, on July 17, 1850, that Prof. Bond obtained the first photographic image of a star, and from that time forward much important work has been accomplished, culminating in the Draper Catalogue of the photographic spectra of 10,347 stars. The progress of this latter branch of astronomical work has been but slow, and it is a remarkable fact that its extraordinary development during the last few years has followed from the revival by Prof. Pickering of the method of observation first employed by Fraunhofer in 1824. Accounts of the progress of the work have been published from time to time, and have been noticed in our columns. A complete account of the "Preparation and Discussion of the Draper Catalogue," which has recently been issued, forms vol. xxvi., part i., of the *Annals of the Astronomical Observatory of Harvard College*.

The earlier attempts to photograph the spectra of the stars were made with spectroscopes having slits, although, from the time of Fraunhofer, it was recognized that a slit was not an essential part of a stellar spectroscope. In 1863, Dr. Huggins succeeded in photographing the spectrum of Sirius, but none of the characteristic lines were visible. In 1872 Dr. Henry Draper, to whose labours in the field of astronomical photography the Draper Catalogue forms a fitting memorial, succeeded in obtaining a photograph showing four lines in the spectrum of Vega. Dr. Huggins again took up the work, and since 1879 has obtained a considerable number of photographs, none of which, however, appear to show anything approaching the amount of detail now obtainable. In all these attempts the spectroscope was attached to the eye end of the telescope, so that the image of the star was formed on the slit, a cylindrical lens being interposed in order to give width to the spectrum.

In the method which has been so pre-eminently successful, the slit and collimator, which form an essential part of an ordinary spectroscope, are dispensed with, the rays from a star already possessing the necessary parallelism and its image being almost a perfect slit without length. It is only necessary, therefore, to fix a prism in front of the objective of a telescope, and to introduce some means of widening the spectrum, to obtain a complete stellar spectroscope. For eye observations the necessary width is obtained by the use of a cylindrical lens in conjunction with the eye-piece of the telescope. For photographic work, the prisms are so arranged that the spectrum lies along a meridian, and it is then only necessary to allow the driving clock to be slightly in error to obtain a widened spectrum. The clock error must of course vary according to the magnitude and declination of the star.

The great advantage of the "slitless spectroscope" depends upon the fact that every scrap of light passing through the object-glass is utilized; with the ordinary spectroscope it will seldom happen that all the light passes through the slit, and it is further reduced by absorption in the lenses and prisms of the spectroscope. Further, on account of the large focal length of the telescopes employed, a high dispersion is obtained even with a prism of small angle; and a large number of spectra can be photographed at a single exposure. Prof. Pickering has photographed the spectra of as many as 260 stars on the same plate, and the labour involved in the construction of the Draper Catalogue has thus been enormously reduced. Indeed, the whole of the 10,347 spectra were photographed on 585 plates. The improvement in photographic processes has undoubtedly done much to facilitate the work, but it is lamentable that the "wholesale" method was not applied twenty years ago, for even with the less perfect processes then in vogue, our knowledge would have been much advanced.

An important feature of Prof. Pickering's work is the method of enlargement of the negatives, which renders the fainter lines clearly visible. "The negative is covered by a diaphragm, having a slit in it which is made to coincide with the spectrum. An image is then formed by an enlarging lens in the usual way. A cylindrical lens is next interposed near the enlarging lens, with its axis perpendicular to the lines in the spectrum. The width of the latter may thus be increased indefinitely without changing the length. In the case of faint stars very narrow spectra only can be obtained. Their energy is so feeble that they are capable of decomposing the silver particles only if allowed to fall upon them for a long time. In the enlargement the energy of the sun is substituted for that of the star, and thus an indefinite number of silver particles may be decomposed." (Introduction, p. xix.) The original negative may, perhaps, be compared to a "relay" in electrical apparatus.

The preparation of the Draper Catalogue involved five different steps, which are thus stated on p. 74:—

I. Measurement of the spectra on each plate, including the determination of their positions, intensities, and the classes to which they belong.

II. Identification of each spectrum with that of a star in the Durchmusterung or other catalogue.

III. Reduction of the measures of brightness to the scale of the Harvard Photometry.

IV. Catalogues of plates.

V. Preparation of the final catalogue, bringing forward the places of all the stars to 1900, including various methods of checking and correcting the results.

That a catalogue of spectra may be of service to astronomers, a sound system of classification is essential, and this, as far as possible, should have some reference to chemical or physical constitution. The notable classifications which were suggested by eye observations were those of Secchi, Vogel, and Lockyer, but it is not surprising to find that the greater detail shown on the photographic plates requires modifications of these in order that all the spectra may be included. A detailed but somewhat arbitrary classification has been adopted by Prof. Pickering, the chief merit of which is that it readily lends itself to translation into other systems. Varieties of Secchi's first type are indicated by the letters A, B, C, D, those of the second type by the letters E to L, of the third type by M, and of the fourth type by N; bright line stars are referred to as O, planetary nebulæ as P, and other spectra as Q. Of the varieties of the first type, A includes all the stars with spectra similar to Sirius, and B those with spectra of the Rigel type, in which, in addition to lines of hydrogen, there is a small number of strong lines of which the origins are at present unknown.

Results of special interest, such as the discovery of bright lines in the spectra of variable stars of long period, have already been referred to in NATURE, and we shall now confine ourselves to the more general results. As some of the most interesting spectra belong to stars of small magnitude, it is necessary to be very guarded in making generalizations. Still, the fact that Prof. Pickering's researches have extended in some cases to stars of the ninth and tenth magnitude perhaps justifies the assumption that all types of spectra are now included. We cannot do better than let Prof. Pickering speak for himself.

"The general conclusion derived from the study of these spectra, is the marked similarity in constitution of the different stars. A large part of them—those of the first type—have a spectrum which at first sight seems to be continuous, except that it is traversed by broad dark bands due to hydrogen. Closer inspection shows that the K line is also present as a fine dark line. If the dispersion is large and the definition good, many more dark lines are visible, as stated above. These lines may be divided into two classes—first, those which predominate in many stars in the Milky Way, especially in the constellation of Orion; and, second, those present in the solar spectrum. Nearly all the brighter stars may be arranged in a series, beginning with those in Orion, in which the auxiliary lines are nearly as intense as those due to hydrogen. Other stars may be found, in which these lines successively become fainter and fainter, until they have nearly disappeared. The more marked solar lines then appear, become stronger and stronger, and the hydrogen lines fainter, until they gradually merge into a spectrum identical with that of the sun. At least, several hundred lines appear to be identical, and no differences can be detected. Continuing the sequence, the spectra pass gradually into those of the third type. Certain bands become more