Royal Society of Victoria.

# TRANSACTIONS

AND

# PROCEEDINGS

OF THE

# Royal Society of Victoria.



## VOL. XI.

*Edited under the Authority of the Council of the Society.*

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THE AUTHORS OF THE SEVERAL PAPERS ARE SOLELY RESPONSIBLE FOR THE SOUNDNESS OF THE OPINIONS GIVEN AND FOR THE ACCURACY OF THE STATEMENTS MADE THEREIN.

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# PREFACE.

The Volume now presented to the members of the Royal Society of Victoria constitutes No. XI. of the Society's Transactions. It is intended to meet the demand for the more speedy publication of papers by printing them in future immediately after delivery, for circulation among the members at the following meeting.

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# Royal Society of Victoria.

1873.

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# Royal Society of Victoria.

## ANNIVERSARY ADDRESS

OF

## The President,

MR. R. L. J. ELLERY, F.R.A.S., Government Astronomer.

[Delivered to the Members of the Royal Society at their Annual *Conversazione*, held on 8th August, 1873.]

GENTLEMEN OF THE ROYAL SOCIETY,

We meet together to-night to commemorate the 16th year of this Society's existence, and it becomes my duty, as your President, to address you briefly upon its past year's history and present position. On former occasions of this kind I have usually trespassed upon your attention by referring to some subjects of prominent scientific interest; with your permission, I will adopt the same course to-night, but as briefly as possible. First let me speak of the Society's business.

I am happy to be able to deviate from the almost stereotyped statement that I have unfortunately felt compelled to make in previous addresses, concerning the non-publication of our Transactions; at last these are in course of printing, and in so forward a state as to be shortly ready for distribution. This volume (the 10th) will contain the papers and other results of the Society's labours from the year 1868 to the commencement of the present year.

This result I must explain is mainly owing to the fact that the present Government has liberally renewed the grant in aid to the Royal Society which has been unfortunately withheld for several years past. It should be remembered that the only real objects of this Society are, the advancement of knowledge in the colony, and the development of its manufactures, industries, and resources; and however inadequately it may fulfil these objects, its efforts are steadfastly and earnestly directed to that end. Relying on these facts, we trust that the Government will for the future help our endeavours, at least as far as the publication of our Transactions is concerned.

Before going to press with the accumulated proceedings of the past sessions, your Council appointed a printing committee to revise the papers and communications, and decide upon which to print in full, which in abstract, and which should be merely noticed in order by the simple title; for it was found that many of the papers having reference to matters of passing interest at the time of their reception, possessed no longer their original value, while many others were regarded as likely to be more valuable in abstract than in full. The committee had a somewhat invidious task to perform, but I believe it has done its work fairly, with due attention to the interests of the Society as a body, and with due consideration of the claims of the various authors. The Council has authorised the illustration of papers by lithographs, photographs, and woodcuts, wherever the subjects have appeared to warrant that additional expenditure.

The present intention is to continue publishing our transactions up to date, and issue them in half-yearly or quarterly parts, or even in sheets if found desirable.

The state of publication is necessarily a reflex of our financial condition, which is indeed now in a far more satisfactory state than it has been for many years past.

I would beg now to draw your attention to the work of the Society during the past year. I cannot congratulate you on the fulness of the harvest, although some very valuable contributions have been received.

The only immediate reward that usually falls to the lot ot most workers in science, literature, and art, who come forward at this and similar societies to describe or illustrate the results of their labours and researches, is that credit and admission of priority which may be secured to them by prompt publication in the form of the Society's Transactions, and dissemination to kindred societies in other parts of the world. Papers consigned to the archives of a society in the manuscript form, instead of being immediately printed and distributed, partake too much of the nature of buried treasure, for which the author receives no credit, and from which the world derives no benefit.

The long delay in the resumption of publication in this Society may therefore partly account for a somewhat barren session, but there have been doubtless other causes operating, and it may be mentioned that if we look at the past year's results in similar societies abroad, we see a like barrenness, as compared with other years, which almost warrants the belief that the vigour of such societies has its undulations.

The first meeting after our last *Conversazione* was held in August, and at this and the several meetings held until the 18th November, the following papers were read :—

"On the Extraction of Vegetable Oils with Bisulphide of Carbon," by Mr. Cosmo Newbery.

"On the Mechanical Assay of Quartz," by Mr. Foord.

"On a Method of Verifying a Ship's Position on a Coast," by Capt. Perry.

"On the Treatment of Criminals in Relation to Science," by Mr. H. K. Rusden.

"On Matter a Mode of Motion," by Mr. F. MacGeorge.
And Mr. O. Pritchard exhibited an instrument he styled a "Kaleidograph," by which the beautiful and changing patterns seen in a Kaleidoscope are perfectly projected on a transparent screen, from which they could readily be copied by hand or photograph.

At some of the meetings new apparatus was exhibited and described, and short illustrations given, and at the October meeting an alteration was made in the law of the Society relating to country members, so as to permit the admission of residents in the country as life members at half the usual composition fee.

During the Exhibition in November and December, it will be remembered, we held extra fortnightly meetings, and invited exhibitors to describe and illustrate their inventions, improvements, or manufactures; the invitation was so far responded to as to occupy three extra meetings, and the experiment in a measure fulfilled the purpose for which it was intended.

At the December meeting two papers were read—

"On Ocean Wave Power Machinery," by Mr. S. R. Deverell.

And the other

"On Kinship Systems," by Rev. L. Fison.

The annual meeting for the election of officers took place in March, and at the May meeting Mr. A. K. Smith read a paper "On the Stormwaters of Melbourne, with suggestions for obviating the damage caused by them."

This summarises the business of the Society at its ordinary meetings, and admitting on the one hand that the number of contributions is not great, it may be stated on the other, that the Council meetings during the session have been punctually attended, and much business conducive to the future healthful activity of the Society has been transacted.

Our library continues to be enriched by liberal donations from kindred societies, various Governments, and individuals, and it now forms a most important collection of the publications from scientific societies in all parts of the world. To render these works readily available to the members it will be necessary to get a great deal of binding and arrangement done, a matter which your Council has already taken in hand, and which it intends to push on with vigour.

At the conclusion of this address, I have a few words further to add concerning the internal business of the Society, but leaving that subject for the present, I propose to occupy your attention with some brief observations on more general scientific matters.

The immense importance to mankind generally that attaches to further advancement in meteorology and the elucidation of the laws which govern the weather, from out of their complex entanglement with other physical conditions, is becoming more and more apparent, and is claiming the attention and energy of not only scientific individuals, but States and Governments.

The extension of the electric telegraph over a large portion of the world has placed in the hands of physicists and meteorologists a most powerful aid towards investigation in this portion of Nature's dominions, and enables them to take far more comprehensive views of the physical changes taking place in the atmosphere and on the earth's surface, than was previously possible. A few years ago it took months to gather together the meteorological statistics from the various stations of a small territory, and deduce from them what changes *had* occurred. Now, it is not too much to say that observations extending over a quarter of the globe are interchanged, digested, and conclusions deduced from them in a few hours, so that the "probabilities" (as they are called) and "storm warnings" can be disseminated throughout the continents, in time to enable mariners, farmers, and others to take advantage of the ominous or cheering forecasts of coming weather.

Within the last two years international meteorological conferences have been held in Europe, at which representatives of all the western world nations were present, and scientific alliances have been formed, by help of which it is proposed to carry out a grand scheme of ocean and land meteorolgy. This scheme provides for the exchange, several times in the day, of weather telegrams between England, most parts of Europe, America, and the portions of the African coast of the Mediterranean already connected by wire with Europe. Central offices have already been established in the chief cities, where these telegrams are received, fitted together, and plotted on skeleton maps; from the graphic representations thus afforded of what is going on in the atmosphere and on the earth's surface, deductions are made concerning the rising and movements of storms, strong winds, rain, or dry weather. The deductions so made are in some countries disseminated as "forecasts" of probable approaching weather, while in others "warnings" only are given on the approach of dangerous storms. In the United States "probabilities" are daily disseminated to all the post offices, where they are posted for public inspection.

The system of storm warnings instituted by the late Admiral Fitzroy, and adopted on many parts of the British coast some years ago, which was simply based upon a comparatively very incomplete chain of observing stations, is estimated to have saved an immense amount of life and property from shipwreck. How much more good then is likely to come from the great scheme I have referred to.

The first and most important objects to be obtained relate to ocean meteorology, a furtherance of our knowledge of the conditions which govern, or influence, the origin of great atmospheric disturbances over large areas, with the grand view of rendering navigation safer. The next and but little less important object will be the discovery and systematising of the various laws or conditions which lead to important rainfall, or dry weather, high winds, and change of temperature; objects of such vast importance to agriculture, and other occupations, as to render them cheaply obtained at any possible national expenditure of time or money. The laws which govern the movements and behaviour of storms over the most of Europe, the Atlantic, and a large part of America, are being already slowly unravelled by the clear heads of the directors and able assistants of the Great National Meteorological Bureaus, and some most interesting and decisive results arrived at. It may be thought somewhat chimerical to hope that facts may eventually be deduced by which the greater meteorological changes, and even those that are agriculturally important, may be foretold and forestalled; such a consummation nevertheless appears far less problematical than a year ago, and facts already established indicate the possibility. The extension of the telegraph, and the co-operation of almost all civilised countries in the work, is one great step towards the attainment of so desirable an end.

In concluding my address three years ago, I made use of these words—"The further physical science advances the closer and more numerous seem to be the relatious between the sun and terrestrial phenomena, and to my mind it appears quite probable that solar physics will eventually be found the true key to meteorology." Of course these views were held by others, but a remarkable ratification of the belief I then expressed has been given in the results of some investigations as to the existence of relations between sun spots and sun disturbances, and rainfall and temperature on the earth, by Mr. Meldrum of Mauritius, and Mr. Stone of the Cape. Mr. Meldrum shows that the years of maximum and minimum of sun spots coincide with the maximum and minimum of Mauritius cyclones, and then compares the rainfall at Brisbane, Adelaide, and Mauritius with those periods, and finds a similar coincidence: least rainfall with minimum of solar spots, and *vice versa*. Mr. Norman Lockyer, writing in *Nature* an article called "*Meteorology of the Future*," concludes with the following words, which I am sure all scientific men will endorse:—

"What, therefore, is necessary in order to discover the true nature of this nexus? Two things are necessary, and they are these: In the first place, we must obtain an accurate knowledge of the currents of the sun, and secondly, we must obtain an accurate knowledge of the currents of the earth. The former of these demands the united efforts of photography and spectrum analysis, and the second demands the pursuit of meteorology as a physical science, and not as a mere collection of weather statistics. When these demands are met—and in spite of the Mrs. Partingtons who are endeavouring to prevent this, they will soon be met—we shall have a Science of Meteorology placed on a firm basis—the Meteorology of the Future."

We have often suspected in Australia that our wet seasons and droughts were cyclical, but the period over which observations have extended scarcely admitted of any trustworthy deductions; if we compare however, the results of observations made in this colony since 1844—the decidedly larger rainfall in the maximum sun spot years and the less in the minimum years, is well marked.

A system of meteorological work, such as I have referred to above, would eventually become of inestimable value in Australia, if by a careful selection of typical stations, a proper meteorological blockade could be established. We have now the electric telegraph extending from the tropics to moderately high latitudes (a large portion over the centre of the continent), besides a long stretch of coast line, both east and west and north and south, electrically connected, comprising places admirably adapted for stations. The great requirement is an intercolonial agreement upon one uniform plan of observations to be systematically carried out at selected stations, the establishment of a head quarters in each colony, and an authorised use of the various intercolonial telegraph lines and cables for transmission of weather telegrams. In talking over these matters some time since with Mr. Todd, of Adelaide, he expressed himself strong in the conviction that one important key to our meteorology in the South of Australia was the varying southward reach of the monsoons; the determination of this point alone would, for its own sake, and without reference to its future bearings, be a great work effected, and is certainly one which should be immediately undertaken. The success that has already attended the international meteorological system in Europe and America should encourage Australia to a similar organisation, for in no part of the world would the power of forecasting weather be of more value.

One of the most important of all astronomical occurrences will take place in December, 1874—the *Transit of Venus across the Sun's disc.* This phenomenon, as is well known, presents one of the best means by which to determine the length of the "great astronomical measuring rod," the distance between the earth and the sun; as the very foundations of astronomy rest upon the correctness of this distance, and as the opportunities for redetermination by this method are so rare as to occur only once or twice in a century, it is not to be wondered at that considerable interest and excitement have been manifested among astronomers of all nations in the preparations for the great event. The last occurrence of this phenomenon was in 1769, when Captain Cook commanded an expedition to the south seas for the purpose of observing it, and it was while on this expedition, and after observing the transit of Venus, he discovered the east coast of Australia, and took possession of it in the name of Great Britain, and named it New South Wales. One hundred and four years have elapsed since. Two transits of Venus will now come together with an interval of only eight years; the first takes place on December 8th, 1874, the second on December 6th, 1882, but no other will happen till June 7th, 2004. Nearly every country in the world will take part in observing the phenomenon, and as the portion of the earth over which it will be usefully visible is limited to the Eastern hemisphere, the undertaking will in most cases involve costly expeditions. There seems, however, to have been but one consideration with all, to do the best possible for so important a determination; it is a grand work in which all nations of the earth are allied, and in which the cost has scarce been counted.

It would be out of place on such an occasion as this to give any detailed description of the various observations that it will be requisite to make, of the data to be determined, or of the various methods suggested for the determination, but as many public papers and periodicals have teemed with discussions on some moot points concerning the observing stations to be selected, it may be permissible to briefly refer to this part of the subject, more especially as Australia has been named as not unlikely to undertake a duty which by some is considered of paramount importance, and which there appears a possibility of being left undone.

For brevity's sake it may be stated then, one great desideratum in observing the transit of Venus is to get two observing points as nearly as possible the earth's diameter distant from one another, so that the apparent paths of Venus across the Sun's disc shall be as widely separated as possible, such separation being due to the difference of distance between the Sun and Venus, Venus and the Earth, as well as to the widely separated position of the observers. This being the case, and one extreme position presenting itself at Nertchinsk, a mining town in North Siberia, some position in the extreme south was indicated as the other desirable station, such a position is represented by the Antarctic shores, and notably that position called South Victoria Land, an island off which visited by Sir J. Ross in 1841, called "Possession Island," has been most strongly recommended as *the* station of the south, by Mr. Proctor and others. By none of the projected national expeditions is a station on this island, or any place so far south contemplated, and this omission has been most energetically criticised, especially by Mr. Proctor, who has lost no opportunity of forcibly urging that almost national disgrace will attach to Great Britain if so valuable an opportunity be neglected. It is true that Mr. Proctor shows very conclusively the astronomical value of such a southerly station, but there is another equally important side to this question, on which there appear numerous, if not all-sufficient reasons, for not sending an expedition to such inhospitable regions, and these have evidently outweighed the simple astronomical importance. Possession Island is in 72° south latitude, it is enclosed in bonds of ice until the middle of January, or beginning of February in each year. No expedition would be able to reach Antarctic Land until late in December or early in January; it would be necessary, therefore, that it should arrive there ten months beforehand, and remain through a polar winter, and wintering in Antarctic regions means the incurring of very serious risks. Some of our best navigators who were in those regions with Sir James Ross, are even of opinion that the party would have to be landed, and *left* for about twelve months, as it is not considered safe for a ship to winter there. Dr. Hooker, of Kew, who was also there with Sir J. Ross in 1841, speaks of Possession Island and that region in very chilly terms—he says the island is a "mere rock in a very inaccessible position. The chance of landing a well-equipped party upon it when reached, and the prospect of its subsequent removal by ships, if landed on, is very small. In any case, I feel little uncertainty as to what would be the fate of a party left there for the winter, and the prospect of their seeing the transit would be absolutely *nil.*" And further on he says—"The fact is, there is no summer or clear weather to be had, except by the rarest chance. For days and days we worked by dead reckoning alone. Storm, wind, and snow, are the prevalent summer phenomena. Still, some seasons are not so bad as others, and Weddell got to 74½° in an open sea in the meridian where we barely reached 66°." These facts form, I believe, the principal reasons why Possession Island or some other equally southern point, has not been selected by any of the expeditions. There are islands without the *ice zones* which, although in an astronomical sense less favourably situated than Possession Island, or Victoria Land, are still valuable positions, and which so far as can yet be ascertained remain unappropriated as stations; Emerald Island, Macquarrie Land, and Royal Co. Island for instance, where the duration of the transit as compared with Possession Island, at which place we may call it 33 mins., are respectively 29·3 mins., 29·1 mins., and 28·6 mins. These islands, I believe, are all accessible, and being wooded probably possess comparatively genial climates in the southern summer.

The southern stations already decided upon are—Rodriguez, Auckland, Alexandria, Kerguelen Land, St. Paul's

Island, Amsterdam Island, St. Denis (Isle of Bourbon), Cape of Good Hope, Melbourne, Sydney, Auckland Island, Noumea, Tahiti, and Noukahiva (in the Marquesas group). These stations will all be manned by either English, German, Russian, or French expeditions. In the general programme of this work Australia proper is supposed to take its *own* share, and it is not contemplated by the European or American observers to have any stations in Australia, except perhaps in Hobarton, where a United States observing party may be placed. The New South Wales Government have already granted a thousand pounds (£1000) to Mr. Russell, the Government Astronomer of Sydney, towards making preparations for the proper observation of the phenomenon in that colony. In South Australia I am informed a somewhat similar provision will be granted to Mr. Todd, the observer in Adelaide; and I have every reason to believe that our own Government will also provide the necessary funds to enable us to maintain our proper position in this matter, and do our fair share of this "*whole world's*" work.

In conclusion, I wish for a moment to return to the affairs of our Society. It has for a long time been felt, that the public at large have uniformly shown a warm interest in our annual conversaziones, and it has been recognized that whenever the public interest is in any way engaged in our proceedings, a real advantage is so far achieved. We gain something by popularising our meetings, but on the other hand the real hard business of the Society, many of the questions to which the members should devote their energies, are of a kind productive of papers which, however valuable in a purely scientific sense, are the opposite of what is called popular. In truth, these dry papers, resulting from hard work and close thought, whenever we can obtain them, are the most valuable of our acquisitions, which should on no account be sacrificed.

In recognition of these opposite facts, it has recently been proposed and discussed at our council meetings how to encompass the two ends, so as to prevent them conflicting one with the other; how to make our Society more accessible, and to become more immediately and personally useful to the public, and at the same time cherishing all that concerns original scientific investigation. In a new country, where all or almost all must be regarded as bread winners, with each a day's work of ordinary business to perform each day, and with relatively little unbroken time for close study, good original scientific papers are not always to be had; and with us, in our past experience, evenings have occasionally lapsed for want of contributions. We propose to limit the number of ordinary meetings, and to inaugurate a series of meetings of a more social character. At these latter it is proposed to give short lectures, illustrations, and experiments, not necessarily original or involving the preparation of a paper, but interesting as explaining important points in science and technology.

We hope by this alteration to increase our connections and usefulness on the one hand, and to concentrate our efforts in the pursuit of original research on the other.

A desire has also been expressed by some of our members to form an astronomical and physical section of the Society, according to the provision made in the rules for such a course. I think you will agree with me that the formation of this section is to be greatly desired; it would, I believe, ultimately become a strong one, as it will embrace many fields of research which are not only exceedingly interesting, but are of the highest importance to the intellectual and material advancement of the community.

## Art. I.—*On the Prevention of Street Floods in the City of Melbourne.*

By A. K. Smith, C.E., &c. &c.

[Read 14th May, 1873.]

I have been induced to bring this subject before the Society, not because the suggestion has the merit of novelty, as I have several times brought it under notice before, but because the surroundings of the question have altered so much, as to render the necessity of taking preventive measures of greater importance than it was nineteen, or even sixteen years ago, when I brought the subject under the notice of the Philosophical Institute.

At the date last-named, I find from a series of observations made at the time (1856-7), that it took an average of 32½ minutes, after the commencement of a heavy and continuous fall of rain, before the street-channels in Elizabeth and Swanston-streets were filled to over-flowing, so as to impede ordinary foot traffic; the minimum time being 30 minutes on the 23rd September, 1856.

At that date comparatively little foot pavement was laid, or yards and rights-of-way pitched, so that a considerable amount of the rain was absorbed before the remainder found its way to the street-channels. Much of the ground was then vacant, and further assisted for a time to retain the storm-water from the streets. However, so far as the sudden rise of street-floods is concerned, the Melbourne of 1873 is widely different from that of 1856. Since the latter date large numbers of houses and stores have been erected with iron or slate roofs; most of them draining immediately into the street-channels. Many miles of streets and roads with hard and even surfaces have been formed, and numerous yards, courts, and rights-of-way have been paved and pitched, all in such a manner as to readily discharge the storm-water falling upon them.

I find, that in 1872-3 the street-channels, after sudden and heavy falls of rain, become so flooded as to impede pedestrian traffic in less than half the time they did formerly; for, on the 15th October, 1872, I carefully noted the time, and found it to be 14½ minutes from the commencement of a thunder-storm until the streets became impassable. It will thus be seen that the danger to human life and property is greatly increased by the suddenness of the change from the dry street to the bed of a raging torrent.

The area drained by the channel on the east side of Swanston-street, when I made my survey in 1864, was 250.2 acres; but this area has been increased 27.5 acres, by altering the open channel that then crossed Flinders-street at its junction with Russell-street, so as to discharge the storm-water at Swanston-street, instead of under the Suburban Railway Station. This makes the total area drained by Swanston-street 277.7 acres, the greater portion of which is closely built upon, and otherwise having favourable rates of inclination upon its surface for the rapid discharge of storm-water. It extends to Grattan-street on the north; to Brunswick-street, Fitzroy, on the east; and to Flinders and Swanston-streets on the south and west. Had the main street channel in Swanston-street as rapid a fall as those in portions of Collins and Bourke-streets east, but little harm would be done; but it has not, and so between Little Bourke-street on the north and Collins-street on the south, on the occurrence of any heavy fall of rain, this channel fills and overflows the street, running down Little Bourke-street, Great Bourke-street, Little Collins- and Collins-streets, into Elizabeth-street, there to increase the damage and danger of its already impassable torrent.

Seeing then that the storm-water from the 277.7 acres drained by Swanston-street is greatly in excess of what the channels in that street can discharge without overflowing, and that the floods there are a constant source of inconvenience to the public and loss to the Corporation, it will the more readily be understood how inadequate are the channels in Elizabeth-street to carry off the drainage of no less than 497 acres, particularly when the water from that area is so increased by the overflow from Swanston-street previously alluded to.

Referring to past observations I have made on this subject, I find that on the 11th February, 1857, a heavy and almost continuous rain for a period of seventeen hours enabled me to take notes of the discharge of surface water at the junction of Elizabeth and Flinders-streets, and I found that the maximum quantity discharged on that occasion was between the hours of 9 and 10 a.m., on the 11th February, when it amounted to no less than 9,204,384 imp. gallons, and the damage to private property in Elizabeth-street alone to £2,500; the rain gauge on that day indicated a fall of 3.42 inches, which when compared with the previous calculations, after allowing for absorption and storage over the superficial area drained, approximates so closely as to become strong corroborative evidence of its accuracy.

Some idea of the force of the stream may be formed from the fact that a piece of freestone weighing 38 pounds was washed or carried away from the front of the then new building at the corner of Elizabeth and Collins-streets, and immediately opposite to Mr. Cashmore's, and deposited a little above the New Bank in Elizabeth-street (English and Scottish Chartered.)

To obviate or prevent these excessive floods has been my aim for many years, and I have repeatedly suggested, what I consider the best method of doing so, namely, to arrest the water at a given point, and at a given level, and to carry it off by a tunnel, and so prevent it from entering the town.

When I made the survey of the area drained by the five several outlets from the City-proper in 1864, I shewed upon the plans, one of which I now exhibit, that the drainage from about 547 acres might be thus arrested, and the total area reduced from 956 to 409 acres, with the following effect:—

In Elizabeth-street only *one-fourth* or 25 per cent. would be discharged at the outlet; and the result of this relief at Lonsdale-street would be that, instead of 83 per cent. of the total quantity of water discharged at the outlet passing Lonsdale-street, there would only be about 8 per cent. At the Post Office, 14½ per cent., instead of 89½ per cent.; at Collins-street, 20 per cent., instead of 95 per cent.; and at the outlet in Flinders-street, 25 per cent., instead of the whole quantity, as before stated. Swanston-street (at its intersection by Bourke-street) would be relieved of no less than 85 per cent. of the water which so frequently renders this part of the city impassable to foot passengers.

Although I have made careful observations of the height to which the water rises in the street-channels, I have been, and I am at present at a loss to know what quantity of rain falls per minute, or in a given number of minutes, during a rain-storm; and I am, therefore, unable to speak with certainty of the maximum height to which the water has risen in the shortest time.

I can only speak of results, without being able to trace the element of time so accurately as I could wish, and as it is of the utmost importance to ascertain the largest quantity of water that falls in a given time, I have designed a self-registering rain-gauge, that will give the information I require. Possibly and probably I might be able to obtain the information from the Government Observatory, where there may be instruments that register the quantity of water falling per minute. If so, our President will be able to inform me; if not, I will endeavour to have one constructed as follows:—

For strict accuracy and facility of calculation I would make the area of the rain-gauge 100 inches, or a square of 10 inches; the rain falling upon this would pass into a vessel mounted upon a spring balance, that would indicate the weight of water as it fell; then, by having a disc of paper or an endless web driven by clockwork and divided into minutes by radiating or lateral lines, a small spring pencil would inscribe the weight of the water each minute as it fell, and a properly calculated table would show the quantity, and that with an accuracy, notwithstanding the friction of the pencil (which would be almost a constant and could be allowed for), that has seldom or ever been hitherto obtained, that is so far as I am aware of. The same end might be accomplished by a float, &c., but for accuracy I would prefer the spring-balance. However, as I may make this instrument and the result of the experiments with it the subjects of a short paper at some future date, I will not further intrude upon your time by giving a more detailed description of it; but will conclude my remarks, by observing that the records of such an instrument, if it exists or can be made, will be of signal service in determining the size of drains or culverts requisite for the discharge of storm-waters from any giving area.

Reverting to the heavy rainfall of the 11th February, 1857, I have calculated that the total that fell upon the 956 acres forming the water-shed draining through the city, was nearly 74 millions of gallons, or over 330 thousand tons; and that, of this quantity more than 38 millions of gallons or 170,000 tons fell upon the area drained by Elizabeth-street alone. The quantity of water that then fell, as indicated by the rain-gauge, was 3·42 inches in 17 hours; but it is not the rainfalls of long continuance that are so likely to be mischievous in their effects as the sudden heavy ones, such as that of the 23rd September, 1856, when ·92 inches fell in twenty minutes.

On the 18th February last, a rainfall of ·90 inches in two hours did more damage than any other storm that has occurred for many years. From the appearance of the streets I am of opinion that the greater portion of the ·90 inches fell in a very short period, for on the 16th of the same month ·53 inches fell in one hour, without doing much damage, showing that in the latter case the rainfall had been more regular during the one hour. If we may judge by results, the rainfall of the 18th, though distributed over two hours, must have been abnormally heavy during a a portion of that time, as from a return I had made for the City Council, I find that the officers of the City Surveyor's department reported that damage to the extent of over £1,100 was done to fourteen miles of streets, exclusive of the injury to private property; and that Swanston and Elizabeth-streets were damaged to the extent of £398. The whole width of Elizabeth-street was covered from Latrobe-street southward, the footpath in some places to a depth of fourteen inches of a swiftly running stream.

Some idea of the depth of water in the street-channels in Elizabeth-street may be formed from the fact that the level of the centre of Elizabeth-street opposite the centre of Bourke-street is nearly two feet (1·97) higher than the bottom of the channel, and yet the centre of Elizabeth-street was covered to a varying depth of from two to nine inches.

At the Post Office Hotel, corner of Little Bourke and Elizabeth-streets the water ran in at the front door, filled the cellar, and ran out at the side doors in Little Bourke-street; in the hotel it attained the level of the first step of the stair leading to the first floor.

The damage done by these heavy floods in Elizabeth-street is greatly augmented by the overflow from Swanston-street, the whole of which enters the Elizabeth-street channels at right angles, and the swift current in Elizabeth-street has the effect of ponding back the water, and thus further increasing the damage. On the 18th February, the water on the north side of Collins-street (as surveyed by

Mr. James Blackburn at my request) was ponded back 162 feet in Collins-street west and to a distance of 92 feet in Collins-street east, and these distances had been considerably exceeded, as the level of the water at each extremity was four inches below the level of the centre of Elizabeth-street, which was covered to a depth of several inches during the same storm.

I need say nothing of the great number of shops that were inundated on that as well as on other occasions; but if we are to judge from the apathy of those who suffer, it would appear that to them such damage is inevitable; otherwise their inaction is unaccountable, for lately, when a few of the residents got the mayor to call a public meeting with the view of urging upon the Government "That for the protection of human life and property in the city it was imperatively necessary to intercept the storm-waters at or near Latrobe-street, and convey them into Batman's Swamp, and thence, by open cutting, into the Lower Yarra," notwithstanding the importance of the subject, only a few of those interested attended, and the meeting was postponed until another date. The second meeting lapsed also, but partly owing to the *Argus* newspaper giving the wrong date to which it was adjourned.

However, as the preventible street-floods have already led to the loss of human life, as well as that of a large amount of private property, exclusive of the heavy and constantly recurring damage to the streets, &c., under the care of the Corporation, I consider that I am discharging my duty as a citizen in persistently pressing this preventive measure upon the notice of the public, the City Council, and the Government, as I am afraid that some serious accidents will occur, and that at no distant date, when both human life and property will be sacrificed.

To guard against this is my object; and so long as I am able, or until preventive means are established, I will adhere to my self-allotted task of keeping this measure prominently before the public.

In seriously considering this subject, it should not be forgotten that the danger is constantly increasing in magnitude, even with the same amount of rainfall, as the water is discharged in a much shorter period. I have already shown that sixteen years ago, it took about double the time that it now does, for the water to rise to such a height as to impede or stop ordinary traffic, and the same agency that has caused the change is still at work, and will for many years to come still further increase both the suddenness of the street floods, and the volume of water discharged in a given time.

Nor can we reason with any safety that the rainfall itself will not increase, for it is on record that no less than $10\frac{1}{2}$ inches fell at Newcastle, N.S.W., in $2\frac{1}{2}$ hours. If half that quantity were to fall here in the same time, it is impossible to foretell the damage that might be done.

Besides the damage that has been, and may be, occasioned with a given amount of rain, the loss may be much increased by the partial stoppage of the street-channels. At the last heavy street-flood, no less than five of the bridges were carried away, some of them being left in such a position as to partially dam the street-channels; and should the barrier be increased by planks, packing-cases, vehicles, or portions of the boarding round places where new buildings are being erected, the same amount of rainfall that we have had might be much more disastrous in its consequences.

To guard then, as far as possible against these evils, I advocate the construction of a tunnel or underground drain from the northern part of the city westward into the swamp, through which the intercepted waters of no less than 547 acres might be discharged, and so reduce the volume of water passing along Swanston, Elizabeth, and Flinders-streets, to the extent previously named. One objection urged against this plan is that "it is impossible to make a tunnel large enough." To this I answer that the distance from the commencement of the large tunnel in Elizabeth-street to its outlet on the swamp is under a mile in length, and the fall is sufficient to enable a tunnel of only five feet in diameter to discharge 100 millions of gallons per day. I have already mentioned that the heaviest rainfall recorded in the colony for one day amounted to 74 millions of gallons upon an area of 956 acres; and as the tunnel would intercept the drainage of 547 acres of this area, it might be supposed to be large enough; still, to guard against the most exceptional rain-falls, it would be prudent to err on the safe side; and I would therefore recommend a tunnel eight feet in diameter. This tunnel, with the same rate of inclination, would discharge four times more water than a five-feet tunnel, notwithstanding their sectional areas are as 25 to 64.

I have not thought it requisite to give any approximate estimate of the cost of this work, as a deputation from the City Council and the members representing the city in Parliament are appointed to wait upon the Chief-Secretary, for the purpose of urging the Government to undertake the work. I may, however, say that the amount of annual loss to the citizens would do more than pay the interest upon the entire cost, and for this reason, if for no other, the work should be executed.

Apart, however, from the actual damage done by the floods, it is a source of great inconvenience to have the principal streets of the city rendered impassable by rain-storms of half an hour's duration, and this state of things should be remedied with the least possible delay, either at the expense of the Government, which has obtained immense sums of money for the ground on the northern part of the city without making any provision for the storm-waters being carried off, or by the city authorities at the joint expense of the Government and the citizens.

The Public Works Committee of the City Council lately inquired into the cost of lowering the level of Elizabeth-street, and of pitching that portion of it and Flinders-street most damaged by storm-water floods, and the estimated expense was £25,700. If Swanston-street were included, we may safely estimate the expense to be double that of a tunnel or tunnels. I, therefore, after a careful review of all the circumstances connected with the flooding of our streets, think, that to intercept the water and carry it off by a tunnel is the best and cheapest plan; and in conclusion I venture to express a hope that the necessity of doing so will be promptly recognised and the work speedily executed.

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## ART. II.—*Electric Potential.* BY PROFESSOR WILSON.

[Read 8th August, 1873.]

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## ART. III.—*Palladium.* By GEORGE FOORD, Esq.

[Read 8th August, 1873.]

## Art. IV.—*Suggestions for the Construction and Erection of Lightning Conductors.*

By R. L. J. Ellery, Esq.

[Read 15th September, 1873.]

A building constructed entirely of metal without joints, except such as be metallically made, as by soldering, brazing, &c., and being in full contact with the earth, would be safe from the injurious effects of lightning.

A building of brick, stone, wood, or other imperfectly conducting material, will be well protected, if *caged over* by a network or grating of metal wire or rod, all metallically soldered into one continuous system, having projecting above it at one or more places, metal rods forming part of the same system, and having sharp bright points at their upper projecting ends, and if the lower portion of the cage-work be well connected with the earth.

The first condition would be secured in the case of a ship built, rigging and all, of iron, or by a building covered with lead, zinc, or iron, in which all the joints are soldered, and where the metal is continued downwards on all sides, so as to be well buried in the earth. The second condition, by placing over a building a frame-work of iron rod, or wire, so as to have no high or otherwise projecting part of the stone or brick building, above or outside the metallic frame-work, and having the framework projecting downwards into the earth at as many points as possible.

In ordinary buildings, however, it will be generally found more convenient and economical, and almost as effective, to adopt a modification of these arrangements.

The very essence of a lightning conductor is to afford an easy and wide way for the electricity to reach the earth, for it is only when such way is not present that mischief is done. A thoroughly good and extensive connection with the earth should be the first consideration, for without it all lightning-conductors rather add to than diminish the danger.

The surface of the earth, if dry, is a bad conductor; so that a permanently moist stratum is the only one that forms a good earth connection. The sea, a permanent river or creek, a lake, reservoir, or deep well, will all form good earth connections; all water, or gas-mains UNDER GROUND, are also equally good earth connectors, and *perfectly safe*.

In absence of such earth connections the conductor should terminate in a large plate or coil of wire buried sufficiently deep in a permanently moist stratum, and will be best if surrounded by coke or charcoal, which are absolutely imperishable materials of relatively high conductivity, and therefore well-suited for distributing the electrical discharge. There should be several of such earth plates, even to one conductor, which can be arranged by joining two or three such connectors to the conductor before entering the earth.

To summarise this part of the subject it may be laid down that "*A good and extensive earth connection is of paramount importance.*"

From the earth to the higher parts of the building the conductor may assume almost any form of a *continuous* metallic path. Iron rod, wire rope, sheet metal, pipes, or anything of the kind so long as it be large enough and metallically continuous ; mere contact of one piece of pipe or rod with another is dangerous—*they must be joined by solder;* thus down pipes and ridging metal may be quite safe to use if *every joint is soldered over a large surface : no lapping,* however extensive, will do. Whatever be used must take the form of a continuous metal connection with the earth.

It is unnecessary, and in fact wrong, to insulate the conductor from any part of the building at all ; it should lay on the roof, along the gutters, or anywhere convenient, and pass down the walls at any convenient place, and be kept in position by any ordinary hold-fasts.

The upper projecting-rod of a lightning-conductor need never be more than three to five feet above the highest portion of the building to be protected, and should terminate in a single point, which it is better to make of a metal not liable to rust, and as most projectives of conductors will be of iron, a *good copper point, stoutly gilt,* well brazed to the iron, will be found the most economical and effective.

From experiments conducted by the French Academy of Sciences it is considered that the area protected by a single lightning conductor is about equal to twice the radius of its height ; therefore, if a conductor were a hundred feet high, it would protect a building covering an area of 100 feet radius ; but half this is now generally taken as the safest proportion, and, therefore, a conductor 100 feet high would protect a building of fifty feet radius. The lower the conductor the less area it will protect, so that a low straggling building will require more projecting *points* than a tall one like a church with a spire.

*Materials.*—Any metal can be used, but lead and zinc being worse conductors than copper and iron, a larger surface of the former than the latter would be necessary. The form may be in rod wire, sheet, or tube, as most convenient. No less surface than is presented by wire quarter of inch thick should be used for copper or iron, and at least ten times that for zinc or lead.

Lead or metal ridging and guttering may be used if soldered at the joints; but as it is not safe to solder the laps themselves, as they would tear by expansion and contraction, a method similar to that suggested in the report of the French Academy for connecting iron framework in lightning conductors should be adopted, namely, at each joint a strip of copper to *form a bridge over it*, should be soldered, so that the bridge of metal will always give and take in the sliding of the lap due to expansion and contraction.

Down-pipes for conveying rain-water from the roof may also be used, if a similar device with regard to joints be adopted, and if a good plan for metallically connecting the guttering with the head of the pipe, and the foot of the pipe with the earth, be devised.

In most modern buildings the metal used on the roofs can be made to form a very effective portion of the system of a lightning conductor, by keeping in mind the foregoing suggestions, and all the ridging, guttering, &c., will in reality form a portion of a metallic cage protecting the roof.

Whether such metallic parts of the building form part of the true conductor or not, it will always be safest to connect all those parts *together* and *with the conductor.*

To put the foregoing into a more practical form, let the case of a church, with a spire 120 feet high, and a roof 100 feet long, be taken; the spire may have a *terminal* and weather vane of iron, or of wood sheathed in copper; then from the terminal below the vane, a copper or iron rod should spring to a little above the vane, terminating in the gilded copper point as already described; then from the base of the pinnacle, well soldered copper or iron rod, strip, tube or rope, take it down outside the spire to the metal ridge of the roof, to which it should be soldered in passing; carry it down to the earth, connecting by solder any metal guttering that it may come near on the way, and take immediately to earth by one of the methods pointed out; and if in a tower, this will best be done by connecting it with the underground water-mains; but not to any portion of the pipes above ground or in the building.

The ridge metal should be connected by bridge strips, and another conductor at the end of the roof farthest from the spire should be erected and taken straight to earth, soldering to the ridge in passing. An arrangement of this kind will form an effective lightning conductor to such a building. If there be other towers or turrets more than 60 ft. or 70 ft. from the chief spire, each should have a small conductor.

In a building without a lofty tower or spire, and where chimney-stacks or gables form the highest points, the conductors should always be placed on the highest and most prominent parts, bearing in mind the proportion between height and area covered by the building, and it will thus often be found that even three, four, or more conductors will be necessary. Let them be fixed to the stacks by holdfasts; soldered to ridges and gutters in passing; taken over the roof OUTSIDE the walls, *each conductor* direct to earth. All the conductors must be connected into one system on the roof, by soldering some of the lines of ridging by bridges; and the more of the roof metal brought into the system the better.

Iron rod, of from three-eighths to half an inch diameter, or tube three-quarters diameter, three-quarter inch copper tube, or strips of stout sheet copper two or three inches broad, or galvanized iron rope from half an inch diameter upwards will perhaps be found the most useful materials; but in case of iron tube, *screwing without soldering* will be insufficient. Copper or iron rope, from its flexibility, will be found very useful; but every joint must be covered with a good mass of solder. In reference to the use of wire rope, it is to be borne in mind that several strands of metal arranged in the form of a rope are liable to more rapid oxidation and decay than equivalent more compact forms of rod or tube; whatever forms be adopted this element of decay should always be taken *account of, examining the continuity of the* conductor from time to time. When from any cause a breach of metallic continuity comes about, the building becomes less secure than it would be if such disordered lightning conductors were absent. The use of down-pipes to save the expense of bringing a special conductor to earth cannot be strongly recommended unless they are in one piece, and go directly deep into the earth, as the making and keeping up good sound metallic joints will be found a difficulty in practice.

An independent conductor carried as direct to the earth as possible will be found the least expensive in the long run. Never take the conductors inside the buildings for the sake of *short cuts,* or for any reason except where a more rapid and extensive earth connection can be obtained by doing so, than otherwise.

Lightning conductors, as commonly arranged, are in most cases very far from ornamental additions to the buildings which they protect; the use of vanes, pinnacles, ridging, and other external metallic details of a building to form portion of the conducting system has the recommendation of being less objectionable in an æsthetical sense than the form of lightning-rods wholely extrinsic to the design, as commonly employed; and, by a little judicious management the ornamental terminations of gables, roof, towers, and turrets, may be made to entirely and very effectually subserve the requirements of a lightning protector by keeping in view the foregoing suggestions.

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## ART. V.—*Contaminated Water Supply.* By S. W. GIBBONS.

[Read 13th October, 1873.]

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## ART. VI.—*Eckhold's Omnimeter.* By R. L. J. ELLERY.

[Read 13th October, 1873.]

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## ART. VII.—*On the Occurrence of a species of Retepora (allied to R. phœnicea, Busk), in the tertiary beds of Schnapper Point, Hobson's Bay.*

By R. ETHERIDGE, Jun., F.G.S.,

(Of the late Geological Survey of Victoria).

[Read 13th October, 1873.]

When examining for Foraminifera, portions of the light grey mud from the Eocene or Oligocene beds of Schnapper Point, the accidental fracture of a large mass revealed portions of a species of *Retepora* spread over the fractured surface. Further examination convinced me that the specimen bore a certain resemblance to *R. cellulosa,* Lin. Unfortunately only the posterior or non-celluliferous face is presented to view, its chief characters are therefore somewhat doubtful. The specimen was submitted to Mr. G. Busk, so well known for his researches amongst the Polyzoa, who considers it more closely allied both to a new Mediterranean species about to be described by himself under the name of *R. imperati* (collected during the voyage of the *Porcupine*), and to an Australian species living in Bass's Straits, which he has called *R. phœnicea* (British Museum catalogue). Of the two, the Schnapper Point specimen resembles the latter more closely than the former, but so far as the characters can be made out, Mr. Busk considers it to be a new species. Should more complete specimens bear out this impression, I would propose that it should be called *Retepora McCoyana,* as a slight tribute to the many services rendered to Palæontology by the able director of the National Museum.

The Polyzoarium of the Schnapper Point specimen is curled and undulating; the posterior surface is strongly and irregularly vibicite, with the weals a good deal raised above the surface ; the fenestræ are oval and elongate.

Several other species of Polyzoa were present on the same piece of Tertiary mud, but all fragmentary. The only one recognizable was the *Spiroporinæ vertebralis,* Stolilzka, of the Tertiary greensand of Orakei Bay, New Zealand. This form is placed by its describer amongst the *Cheilostomate* division of the Polyzoa, and belongs to Busk's genus *Onchopora* (*Anarthropora,* of Smith).

A few species of Foraminifera were obtained from the same piece of mud. I hope to forward to the Society a communication on these at a future date.

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## ART. VIII.—*E. K. Horne's Method of finding Greenwich Time and the Longitude.* By E. J. WHITE.

[Read 10th November, 1873.]

## Art. IX.—*Embankment above Prince's Bridge.*

By A. K. Smith, C.E., &c.

[Abstract of Paper read 18th November, 1873.]

In bringing before the Society the subject of the embankment recently constructed along the south bank of the Yarra to the eastward of Prince's Bridge, it is due to myself to say, that I did not wait until it was made before giving my opinion of it, and the evils likely to result from its construction; but that immediately on hearing it was the intention of the Government to make such an embankment, I called the attention of the Honourable the Commissioner of Lands and Agriculture, as well as the City Council, to the danger of so doing.

In a letter lately published in the *Daily Telegraph*, signed "Yarra Floods," the writer states that the embankment is a step in the right direction, and that he hopes Mr. Smith will not frighten them before they are hurt. But, Sir, I think the members of this Society will agree with me, not only in the wisdom of the old axiom, "Prevention is better than cure;" but that in the earnest belief that danger would result from such construction, I did neither more nor less than my duty in calling the attention of the proper authorities to the subject. However, the embankment has been formed, and, whilst happily no floods have as yet occurred to practically test its effect, it is not too late to take remedial steps to avoid to a great extent the disasters which it may cause by damming back the flood-waters upon Richmond and the low-lying lands adjacent to the city, but more particularly to those who have property on the low grounds of Emerald Hill and Sandridge, should the embankment give way. That it will do so, is almost a certainty, as the materials of which it is constructed would not stand the force of flood-waters, having a velocity due to a gradient of 1 in 1237, or a fall of $4\frac{1}{4}$ feet per mile.

That the Yarra had a velocity due to such a fall is a matter of record, for at the Railway Bridge, Cremorne, when the flood was at its highest in December, 1863, it attained a maximum height of 22·83 feet above the datum level, whilst at Prince's Bridge, a distance of 144 chains lower down the river, it rose to 15.17 feet; thus showing a fall of 7·66 feet in 144 chains, or at the rate of $4\frac{1}{4}$ feet per mile, and that at a time when the St. Kilda Road was acting as a bye-wash, and allowing more than twice the quantity of water to flow over it that passed under Prince's Bridge. By reference to the flood-levels taken at the time, I find that the sectional area of the water flowing under Prince's Bridge and through the cattle arch amounted at the highest to about 1,700 square feet (this section is between the level of the falls and the highest flood-level at the bridge.) Whilst the sectional area of the flood-waters flowing over the then depression in the St. Kilda Road, between the southern approach of Prince's bridge and the old military barracks, amounted to over 3,500 square feet.

It is, therefore, a waste of time to debate for a monent whether the bridge is a barrier to the floods or not; from these figures the veriest tyro in hydraulic engineering must know, that to stop the relieving action of a byewash or outlet for the flood-waters, by an embankment of earth is a most dangerous experiment, especially when the narrow spans of Prince's Bridge, and the cattle arch are taken into consideration, and compared with the length of the bye-wash alluded to (820 ft.)

If any argument were necessary to show that the area under Prince's Bridge is too limited for flood-waters, it would be found in the fact, that whilst the height of the flood was 15·17 feet at the bridge, it was only 13.10 feet on the upper side of the Falls, and 11·25 on the lower side; the falls being about 28 chains only from the bridge. This plainly showed that notwithstanding the barrier at the Falls, the flood-water escaped over it, and the adjacent ground so easily, as to reduce the surface level of the water 2·7 feet lower than at the bridge.

Subsequent to my mentioning to the Hon. Mr. Casey about the embankment, that gentleman informed me that since the great flood in '63, the Falls had been lowered, and that no damage from floods need now be apprehended, as there had been a greater rainfall since that date, and that the flood-waters had escaped without approaching anyway near to their former level.

In reply, I admitted that lowering the Falls was a step in the right direction; but I took exception to the statement that there had been a greater rainfall than that in December, 1863. That it might have been greater in some locality of limited area I was not prepared to dispute; but that to imagine there had been a greater rainfall over the same area was altogether a mistake, and that the comparative heights to which the River Yarra had risen at distances from the City, where it was uninfluenced by either the Falls or Prince's Bridge gave unmistakable proofs that such heavier rainfall could not have been over an area of the water-shed of the Yarra equal to that which occurred in 1863. To verify the statement of the Commissioner I was referred to you, Mr. President, and was also informed that the matter would be brought forward in the House of Assembly. If it were so, I have seen no account of it; but I am credibly informed that since the embankment was erected, the Commissioner has referred the subject to a board of engineers to report upon the probable effect of the embankment on floods; that the said board had sent in a report, in which the embankment as placed was condemned, and which further recommended that a considerable portion of it at both ends should be removed.

It, therefore, appears that the primary objections I urged against its construction have now, *after* it has been made, been endorsed by a board of engineers. This recommendation comes too late to save the waste of public money; but if the difficulty be grappled with at once, it is not too late to avert the consequence of its presence.

When we take into consideration that the immediate cause of floods is the checking by any means, natural or artificial, the free flow of the water into the basin which receives it, whether such basin be river lake or sea, we cannot help coming to the conclusion that Prince's Bridge is one of the artificial barriers that prevent the free escape of the flood-waters of the Upper Yarra, and that the reef upon which it is founded is a natural barrier, the retarding influence of which is not at present so much felt on account of the reef at the Falls being higher than that at the bridge.

My only object in cautioning the Minister of Lands and Agriculture before its construction, and bringing the matter before this Society now when it exists, is simply to prevent as far as possible the danger to property, if not human life, by giving timely warning, and by bringing public opinion to bear upon the question, and to insist upon the embankment being wholly or partially removed with the least possible delay.

## X.—*On the Advantages of Burning the Dead.*

By James Edward Neild, M.D.,
Lecturer on Forensic Medicine in the University of Melbourne.

[Read 8th December, 1873.]

I think there is no more loathsome object than a putrid human body. It offends the senses, and it shocks the sensibilities, even of those whose duties make them familiar with the sight. As a rule, interment takes place before decomposition has advanced sufficiently far to alter the appearance of the dead, so that sorrowing survivors are not generally distressed by witnessing those repulsive changes, which begin to take place more or less rapidly, according to temperature, as soon as life ceases. But they do take place, whether the body be above ground, in the earth, or under the water. A number of offensive gases are liberated, and the air is thereby contaminated, and rendered to that extent less fit for respiration. Doubtless it is only in the course of nature, that the human body, like every other organised substance, should undergo those changes by which the elements composing them separate from each other, in order to effect new combinations, and serve in their turn to compose other organised structures. While acknowledging this law of continual change, however, it would, I think, be only in accordance with the improved hygiene which is one of the principal characteristics of the present time, to reduce, as far as may be, the unpleasantness and the unhealthiness accompanying these organic reactions. What is known as sanitary science, comprehends in its teachings and purposes, a mitigation of the effects of such chemical reactions. Drainage, sewerage, the removal of refuse and excreta, deodorisation, disinfection, ventilation, all have reference to the lessening of the effects upon the system, of certain gaseous products, and the disease-germs which frequently accompany them. In securing sanitary precautions, the common good has sometimes been obtainable only by over-riding old prejudices, and combating long-cherished but mistaken convictions; and, indeed, the principal obstacles to such improvements, have, for the most part, been represented by a mistaken conservatism. For example, there are still many otherwise excellent and intelligent persons, who regard cold-bathing every day as a rash exposure to serious risk. It is this general prejudice against innovation, coupled with some superstitious regard for the dead bodies of those whom we have known during life, which has operated, and will continue to operate, to prevent any material change being effected in the prevalent mode of disposing of the dead. It is true that the practice of intra-mural interment has been abolished in England in certain localities, and that the mounds of human putrefaction which only quite lately were to be seen in the most populous portions of London and other large cities, are no longer permitted to exist. But the alternative to the narrow old-fashioned churchyard, is only the larger area of the cemetery, and, already, some of these places of sepulture are, by the increase of population, becoming as much enclosed as the old churchyards, and are almost as much crowded with bodies. In this part of the world, we have benefited by the experience of the old country, and, in Victoria at least, there are no such things as churchyards, as we understand the phrase. But, in all other respects, we bury our dead pretty much as they have been buried in the old country for the last 1,500 years. We enclose them in wooden boxes, and lay them in the earth to rot. During the last seven years I have had the opportunity of examining some hundreds of bodies in all stages of decomposition, and I have probably, in studying the phenomena of putrefaction as a part of my professional duty, become so accustomed to the sight of this form of fermentation, that I am now less conscious of the repulsiveness which characterises this chemical process, than those who witness it only occasionally. But I am not the less aware of the extent to which the atmosphere must of necessity be polluted by the gases arising, slowly but surely, through the earth, out of the graves of the thousands of bodies which are annually interred in this large city. I am not going to assert that a foul smell is, of necessity, directly injurious to health. I am aware that many persons whose occupation renders it necessary for them to breathe the gaseous products of putrefaction, enjoy what appears to be good health. Indeed, a gentleman some time ago read a paper before the Royal Society, in which he took considerable pains to show that vile smells were rather salutary than not, and another gentleman, shortly after, made a good point in the course of a forensic address, by relating an anecdote, in which a robust nightman, who had never known nausea before, fainted from suddenly, in the course of his duties, coming upon a stratum of frangipanni. But as we know that sulphuretted and phosphuretted hydrogen gases are very active poisons, even in a diluted form, it is tolerably easy to conclude that, though they may not kill outright when taken into the system in small doses, yet that their continued influence, when breathed during an extended period, must have an operation the reverse of salutary. Besides these gases, however, given out by putrefying bodies, it is tolerably certain that a vast quantity of volatilised matter must be dispersed through the atmosphere during the process, notwithstanding the weight of superincumbent earth. Mr. Walker, a London surgeon, published some 40 years ago a curious book, entitled "Gatherings from Graveyards," in which he showed very conclusively that from the surface of the ground above dead bodies, there was continually arising a miasma possessing distinctly poisonous qualities. Considering the subtle and mysterious properties of disease-germs, it is far from unlikely that many cases of disease, in which the agencies of causation are obscure, derive their origin from infectious particles thus volatilised. Considering, therefore, how serious a deterioration of the atmosphere is likely to take place by the continual passing into it of volatilised portions of the dead that we bury in the earth, I have for some time concluded that it would only be in accordance with the progress of hygienic improvement, to substitute for the slow, dangerous, and loathsome process of putrefactive fermentation, that of rapid decomposition by fire. Cremation is one of the most ancient of the many modes in which the dead have been disposed of, and I need hardly remark that it is still practised in some countries, notably in India, at the present day. Of all the many methods at various times in use, it commends itself, to my thinking, as the most rational. It substitutes for a process which takes months to complete, and which is accompanied by concomitant products of the most disgusting kind, a rapid method whose products do not offend the senses, which do not pollute the air, and which do not therefore endanger the health of the living. By the aid of fire, in the course of an hour or two, a body can be resolved into carbonic acid, watery vapour, and a few ounces of solid residuum; for I need hardly say that the earthy residual portion of a body, forms a very small percentage of the whole mass, which consists mostly of water. I am fully aware that the prejudices of modern society are so strong as to prevent the practical adoption of cremation for many years to come, but I think it will be adopted as an almost necessary part of sanitary ordinances. I do not claim to be original in having now suggested its revival. Professor Polli, of Milan, has lately been strongly advocating its resumption, and, in England, its desirability has latterly been discussed with emphatic approval by several leading social reformers. At Hamburg, I learn that a club has been formed, which is steadily increasing in numbers, the members of which, on entering, make a will, ordering that at their death their remains shall be burned. There is an additional argument in favour of its adoption in the old country, in that grave-yards and cemeteries frequently occupy valuable ground which could be put to much more rational use than to serve as pits of putrefactive foulness. This reason does not so strongly declare itself in Australia, because we might bury our dead in the far interior, where population is not likely to extend for the next century. The only objection would be the expense; and on this point I may take occasion to say that the burning process would, of necessity, be much more economical than any other. I think the useless display frequently made at funerals, for which it is as difficult to account as it is apparently impossible by any sort of reasoning to counteract, is of many unwise customs one of the most unwise. This habit of lavish outlay at funerals, is probably a part of the present system of inhumation, and the revival of cremation might bring with it a simpler, and less costly form of obsequies. The objection to the revival of the process of cremation is, I have no doubt, principally of a sentimental kind. There are attached to the dead a solemnity and a sacredness, which every one almost instinctively confesses, and few things are resented more keenly than any outrage offered to the remains of those whom in life we have loved. This is a feeling which I should be most unwilling to disturb. It is part of the poetry of our nature to visit the tombs of the departed, and to think of them as we knew them in the flesh. This sacredness of the dead has manifested itself at different ages and in different countries, often in curious forms. The Egyptians, as we know, went to great pains and expense in embalming their dead. The Scythians, like some of our aboriginals, made their graves on platforms above the earth. The Icthyophagi, according to that quaint authority, Sir Thomas Browne, consigned their dead to the sea, in exchange for the fish upon which they had lived. The old Baleareans, according to the same authority, "used great urns and much wood, but no fire in their burials, while they bruised the bones and flesh of the dead, crowded them into urns, and laid heaps of wood upon them." The Parsees, to this day, imitate the ancient Persian Magi, and reverently expose their bodies on high towers, where vultures gnaw their flesh and leave the skeletons, which are then carefully preserved. Indeed, the history of funerals would show the most contrary practices, all arising, however, from a genuinely reverent feeling, associated usually, if not always, with religious beliefs. Even the practice of the Battas, who are said to eat their aged and infirm relatives as an act of pious duty, may be so regarded. It is known to all of you, I have no doubt, that the Chinese dying here are frequently exhumed and exported to their native land, in accordance with some belief, I am told, to the effect that their future existence will be jeopardised if they be buried in a foreign country. We are bound to respect all prejudices of this kind, and therefore I would speak with the greatest consideration for the feelings of those who would think it an outrage done to the remains of their relatives to consume them by fire. But I am afraid that very few persons, when they take that last sad kiss before the coffin-lid shuts for ever those loved features from their sight, consider how that face would look if they could see it in a week's time. They go to the grave every day, they place flowers upon it, they lay out a garden over it, and, in other ways, show how tenderly they feel towards the dead relative who lies mouldering beneath. And it is an evidence of their better nature and of the poetry within them to do so. But whenever I see a garland of flowers upon a new-made grave, and some sorrowful mourner dropping hot tears upon it, I always feel shocked to think of the seething mass of putrefaction, upon which these said endearments are bestowed. It is a beautiful thought which Shakspeare puts into the mouth of Laertes, where he makes him say:—

> "Lay her i' the earth,
> And from her fair and unpolluted flesh,
> May violets spring;"

but we know very well that in a few days the "fair Ophelia" will be a terrible thing, at which both Hamlet and Laertes would shudder if they beheld it. I ask, therefore, would it not be better that all that can be preserved of those whom we have so loved in life, should be preserved, so that we might place it where, at any time, we may derive from the contemplation of it, that refined pleasure which comes from sad associations, unmixed with the loathsomeness of corruption ?

And this naturally suggests the subject of urns. The small compass into which the solid residuum remaining after the incineration of the body may be compressed, and its perfectly inorganic character, render it easy to preserve it in an ornamented receptacle, that can be included among those valued relics of domestic interest which every household possesses. Perhaps the superstitious dread of human remains of any kind would, at first, supposing the practice of cremation to be adopted, be sufficient to prevent persons from placing the sepulchral urn among their household treasures ; but there would really be no more occasion for superstitious dread in having a few ounces of phosphate of lime in a sculptured vase, than in keeping a lock of hair in a ring or brooch. And a new branch of art would be revived by the adoption of the practice, and sculpture might thus show itself in unexpected developments of fanciful inventions. The only valid exception which can be taken to the practice of cremation is, that it might prevent those investigations which are sometimes necessary, long after death, for medico-legal purposes. I do no forget that the ends of justice have sometimes been served, by the exhumation of the dead. Crime has often been brought home to the perpetrators, years after its commission, by autopsies conducted upon disinterred bodies, and it may be urged that it would be unwise to deprive society of any means, however remote or infrequent, of bringing offenders to justice. But this objection might be overcome by instituting *post mortem* examinations, in anticipation, in all cases where the least doubt whatever existed, a precaution which now is not taken. If an official inspection were made of all bodies prior to their cremation, perhaps advantages would result which at present are not secured.

Among other objections to cremation it has been urged that it is not necessary, if only bodies are buried sufficiently deeply, so that the evolved gases cannot rise to the surface, but be absorbed by the surrounding earth. I have also been reminded that the dangers from evolved gases have been exaggerated, and that the law of the diffusion of gases, at once effects their dilution to an extent sufficient to render them innocuous. I am by no means clear, however, that any depth would be a complete security against the evolution of the products of putridity, and I think it will be admitted that the very fact of a gas having a foul smell is an indication, our stench-defending friend to the contrary, that there is danger near. The foul smell, in fact, has been well described as "Nature's monitor," a sense-indicator, suggesting danger. Of the risk from contamination of water from buried bodies I apprehend there can be no doubt; and though the old well-system is not so much in favour as it once was, it is quite impossible to say how far a contaminated subterranean water-course will extend, or how long the water will retain its poisonous qualities. I have been asked if filling the coffin with anhydrous lime would not effect the same end as burning, I reply that it would only partially do so. The body would be decomposed indeed, and there would be combinations between the gases, the product acids, and the lime; but a fluid mass would still remain, and it is questionable if, after all, complete disintegration would result. It has been suggested as a more utilitarian mode of effecting rapid decomposition, to transform the body into artificial guano, by means of sulphuric acid, as is now I believe extensively practised upon the bodies of sheep and other animals which cannot be used for food. I have no especial objection to this mode, but I think cremation is cleaner, and is, moreover, a less dangerous process. It is certainly more poetical. One other objection is to the effect that, whereas by the ordinary practice of inhumation, the products of decomposition are all kept below the ground, in cremation they are distributed through the atmosphere. I would remind those who take this exception to the practice, that the products of combustion are principally water and carbonic acid; that the water certainly does no harm, and that carbonic acid is being continually disposed of by vegetation.

To such objections to the proposal, as consist in the reproach that cremation does away with "Christian" burial, and is the adoption of a Pagan practice, I have nothing to say. To decry an improvement because it is the revival of an old custom, takes the objector beyond the range of argument. It was once considered an eminently Christian virtue, entitling him who practised it to the honours of canonisation, to discard the use of soap and water; and this kind of mediæval piety prevails a good deal yet, notwithstanding the revival of the good old Roman practice of ablution. I do not find, however, that even Christian sanitarians object to the more frequent use of the bath because it was a Pagan practice.

In any case it would appear that the advantages of cremation far exceed the objections, and that, practically, the objections might be obviated without material difficulty. I am particularly desirous of not being thought inconsiderate towards the feelings of those to whom this proposition may present itself as a horrible outrage upon the sanctity of the dead. In several cases of murder which have occurred, the atrocity of the crime was considered to be aggravated in consequence of the murderers having got rid of the bodies by burning them. Apart from the crime of having taken the lives of their victims, however, there is not, to my thinking, any augmentation of the offence, in the adoption of this mode of disposing of the body. The first impulse of most murderers, after the commission of the deed, is to allay suspicion against themselves, and the difficulty of getting rid of the body is frequently so great, that they are driven to all sorts of expedients to do this. There is really, however, no more of the horrible in burning than in burying a body. Some years ago, there was a great outcry in London, when it was discovered that the churchwardens who had the control of one of those hideous paddocks for the dead, which, in some instances, rise several feet above the roadway, had resorted to burning, as the only sufficient mode of getting rid of the accumulated contents of the "bone-house." There was a howl of indignation all through the land, at the terrible sacrilege assumed to be thus committed. The truth was, though nobody had the courage to say so, that the churchwardens were somewhat in advance of the time. I am afraid, indeed, that in this, as in some other social questions, we are disposed to judge according to our prejudices, and not in obedience to the suggestions of our reason. For all this, I do not forget that some prejudices are respectable, not because they are reasonable, but on account of their having the sanction of long usage, and in that they are held by persons of whose truthfulness and honesty of purpose there is no sort of question. I am prepared, indeed, for encountering both abuse and ridicule for having brought this subject before the Society, and through it to have drawn the attention of the community generally to it. I do not expect to see the practice of cremation adopted; the old method is too intimately associated with long established custom to make it likely that such an innovation would be received, or even discussed, without some feeling. But, I think that, for reasons of health, convenience, economy, and the encouragement of art, it will one day be the established mode of disposing of the dead, and that the sacredness of the affections will then be in reality much more absolutely respected than they are now by the present system, which dispassionately considered, is revolting to a well-ordered mind, and on sanitary grounds hurtful to the common well-being. The resources now at our command in the way of chemical appliances, by means of which an intense heat can be obtained, would enable us to effect the destruction of a body much more rapidly than by the old-fashioned and clumsy mode of a log fire. The author of a paper in *Fraser's Magazine,* to which my attention has been directed by an esteemed friend, has drawn attention, in advocating the substitution of cremation for inhumation, to the great advantages we possess over the ancients in this particular. It will be admitted, however, that if in a few minutes, by the employment of a very high temperature, we could produce complete incineration, we should avoid those intermediate stages in the process which are occasionally described somewhat sensationally by those who have witnessed the burning of bodies in India.

As to the particular mode by which the process of cremation is to be accomplished, I need hardly speak in detail. Science is now so fertile in resources, that no practical difficulty will be found in this respect. The slow and clumsy method of surrounding a body with logs of wood, and then igniting the pile, may be picturesque and classical enough, but it would not be in accordance with modern improvements. I believe, by a properly-constructed Bunsen's gas-burner, an average body could be reduced to powder in about a quarter of an hour. A gentleman in London lately left his body to the Imperial Gas Company to be consumed in a retort; and a modification of the retort, or something which should combine the kiln, the retort and the reverberatory-furnace, suggests itself. I lately read in one of the scientific journals, the following description of a method proposed by Professor Brunetti of Florence: "The apparatus is a brick furnace, in shape a parallelogram, with ten side openings for regulating the draught. The top is covered with a moveable roof provided with iron shutters. The body to be incinerated is laid on a metallic shelf of moderate thickness hung up by chains, horizontally, in the inside of the furnace. A pile of wood beneath the shelf being ignited, the operation commences. A quantity of gas is soon evolved, and let off through the opening of the shutters. After the escape of the gases, the body catches fire spontaneously, and is completely reduced to a cinder in the course of two hours. When the furnace has cooled, the ashes on the shelf are collected and put into a funereal urn. In one case, a body weighing 104 lbs. was reduced to a weight of 3½ lbs."

Whatever the plan adopted, however, I am quite sure that it would be possible to surround the act itself with all the ceremonial and solemnity, considered necessary in performing the last offices for the dead. The practice of necessity involves a change in the law of the land, which at present forbids the final disposal of bodies except by burial, and it also presupposes a very considerable social change as regards the sentimental aspect of the proposition. The difficulties of making the practice acceptable, are, moreover, increased by the religious complications involved; for I have been told that it is "positively wicked to burn bodies." These difficulties, however, are only such as time and a more intelligent consideration of the subject will remove. I do not, as I have already said, expect to see the practice of cremation made general in my own day; but I think it will eventually commend itself for adoption, and only waits its recognition, just as many other social reforms have had to await theirs.

# PROCEEDINGS.

# 1873.

# PROCEEDINGS.

## ROYAL SOCIETY OF VICTORIA.

### ANNUAL MEETING.

*10th March*, 1873.

The President in the chair. The minutes of the proceedings of the last meeting were read and duly confirmed.

Mr. Wm. Thomson, F.R.C.S.E., was duly elected a member of the Society.

The Secretary read the Report of the Council as follows:—

### Annual Report.

"Your council has great pleasure in reporting that, although Volume X. of the Society's Transactions is not yet quite ready for publication, it is in the printer's hands, and will be issued on or before the May meeting of the Society. Great difficulty has been experienced in collecting the papers, particularly those longest on hand. Several of them were returned to the authors at their desire, for various reasons, but mainly because there was no immediate prospect of their being printed, and it was considered that the Society had scarcely a right to retain them. A few of them are thus unfortunately missing, and even if ultimately recoverable, cannot appear in the forthcoming volume. It is hoped that the number of papers which compose it, and the value of some of them, may compensate to a certain extent for the absence of a few. In the condition, until lately, of the finances of the Society, your council did not feel justified in resuming printing, but the liberality of the present Government—by obtaining a vote of the Legislature for £200 for the purpose—has enabled it to do so. Your council trusts that in future the State grant will be an annual one, and that the Society's "Transactions" will henceforward be published periodically and regularly.

"Besides the papers enumerated in the report of the council presented to the last annual meeting, the following additions to the list have since been made, all of which appear or are noticed in the coming volume. The first on "Patents and their Utilisation," was read by Mr. Thomas Harrison, on the 8th April, 1872, and on the same date Mr. Robert Caldwell read a paper on "Meat-preserving." A third paper was contributed at the same meeting by

Mr. P. Ford, on "Biangular Co-ordinates." On the 13th May Mr. Frederick Poolman read a paper describing an apparatus invented and patented by him in 1863, and called "a self-acting regulator and coal economiser for steam engines." Mr. A. K. Smith also produced and described a valve for fire-plugs in Yan Yean mains. On the 10th June Mr. MacGeorge read some notes on Sirius and his companions, and Mr. Sydney Gibbons read some observations respecting the Cranbourne meteorite, and particulars of an analysis of it made by M. Berthelot. On the 8th July, after the delivery of the president's address, Mr. Gibbons read a short paper on "Yan Yean Water," and Mr. George Foord read some notes on a piece of native copper found at Footscray. On the 12th August, Mr. J. Cosmo Newbery read a paper on the extraction of vegetable oils, and the president exhibited and described Siemen's Universal Galvanometer, for testing telegraphic lines. On the 19th September Mr. George Foord read a paper on "The mechanical assay of quartz." On the 14th October Captain C. J. Perry described his method of verifying a ship's position on a coast where only one object can be seen, either in the day or night, by means of his anti-collision dial. On the 11th November Mr. Rusden read a paper on "The treatment of criminals in relation to science." Mr. O. Pritchard described and exhibited a kaleidograph, and Mr. MacGeorge read a paper on "Matter a mode of motion;" and on the 9th December, Mr. W. T. Deverell read a paper by his brother, Mr. S. R. Deverell, on "Ocean wave power machinery;" and the Rev. Lorimer Fison read one, in which he gave a comparative description of various kinship systems existing in widely separated portions of the globe, and exhibiting striking resemblances.

"A special meeting of the Society was held on the 12th August, after due previous notice, for the purpose of making the following alterations in the 25th and 27th laws. For the last sentence in the 26th law, the following was substituted, viz..—'Members resident in Melbourne, or within 10 miles thereof, may compound for all annual subscriptions of the current and future years by paying £21, and members residing beyond that distance may compound in like manner by paying £10 10s." The word 'ten' also was substituted in the second line of the 25th law for the word 'fifty.'

"The idea having been suggested about the time of the opening of the Exhibition that the Royal Society might more fully fulfil its function, and confer a public benefit by offering facilities to exhibitors to explain the peculiar advantages of their exhibits, three extra meetings of the Society were held on the 18th and 25th of November and 2nd of December last. Twelve exhibitors took advantage of the Society's invitation. On the first evening Mr. Robert Bell described a new printing-press which he had invented and made (No. 945 of the Exhibition catalogue); Mr. Mathews described a piano of his own construction (No. 1,386), and Mr. Pittard a new steelyard (No. 966A). On the second evening, Mr. Joachimi described a machine for preparing tea (No. 1,142); Mr. Sullivan exhibited his disinfectant (No 1,165); Mr. Carter described the manufactures of the Victorian Porcelain Company (Nos. 1,479-99); and Mr. Ainley's force-pump was described (No. 942). On the 2nd December Mr. Rasche described his direct-acting steam battery for quartz-crushing (No. 966); Mr. J. S. Bowman described and gave an example of his method of crayon painting with exclusively colonial materials; he also kindly promised to the Royal Society a crayon painting of Victorian scenery, which has been selected, but is not yet quite completed (Nos. 102-114). Mr. Lambert exhibited colonial caoutchouc stamps (No. 597); Mrs. Timbrell's report on sericulture in Victoria was read (No. 364); and Mr. Joseph described his magneto-electric clock (No. 1141). These extra meetings appeared satisfactorily to meet the design with which they were held, and some of the exhibits well deserved the notice which they obtained.

"The treasurer's balance-sheet is as follows:—

## Dr. *The Hon. Treasurer in Account with the Royal Society of Victoria.* Cr.

JANUARY 31, 1872.

| Dr. | | £ s. d. |
|---|---|---|
| To balance from last balance-sheet | | 13 17 0 |
| ,, Medical Society, rent | | 21 6 8 |
| ,, Eclectic Society, do. | | 4 14 0 |
| ,, grant from Government | | 200 0 0 |
| ,, 12 entrance fees | | 25 4 0 |
| ,, subscriptions— | | |
| 1 for 1868 | £2 2 0 | |
| 2 for 1869 | 4 4 0 | |
| 5 for 1870—4 Ordinary, 1 Country | 9 9 0 | |
| $14\frac{1}{4}$ for 1871—10 ,, $4\frac{1}{4}$ ,, | 25 14 6 | |
| $51\frac{1}{4}$ for 1872—45 ,, $4\frac{1}{2}$ ,, | 99 4 6 | |
| 1 for 1873 | 2 2 0 | |
| | | 142 16 0 |
| | | £407 17 8 |

| Cr. | £ s. d. |
|---|---|
| By gas, rates, insurance, &c. | 11 13 5 |
| ,, petty cash | 20 0 0 |
| ,, gate, A. K. Smith | 4 12 0 |
| ,, printing, Stillwell and Knight | 50 0 0 |
| ,, messenger | 3 0 0 |
| ,, refreshments, Norris, conversazione | 8 3 6 |
| ,, five debentures paid | 25 0 0 |
| ,, chairs, Rocke and Co. | 3 12 0 |
| ,, timber, Perry | 1 10 0 |
| ,, gasfitting, White | 5 12 11 |
| ,, plants, Moyes | 1 14 0 |
| ,, ballot-box, Swanson | 2 1 0 |
| ,, commission collector | 16 13 0 |
| ,, interest on debentures | 47 0 7 |
| ,, balance | 207 5 3 |
| | £407 17 8 |

Examined and found correct, (Signed) JOSEPH BOSISTO, P. DE J. GRUT, } Auditors.

Dr. | Cr.

**ASSETS.**

| | £ | s. | d. |
|---|---|---|---|
| Balance | 207 | 5 | 3 |
| Subsbriptions due— | | | |
| 23 ordinary, 1872 | 48 | 6 | 0 |
| 6 country, do. | 6 | 6 | 0 |
| 4½ ordinary, 1871 | 9 | 9 | 0 |
| 3 country, do. | 3 | 3 | 0 |
| 1 ordinary, 1870 | 2 | 2 | 0 |
| 1 country, do. | 1 | 1 | 0 |
| 1 country, 1869 | 1 | 1 | 0 |
| 1 entrance fee, 1872 | 2 | 2 | 0 |
| 1 entrance fee, 1871 | 2 | 2 | 0 |
| Eclectic Society | 9 | 5 | 0 |
| Medical Society | 21 | 0 | 0 |
| Pharmaceutical Society | 2 | 10 | 0 |
| Hall Furniture, &c., Insured for | 2,000 | 0 | 0 |
| | £2,315 | 12 | 3 |

**LIABILITIES.**

| | £ | s. | d. |
|---|---|---|---|
| 113 Debentures, 1879 | 565 | 0 | 0 |
| Interest unclaimed | 21 | 16 | 6 |
| Printing account (old) | 56 | 11 | 6 |
| ,, ,, (current) | 17 | 5 | 6 |
| Charges on Books | 1 | 1 | 0 |
| Rates, &c. | 2 | 10 | 0 |
| Balance | 1,651 | 7 | 9 |
| | £2,315 | 12 | 3 |

**WAYS AND MEANS.**

| | £ | s. | d. |
|---|---|---|---|
| Balance in bank | 207 | 5 | 3 |
| Subscriptions due from previous years | 50 | 0 | 0 |
| New subscriptions and entrance fees | 36 | 15 | 0 |
| Seventy subscriptions for 1873 | 147 | 0 | 0 |
| Letting Hall | 30 | 0 | 0 |
| State grant | 200 | 0 | 0 |
| | £671 | 0 | 3 |

**ESTIMATED EXPENDITURE.**

| | £ | s. | d. |
|---|---|---|---|
| Interest on 113 debentures, £47 9s. 2d. ; arrears, 21 16s. 6d. | 69 | 5 | 8 |
| Lodgekeeper | 6 | 0 | 0 |
| Insurance, &c. | 12 | 0 | 0 |
| Conversazione, &c. | 10 | 0 | 0 |
| Printing account (old) | 73 | 17 | 0 |
| ,, ,, (1873) | 110 | 0 | 0 |
| ,, ,, (current) | 20 | 0 | 0 |
| Petty cash | 20 | 0 | 0 |
| Debentures paid off | 300 | 0 | 0 |
| Balance | 49 | 17 | 7 |
| | £671 | 0 | 3 |

"Your council is gratified at being enabled to submit a more satisfactory statement of account than has been possible for some years past. The sum shown as received for subscriptions is larger than for late years, and more than double the amount of the arrears for which the last council took credit as ways and means has been paid up. Nearly £60 also was received for new subscriptions and entrance fees, instead of £36 15s. as estimated. The estimate of ways and means for 1873 has been framed upon the same cautious principles. The subscriptions are estimated at less than the amount that may reasonably be expected, and £48 6s. due for past years has been left out of the account. Five debentures have been paid off during 1872, and the estimate of expenditure for 1873 contains a suggestion for the payment of a larger number (60). Your council believes itself justified in reckoning upon the annual renewal of the State grant already mentioned as received, and has therefore included a sum of £200, which it would suggest should be solicited. Your council may add that, since the construction of the balance-sheet, £73 17s. has been paid to the printers, and another trifling liability has been discharged: while £18 11s. 4d. has been received on account of subscriptions and rent of the hall. This reduces the actual balance to the credit of the Society to £147 18s. 7d. Twelve new members have been elected during the year."

On the motion of Mr. A. K. Smith, seconded by Mr. E. Howitt, the report and balance-sheet were adopted.

## Election of Office-bearers.

The following office-bearers were elected without opposition:—President, Mr. R. L. J. Ellery; treasurer, Mr. R. Willan; secretary, Mr. H. K. Rusden; librarian, Dr. Neild. A ballot was taken for the remaining office-bearers, with the following result:—Vice-presidents, Professor Wilson and Mr. A. K. Smith; members of Council, Messrs J. Flannagan, S. W. M'Gowan, F. Poolman, E. Howitt, J. Marshall, J. T. Rudall, and E. J. White.

It was announced that a vacancy in the council had been created by the resignation of Baron von Mueller.

## Report of the Honorary Librarian.

The following report was read:—I have the honour to report that during the past year there have been received the following volumes and numbers of publications by the Royal Society:—151 English, 48 colonial (Australian, including N.Z.), 20 Indian, 18 American, 101 German, 31 French, 4 Italian, 2 Russian, 7 Swedish, 3 Dutch; total, 385. These represent about 60 separate publications. In nearly all the serial publications there are breaks of greater or less extent, whether from neglect on the part of the various scientific bodies, or from defect in the postal arrangements, I am unable to say. I have to apologise to the society for not having completed a catalogue up to the present time, but I will take the earliest opportunity of doing so. JAMES EDWARD NEILD, M.D., Hon. Librarian.

The proceedings then terminated.

(Signed),

R. L. J. ELLERY, ESQ.,
*President.*

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## ORDINARY MEETING.

*Wednesday, 14th May,* 1873.

The President, R. L. J. Ellery, Esq., in the chair.

The President announced that His Excellency the Governor had kindly acceded to the request of the council that he would accept the office of Patron to the Society.

The Librarian acknowledged the receipt of the following publications :—" Nature," Nos. 164 to 175 ; " New Theory of the Figure of the Earth, by Wm. O'Gilby, Esq. ; " Catalogue of Photographs in the British Museum ;" " Journal of the Royal Dublin Society," No. 2, vol. 6 ; " Reports of Geological Explorations," by James Hector, M.D. ; " Seventh Annual Report of the Colonial Museum and Laboratory, New Zealand ;" " Monthly Record of the Melbourne Observatory for January and February ; " Statistics of the Colony of Victoria," Part VIII. ; Annuaire de l'Academie Royale de Belgique, 1870 ;" Bulletins de l'Academie Royale de Belgique, 1869," T. 27 and 28 ; " Annales Meteorologique de l'Observatoire Royale de Belgique, 1869 ;" " Cosmos di Guido Cora, Torino, 1873 ;" " Die Aufgabe des Chemischen Unterrichts, von Dr. Emil Erlenmeyer ;" " Abhandlungen, der Mathematisch-Physikalischen Classe, München, 1871 ;" " Die Erdgeschichte odor Geologie, von Robert Grassman ;" " Sitzungsberichte der Königl bayer Akademie der Wissenchaften zer München, 1869 to 1871 "—8 Nos. ; " Verhandlungen des Naturhistorisch-Medicinischen Vereins zer Heidelberg, 1872 ;" " Almanach der Königl-bayerischen Akademie der Wissenschaften, 1871 ;" " Memoirs de la Société Royale des Antiquaires du Nord, 1871-2 ;" " Pamphlet on Australian Kinship," by L. H. Morgan, presented by Rev. L. Fison ;" " Catalogue of the Described Coleoptera of Australia," by Mr. George Masters," presented by Mr. French, 4 parts. Totals — English, 12 ; Colonial, 9 ; German, 13 ; Belgian, 4 ; Italian, 1 ; Swedish, 1 ; American, 1.

Mr. A. K. Smith then read a paper on " The Storm Waters of Elizabeth and Swanston streets, Melbourne, and how to prevent them." See *Transactions*, Art. No. i.)

Discussion followed.

(Signed) R. L. J. ELLERY.

## Conversazione,

Held in the Hall on Friday, the 8th August.

The President read his inaugural address at eight o'clock.

Professor Wilson afterwards gave some illustrations of the meaning of the words " Electric Potential," and Mr. George Foord read a short paper on " Palladium."

Some fine crayon paintings were exhibited by Mr. J. S. Bowman, and a collection of remarkable coleoptera, by Mr. French.

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## Ordinary (Social) Meeting.

*Monday, 15th September,* 1873.

The President, R. L. J. Ellery, Esq., in the Chair.

The President first explained that it was intended to give a less formal character to the proceedings, in order to make them more popular, and then submitted some observations on the subject of lightning and lightning conductors. (See *Transactions,* Art. No. iv.)

Discussion ensued.

(Signed) R. L. J. Ellery.

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## Ordinary Meeting.

*Monday, 13th October* 1873.

The President, R. L. J. Ellery, Esq., in the chair.

The President called attention to a fine picture (Victorian crayons) of Mount Kosciusko, presented to the Society by the artist, Mr. J. S. Bowman.

Professor Wilson moved, and Mr. Foord seconded a vote of thanks to Mr. Bowman, which was carried unanimously, and the Secretary was desired to inform Mr. Bowman accordingly.

The following gentlemen were then elected members of the Society :—The Rev. H. P. Kane, and Messrs. T. B. Muntz, John Noone, and W. H. Steele.

Mr. Sydney Gibbons read a paper on " A Contaminated Water Supply."

Discussion followed, in which Messrs. Foord and White, and Professor Wilson took part.

The President exhibited and explained an instrument called " Eckhold's Omnimeter ;" and a machine for lighting gas burners was exhibited by Messrs. Scott and Cool.

The President also read a paper contributed by Robert Etheredge, Esq., on a new species of " Retepora," found on Tertiary deposits near Schnapper Point. (See *Transactions,* Art. No. vii.)

(Signed) R. L. J. Ellery.

ORDINARY (SOCIAL) MEETING.

*Monday,* 10*th November,* 1873.

The President, R. L. J. Ellery, Esq., in the chair.

The following gentlemen were elected members of Society :—Messrs. F. J. Pirani and A. M. Henderson.

The President announced the names of the officers of the Society who retire at the end of the session, namely : — President, R. L. J. Ellery, Esq. ; Vice-Presidents, A. K. Smith, Esq., and Professor Wilson ; Treasurer, R. Willan, Esq. ; Secretary, H. K. Rusden, Esq. ; Librarian, Dr. J. E. Neild.

Members of Council : — Dr. Barker, J. Bosisto, Esq. ; George Foord, Esq., The Rev. Wm. Kelly, G. H. F. Ulrich, Esq., and J. Flannagan, Esq.

The members who retain their office being—E. Howitt, J. Marshall, S. W. McGowan, Fredk. Poolman, J. T. Rudall, and E. J. White, Esqrs.

The Librarian read the following list of donations and publications received since the last meeting of the Society :—" Catalogue of the Marine Mollusca of New Zealand," F. W. Hutton, 1873 ; " Jahres-Bericht des Frankfurter Vereins fur Geographie und Statistik, 1871-2 ; " Report of Progress of Geological Survey of Canada," 1871-2 ; " Transactions and Proceedings of New Zealand Institute," Vol. V. ; " Transactions of the Royal Society of New South Wales," 1871 ; " Transactions of the Royal Scottish Society of Arts," Vol. VIII., Parts 3 and 4 ; Monatsbericht der K. P. Akademie der Wissenchaften zu Berlin, November and December, 1872 ; " Australian School Review," Vol. 1, No. 1 ; " Bernard Quaritch's list of valuable books," 1873, No. 12 ; " Cosmos," No. 2, 1873 ; " Jahres-Bericht der Deutschen Scewarte," 1872 ; " Nature," Nos. 176 to 191 (No. 181 missing) ; " Natural History and Scientific Book Circular," No. 6 ; Monthly Notices of Meteorological Society of Mauritius," October 1872, and February 1873 ; " Proceedings of the Zoological and Acclimatisation Society," Vol. II., 1873 ; " Proceedings of the Royal Geographical Society," Vol. XVI., No. 2 ; " Quarterly Journal of the Geological Society," Vol. XXIX., No. 114 ; " Mittheilungen der Deutschen Gesellschaft fur Natur und Volkerkunde Ostasiens (1st part), May 1873 ; " Statistics of the Colony of Victoria," 1872, Part 3 ; " Journal of the Statistical Society," December, 1872 ; " Proceedings of the Royal Society of Edinburgh," 1871-2 ; " Transactions and Proceedings of the Botanical Society," 14 parts ; " Proceedings of the Royal Society," No. 130 to 137 ; " Bye-laws of Institute of Civil Engineers," 1873 ; " Transactions of the Institute of Naval Architects," 1872 ; " Twentieth Report of Liverpool Free Public Library," " Nature," Nos, 192 to 195 ; " Journal of Applied Science," Nos. 36 to 41 ; " Monthly Record of Observations at Melbourne Observatory," March and April: "Statistics of the Colony of Victoria, Accumulation;" "Bulletin de la Societé Imperial des Naturalistes de Moscow," 1872; Notices de l'Academie Royale de Belgique pour 1873;" "Annuaire de l'Academie Royale de Belgique," 1872-3; Bulletins de l'Academie Royale de Belgique, 1871-2; "Centieme Anniversaire de Fondation de l'Academie Royale de Belgique," t. 2; "Annales Meteorologiques de l'Observatoire Royale de Bruxelles," 1871; "Tables de Mortalité par A Quetelet, Jahresbericht des Frankfurter Vereins, 1870-1; "Beitrege zur Statistik der Stadt Frankfurt am Main," 1871; "Jahrbuch der Kaiserlich-Königlichen, 1872, 2 Nos.; "General Register," do.; "Verhandlungen," do.; "Notizblatt des Vereins fur Erdkunde," 1871-2; "Transactions of the Royal Academy of Sweden," 9 Nos.

The President presented a paper from Mr. E. K. Horne, of Adelaide, in which he proposed a method of finding Greenwich time and longitude, whereby any error in the observations may be at once and exactly known.

Mr. E. J. White shewed the general inutility of the proposal.

The President then read some suggestions for the construction and erection of lightning conductors. (See *Transactions*, No. iv.)

The President reported the receipt of a letter from W. C. Kernot, Esq., stating that fifteen gentlemen had held a meeting, and formed section A, for the prosecution of Physical, Astronomical, and Mechanical Science and Engineering, and that officers had been appointed provisionally, pendiug the elections in March next.

The consideration of Mr. A. K. Smith's paper on the Embankment on the South bank of the Yarra was postponed till the 18th.

(Signed) R. L. J. Ellery.

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### Adjourned Meeting.

*Tuesday*, 18*th November*, 1873.

The President, R. L. J. Ellery, Esq., in the chair.

Mr. A. K. Smith read his paper on the new embankment on the south side of the Yarra. (See *Transactions*, Art. No. ix.)

Discussion ensued.

(Signed) R. L. J. Ellery.

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### Ordinary Meeting,

*Monday*, 8*th December*, 1873.

The President, R. L. J. Ellery, Esq., in the chair.

Messrs. P. de J. Grut and J. Bosisto were elected auditors for the year.

The following nominations of officers for 1874 were made :—

*President :*

R. L. J. Ellery, Esq.

*Vice-Presidents :*

G. Foord, Esq.
A. K. Smith, Esq.
Professor Wilson.

*Treasurer :*

P. de J. Grut, Esq.

*Secretary :*

F. J. Pirani, Esq.

*Librarian :*

Dr. J. E. Neild.

*Members of Council :*

Dr. Barker.
James Duerdin, Esq.
Rev. H. P. Kane.
T. E. Rawlinson, Esq.
Dr. H. C. Wigg.
J. Bosisto, Esq.
J. Flannagan, Esq.
J. C. Newbery, Esq.
H. K. Rusden, Esq.
Wm. Thomson, Esq.

For ballot on the 9th March next, 1874.

Mr. A. K. Smith revived the discussion upon his paper on "The Embankment of the Yarra."

Discussion followed, in which Messrs. Rawlinson, Kernot, Joachimi, E. J. White, and the President took part.

Dr. Neild then read a paper on "The Advantages of Burning the Dead."

Discussion ensued, in which Messrs. Gibbons, White, Pirani, Rusden, Smith, and the President took part, and in which the proposition was favourably received.

(Signed) R. L. J. Ellery, President.

# LAWS.

Name. I. The Society shall be called "The Royal Society of Victoria."

Objects. II. The Royal Society of Victoria is founded for the advancement of science, literature, and art, with especial reference to the development of the resources of the country.

Members and Honorary Members. III. The Royal Society of Victoria shall consist of Members and Honorary Members, all of whom shall be elected by ballot.

Patron. IV. His Excellency the Governor of Victoria, for the time being, shall be requested to be the Patron of the Society.

Officers. V. There shall be a President, and two Vice-Presidents, who, with twelve other Members, and the following Honorary Officers, viz.: Treasurer, Librarian, and Secretary of the Society, shall constitute the Council.

Management. VI. The Council shall have the management of the affairs of the Society.

Ordinary Meetings. VII. The ordinary meetings of the Society shall be held on the second Monday of each month during the Session, from March to December inclusive, subject to alteration by the Council with due notice.

General and Anniversary Meetings. VIII. In the second week in March there shall be a General Meeting, to receive the report of the Council and elect the Officers of the Society for the ensuing year.

Retirement of Officers. IX. All Office Bearers and Members of Council, except the six junior or last elected ordinary Members, shall retire from office annually at the General Meeting in March. The names of such Retiring Officers are to be announced at the ordinary meetings in November and December. The officers and members of Council so retiring shall be eligible for the same or any other office then vacant.

X. The President, Vice-Presidents, Treasurer, Secretary, and Librarian, shall be separately elected by ballot (should such be demanded), in the above-named order, and the six vacancies in the Council shall then be filled up together by ballot at the General Meeting in March. Those members only shall be eligible for any office who have been proposed and seconded at the Ordinary Meeting in December, or by letter addressed to the Secretary, and received by him before the 1st March, to be laid before the Council Meeting next before the Annual Meeting in March. The nomination to any one office shall be held a nomination to any office the election to which is to be subsequently held. And such ballot shall take place prior to the ordinary business of the meeting. **Election of Officers.**

XI. No Member whose subscription is in arrear shall take part in the election of Officers or other bnsiness of the meeting. **Members in arrear.**

XII. An Address shall be delivered by the President of the Society at either a Dinner, Conversazione, or extra meeting of the Society, as the Council for the time being may determine, not later than the ordinary meeting in June in each year. **Inaugural Address by the President.**

XIII. If any vacancy occur among the Officers, notice thereof shall be inserted in the summons for the next Meeting of the Society, and the vacancy shall be then filled up by ballot. **Vacancies.**

XIV. The President shall take the chair at all meetings of the Society, and of the Council, and shall regulate and keep order in all their proceedings; he shall state questions and propositions to the meeting, and report the result of ballots, and carry into effect the regulations of the Society. In the absence of the President the chair shall be taken by one of the Vice-Presidents, Treasurer, or ordinary member of Council, in order of seniority. **Duties of President.**

XV. The Treasurer may, immediately after his election, appoint a Collector (to act during pleasure), subject to the approval of the Council at its next meeting. The duty of the Collector shall be to issue the Treasurer's notices and collect subscriptions. The **Duties of Treasurer.**

Treasurer shall receive all moneys paid to the Society, and shall deposit the same before the end of each month in the Bank approved by the Council, to the credit of an account opened in the name of the Royal Society of Victoria. The Treasurer shall make all payments ordered by the Council, on receiving a written authority from the chairman of the meeting. All cheques shall be signed by himself, and countersigned by the Secretary. No payments shall be made except by cheque, and on the authority of the Council. He shall keep a detailed account of all receipts and expenditure, present a report of the same at each Council Meeting, and prepare a balance sheet to be laid before the Council, and included in their Annual Report. He shall also produce his books whenever called on by the Council.

Duties of Secretary.

XVI. The Secretary shall conduct the correspondence of the Society and of the Council, attend all meetings of the Society and of the Council, take minutes of their proceedings, and enter them in the proper books. He shall inscribe the names and addresses of all members in a book to be keep for that purpose, from which no name shall be erased except by order of the Council. He shall issue notices of all meetings of the Society and of the Council, and shall have the custody of all papers of the Society, and under the direction of the Council, superintend the printing of the Transactions of the Society.

Meetings of Council.

XVII. The Council shall meet on any day within one week before every ordinary meeting of the Society. Notice of such meeting shall be sent to every Member at least two days previously. No business shall be transacted at any meeting of the Council unless five Members be present. Any Member of Council absenting himself from three consecutive meetings of Council, without satisfactory explanation in writing, shall be considered to have vacated his office, and the election of a member to fill his place shall be proceeded with at the next ordinary meeting of members, in accordance with Rule XIII.

Special Meetings of Council.

XVIII. The Secretary shall call a Special Meeting of Council on the authority of the President or of three Members of Council. The notice of such meeting shall specify the object for which it is called, and no other business shall be entertained.

XIX. The Council shall call a Special Meeting of the Society, on receiving a requisition in writing signed by twenty-four Members of the Society, specifying the purpose for which the meeting is required, or upon a resolution of its own. No other business shall be entertained at such meeting. Notice of such meeting, and the purpose for which it is summoned, shall be sent to every Member at least ten days before the meeting. Special General Meetings.

XX. The Council shall annually prepare a Report of the Proceedings of the Society during the past year, embodying the balance-sheet, duly audited by two Auditors to be appointed for the year at the Ordinary Meeting in December, exhibiting a statement of the present position of the Society. This Report shall be laid before the Society at the Annual Meeting in March. No paper shall be read at this meeting. Annual Report.

XXI. If it shall come to the knowledge of the Council that the conduct of an officer or a member is injurious to the character of the Society, and if two-thirds of the Council present shall be satisfied, after opportunity of defence has been afforded to him that such is the case, it may call upon him to resign, and shall have the power to expel him from the Society, or remove him from any office therein at its discretion. In every case all proceedings shall be entered upon the minutes. Expulsion of Members.

XXII. Every candidate for membership shall be proposed and seconded by Members of the Society. The name, the address, and the occupation of every candidate, with the names of his proposer and of his seconder, shall be communicated in writing to the Secretary, and shall be read at a Meeting of Council, and also at the following Meeting of the Society, and the ballot shall take place at the next following ordinary meeting of the Society. When the number of votes in favour of any candidate shall be five times the number of those against him, he shall be declared duly elected, and not otherwise. Election of Members.

Members shall sign Laws.

XXIII. Every newly-elected member shall, at the first meeting of the Society at which he may be present, sign a declaration, in a book provided for that purpose, that he will observe the laws of the Society.

Honorary Members.

XXIV. Gentlemen not resident in Victoria, who are distinguished for their attainments in science, literature, or art, may be proposed for election as Honorary Members, on the recommendation of an absolute majority of the Council. The election shall be conducted in the same manner as that of ordinary Members, but nine-tenths of the votes must be in favour of the candidate.

Subscriptions.

XXV. Members of the Society, resident in Melbourne, or within ten miles thereof, shall pay two guineas annually, and Members residing beyond that distance shall pay one guinea annually. The subscriptions shall be due on the 1st of January in every year, and notice thereof shall be sent to every Member during the preceding December. At the commencement of each year there shall be hung up in the Hall of the Society a list of Members, upon which the payments of their subscriptions as made by Members shall be entered. On and after the 1st of July, fresh notice shall be sent to Members still in arrears. At the end of each year a list of names of such Members as have not then paid their subscriptions shall be prepared and submitted for the consideration of the Council, and hung in the Hall of the Society.

Entrance Fee, &c.

XXVI. Newly-elected Members shall pay an entance-fee of two guineas, in addition to the subscription for the current year. Those elected after the 1st of July shall pay only half of the subscription for the current year. If the entrance-fee and subscription be not paid within one month of the notification of election, a second notice shall be sent, and if payment be not paid within one month from the second notice, the election shall be void. Members resident in Melbourne or within ten miles thereof, may compound for all Annual Subscriptions of the current and future years by paying £21; and members residing beyond that distance may compound in like manner by paying £10 10s.

XXVII. At the ordinary meetings of the Society the chair shall be taken punctually at eight o'clock, and shall be vacated not later than half-past ten o'clock. Duration of Meetings.

XXVIII. At the ordinary meetings business shall be transacted in the following order, unless it be specially decided otherwise by the Chairman: Order and mode of conducting the business.

Minutes of the preceding meeting to be read, amended if incorrect, and confirmed.

New Members to enrol their names, and be introduced.

Ballot for the election of new Members.

Vacancies among Officers, if any, to be filled up.

Business arising out of the minutes.

Cummunications from the Council.

Presents to be laid on the table, and acknowledged.

Motions, of which notice has been given, to be considered. Notices of motion for the next meeting to be given in, and read by the Secretary.

Papers to be read.

XXIX. No stranger shall speak at a meeting of the Society, unless specially invited to do so by the Chairman. Strangers.

XXX. No papers shall be read, or business entertained, at any meeting which has not been previously notified to the Council. What business may be transacted.

XXXI. The Council may call additional meetings whenever it may be deemed necessary. Additional Meetings.

XXXII. Every Member may introduce two visitors to the meetings of the Society by orders signed by himself. Visitors.

XXXIII. Members shall have the privilege of reading before the Society accounts of experiments, observations, and researches conducted by themselves, or original papers, on subjects within the scope of the Society, or descriptions of recent discoveries, or inventions of general scientific interest. No vote of thanks to any Member for his paper shall be proposed. Members may read papers.

Or depute other Members.

XXXIV. If a Member be unable to attend for the purpose of reading his paper, he may delegate to any Member of the Society the reading thereof, and his right of reply.

Members must give notice of their papers.

XXXV. Any Member desirous of reading a paper shall give in writing to the Secretary, ten days before the Meeting at which he desires it to be read, its title and the time its reading will occupy.

The Secretary shall lay this communication before the Council at its next meeting. Papers shall be read in the order in which such notices are received by the Secretary.

Papers by strangers.

XXXVI. The Council may permit a paper of a nature similar to the above, not written by a Member of the Society, to be read, if for any special reason it shall be deemed desirable.

Papers shall be the property of the Society.

XXXVII. Every paper read before the Society shall be the property thereof, and immediately after it has been read shall be delivered to the Secretary, and shall remain in his custody.

Papers must be original.

XXXVIII. No paper shall be published in the Transactions unless approved by the Council, and unless it consist mainly of original matter as regards the facts or the theories enunciated.

Council may refer papers to Members.

XXXIX. Should the Council feel a difficulty in deciding on the publication of a paper, the Council may refer it to any Member or Members of the Society, who shall report on the same.

Rejected papers to be returned.

XL. Should the Council decide not to publish a paper, it shall be at once returned to the author.

Members may have copies of their papers

XLI. The author of any paper which the Council has decided to publish in the Transactions may have any number of copies of his paper, on giving notice of his wish in writing to the Secretary, with his paper, and on paying the extra cost of such copies.

Members to have copies of Transactions.

XLII. Every member whose subscription is not in arrear, and every honorary member, is entitled to receive one copy of the Transactions of the Society as published. Newly-elected members shall, on payment of their entrance-fee and subscription, receive a copy of the volume of the Transactions last published.

XLIII. Every book, pamphlet, model, plan, drawing, specimen, preparation, or collection presented to or purchased by the Society, shall be kept in the house of the Society. Property.

XLIV. The Library shall be open to members of the Society and the public at such times and under such regulations as the Council may deem fit. Museum.

XLV. The legal ownership of the property of the Society is vested in the President, the Vice-Presidents, and the Treasurer for the time being, in trust for the use of the Society; but the Council shall have full control over the expenditure of the funds and management of the property of the Society. Legal ownership of property.

XLVI. Every Committee appointed by the Society shall at its first meeting elect a Chairman, who shall subsequently convene the Committee and bring up its report. He shall also obtain from the Treasurer such grants as may have been voted for the purposes of the Committee. Committees elect Chairman.

XLVII. All Committees and individuals to whom any work has been assigned by the Society shall present to the Council, not later than the 1st November in each year, a report of the progress which has been made; and, in cases where grants of money for scientific purposes have been entrusted to them, a statement of the sums which have been expended, and the balance of each grant which remains unexpended. Every Committee shall cease to exist on the 1st November, unless re-appointed. Report before November 1st.

XLVIII. Grants of pecuniary aid for scientific purposes from the funds of the Society shall expire on the 1st November next following, unless it shall appear by a report that the recommendations on which they were granted have been acted on, or a continuation of them be ordered by the Council. Grants expire.

XLIX. In grants of money to Committees and individuals, the Society shall not pay any personal expenses which may be incurred by the members. Personal expenses not to be paid.

L. No new law, or alteration or repeal of an existing law, shall be made except at the General Meeting in Alteration of Laws.

March, or at a Special General Meeting summoned for the purpose, as provided in Law XIX., and in pursuance of notice given at the preceding ordinary meeting of the Society.

Cases not provided for.

LI. Should any circumstance arise not provided for in these laws, the Council is empowered to act as may seem to be best for the interests of the Society.

Sections.

LII. In order that the members of the Society prosecuting particular departments of science may have opportunities of meeting and working together with fewer formal restraints than are necessary at the ordinary meetings of the Society, Sections may be established.

Names and number of Sections.

LIII. Sections may be established for the following departments, viz. :—

Section A. Physical, Astronomical, and Mechanical Science, including Engineering.

Section B. Chemistry, Mineralogy, and Metallurgy.

Section C. Natural History and Geology.

Section D. The Microscope and its applications.

Section E. Geography and Ethnology.

Section F. Social Science and Statistics.

Section G. Literature and the Fine Arts, including Arthitecture.

Section H. Medical Science, including Physiology and Pathology.

Meetings of Sections.

LIV. The meetings of the Sections shall be for scientific objects only.

Members of Sections.

LV. There shall be no membership of the Sections as distinguished from the membership of the Society.

Officers of Sections.

LVI. There shall be for each Section a Chairman to preside at the meetings, and Secretary to keep minutes of the proceedings, who shall jointly prepare and forward to the Secretary of the Society, prior to the 1st of November in each year, a report of the Proceedings of the Section during that year, and such report shall be submitted to the Council.

LVII. The Chairman and the Secretary of each Section shall be appointed at the first meeting of the Council after its election in March, in the first instance from members of the Society who shall have signified to the Secretary their willingness to undertake these offices, and subsequently from such as are recommended by the Section as fit and willing. Mode of appointment of officers of Sections.

LVIII. The first meeting of each Section in the year shall be fixed by the Council, subsequently the Section shall arrange its own days and hours of meeting provided these be at fixed intervals. Times of meetings of Sections.

# MEMBERS

OF

# The Royal Society of Victoria.

Allan, Alex. C., Esq., The Observatory

Barker, Edw., Esq., M.D., F.R.C.S., Latrobe-street East, Melbourne
Barnes, Benjamin, Esq., Rosslyn-street, West Melbourne
Barton, Robert, Esq., F.C.S., Royal Mint
Beaney, J. G., Esq., F.R.C.S. Ed., Collins-street East, Melbourne
Bear, J. P., Hon., M.L C., Brighton
Blair, John, Esq., L.R.C.S., M.B. Syd., Collins-st East, Melbourne
Bland, R. H., Esq., Clunes
Bone, William, M.D., Castlemaine
Bonwick, James, Esq., F.R.G.S., St. Kilda
Brown, Edwin, Esq., C.E., Camberwell
Brown, H. J., Esq., 33 Victoria Parade, Melbourne
Brown, H. Y. L., Esq., Yorick Club, Collins-street, Melbourne
Burrows, Thos., Esq., Burwood-road, Hawthorn

Casey, C. G., Esq., M.R.C.S.E., Timperley Lodge, Brighton
Caselli, H. R., Esq., Ballarat
Clarke, Wm., Esq., Elizabeth-street, Melbourne
Comber, P. F., Esq., Royal Mint
Cook, W. Mansfield, Esq., Crown Lands Office, Melbourne

Danks, John, Esq., Bourke-street West, Melbourne
Dixon, S. E., Esq., Education Office, Melbourne
Duerdin, James, Esq., LL.B., Yorick Club, Collins-street East, Melbourne

Ellery, R. L. J., Esq., F.R.S., F.R.A.S., The Observatory

Fitzpatrick, Rev. J., D.D., St. Patrick's College, Melbourne
Foord, George, Esq., F.C.S., Royal Mint

Gilbert, J. E., Esq., The Observatory
Goold, J. A., D.D., Right Rev. Bishop, St. Patrick's College, Melbourne
Groves, G. W., Esq., Crown Lands Office, Melbourne
Grut, P. de J., Esq., E. S. and A. C. Bank, Gertrude-street, Fitzroy

Haddon, F. W., Esq., *The Argus* Office, Melbourne
Harrison, Thomas, Esq., Registrar-General's Office
Henderson, A. M., Esq., Reed and Barnes, 3 Elizabeth-street
Henderson, J. B., Esq., Sandhurst
Higinbotham, T., Esq , C.E., Engineer-in-Chief, Railway Department
Howitt, E., Esq., Yorick Club, Collins-street East
Hope, A., Esq., Greville-street, Prahran
Hopkins, D. M., Esq., Eaglehawk, Sandhurst
Hunt, Robert, Esq., Royal Mint

Irving, M. H., Esq., M.A., Wesley College, St. Kilda Road

Kane, H. P., Rev. M.A., Darling-street, South Yarra
Kelly, William, Rev. S. J., St. Patrick's College, Melbourne
Kennedy, Daniel, Esq., McKenzie-street, Sandhurst
Keogh, L. L., Esq., 20 Market-street, Melbourne
Kernot, W. C., Esq., M.A., Mining Department

Lewis, George, Esq., Collins-street East, Melbourne
Linacre, A., Esq., Lygon-street, Carlton
Lynch, William, Esq., Collins-street West, Melbourne

McCoy, F., Professor, F.G.S., University, Melbourne
McGillivray, P. H., Esq., M.A., M.R.C.S., Sandhurst
McGowan, S. W., Esq , General Post Office, Melbourne
Manton, C. A., Esq., The Treasury, Melbourne
Marshall, John, Esq., M.A., Hotham
Miller, F. B., Esq., F.C.S., Royal Mint
Moerlin, C., Esq., The Observatory, Melbourne
Morrison, R., Esq., M.A., Scotch College, Melbourne
Moors, Henry, Esq., Office Chief Commissioner Police, Melbourne
Munday, J., Esq., Clunes
Muntz, T. B., Esq., Town Surveyor's Office, Prahran

Neild, J. E., Esq., M.D., Collins-street East, Melbourne
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Nicholas, W., Esq., Mining Department, Melbourne
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# Royal Society of Victoria.

# TRANSACTIONS

AND

# PROCEEDINGS

OF THE

# Royal Society of Victoria.

## VOL. XII.

*Edited under the Authority of the Council of the Society.*

THE AUTHORS OF THE SEVERAL PAPERS ARE SOLELY RESPONSIBLE FOR THE SOUNDNESS OF THE OPINIONS GIVEN AND FOR THE ACCURACY OF THE STATEMENTS MADE THEREIN.

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ERRATA—Vol. XI., p. 14.

Line 27—For Spiroporin*æ*, read Spiroporin*a*.

Line 29—For *Cheilo*stomata, read *Cyclo*stomata.

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# Royal Society of Victoria.

## ANNIVERSARY ADDRESS

OF

## The President,

MR. R. L. J. ELLERY, F.R.A.S. (Government Astronomer.)

(Delivered to the Members of the Royal Society, at the Annual *Conversazione*, held on 27th August, 1874.)

YOUR EXCELLENCY, AND GENTLEMEN OF THE
ROYAL SOCIETY,

We meet to-night to commemorate the entrance of this Society into its seventeenth session, and, in accordance with our usual custom, I propose to address you briefly on the history of the Society during the interval that has elapsed since we last met here on a similar occasion in August, last year. Although I am extremely happy to state that I have to report no gaps in our ranks from death during the past year, it is nevertheless my painful duty to refer to the recent loss of a gentleman who, though not a member of our Society, was most honourably associated with it in the Eclipse Expedition. I refer to the late Commander Gowlland, R.N., who was recently drowned in the Sydney Harbour whilst performing his duties there as Admiralty Marine Surveyor. Commander Gowlland, most of you will remember, gave his services, and commanded the Eclipse Expedition Steamer *Governor Blackall*, and also formed one of the Sydney observing party. The expedition was fitted out under the auspices of this Society, and was accompanied by many of our members, who had ample opportunity of estimating the qualities of Commander Gowlland as a navigator, a commander, or a friend; and I believe I but echo the opinion of all who went on that expedition when I say that he won the esteem and confidence of all, and the lasting friendship of a great many. I feel assured, gentlemen, that you share with me the most sincere regret at the untimely loss of one who volunteered his gratuitous services to help us in a scientific undertaking, and performed them so efficiently, genially, and well.

The great event of our past year's history is the completion of the publication of our Transactions to the end of 1872. In February last the 10th volume, containing the results of the Society's work from August 1869 to the end of 1872 was issued. This, for many reasons, is a matter for congratulation. Our Society has been in the regular receipt of the publications of kindred Societies abroad, yet for several years past we have been unable to reciprocate. The new volume has now, however, been distributed to all foreign Societies and Institutions with whom we have interchanges, and we have thus in some small degree diminished this debt, and given proof to our brother workers in other parts of the world that our Society has not been asleep.

The income proper of the Society has not been found sufficient to cover the working expenses, interest on the building, and printing the Transactions as well, and our ability to publish must yet depend upon the continuance of the small annual vote from the State funds which the Government has again most liberally granted to us for the last three years. The Transactions of Session 1873 are not yet printed, but it is intended to proceed with the work at once, so as to issue the volume before the close of the year.

Since our last Annual Conversazione we have held nine ordinary meetings, at which thirteen original papers were read, having reference chiefly to the application of science to useful purposes, among which I am glad to say are two from an ex-member, engaged in scientific work in Scotland, who has sent us in this form the results of some of his geological researches made during a somewhat brief stay in the colony.

At the September meeting I read a paper "On Lightning and Lightning Conductors," with a view of popularizing a knowledge of the principles of protection of buildings from the effects of lightning, and the methods of putting them into practice. At the October meeting Mr. S. W. Gibbons read a paper "On Contaminated Water Supply," which clearly indicated the danger of adopting any source of water supply for a community without a thorough investigation as to its purity and freedom from chance of contamination. At the same meeting a short paper by Mr. Etheridge, "On the occurrence of Retepora in Tertiary Deposits at Schnapper Point," was read. At the November meeting a discussion on "A proposed Method for Determination of Longitude" took place. The method proposed claimed to involve less calculation than is usually necessary in ordinary lunar distances—it consisted in observing the moon and star or sun on the same vertical. Mr. White clearly showed that the method did not possess the advantages claimed. In November Mr. A. K. Smith read a paper on "The New Embankment on the South Bank of the River, near Prince's Bridge," in which was pointed out the dangers likely to accrue in case of a large flood in the Yarra.

At the meeting on December the 8th, Dr. Neild read a paper on "Cremation," in which that method of disposing of the dead was advocated. This meeting was the last of the session, and no ordinary meeting took place till the commencement of the present session in April, when Mr. S. W. Gibbons read an "Account of a New Method for the Disposal and Utilization of Excreta." At the May meeting I gave a brief account of the forthcoming "Transit of Venus," and of the preparations being made for its observation. In June two communications were read—one by Mr. D. Kennedy, "Account of an Escape of a Miner from Drowning in a Flooded Mine," where the miner was a considerable time in a drive below, and actually sealed by the water; the other by Mr. Etheridge, jun. (of Edinburgh), "On the Sand Dunes of the Coast of Victoria." At our last meeting a contribution by Mr. Corbett was read—"An Account of Practical Experience in the Use of Abyssinian Tube Wells" in the colony. Mr. S. W. Gibbons also read and illustrated a paper "On Cremation," in which the writer dealt with the different methods by which this plan of disposal of the dead could be carried out with the least possible objections.

This then summarises the ordinary work of the session. It is worthy of remark that the discussions on the various papers or subjects brought before the ordinary meetings during the last year have certainly been more general and animated than before, indicating perhaps a greater interest in the subjects, or possibly a diminution of that diffidence for which many of our members are not a little remarkable. While speaking of this part of our Society's affairs, I may mention that some little difficulty has been experienced by the Council with regard to the custody of the papers after they have been read to the Society. It has been our custom to allow members of the press, if they made the request, to have the MSS. for publication, in full or in abstract, more especially when the Society was not in a position to publish its transactions regularly. Our rules, however, are very explicit on this point, and allowing the papers to go out of the custody of the secretary, except for publication in the Transactions, was clearly a breach of them; again, several papers so lent had been lost, and therefore could not appear in our Transactions when published. There can be no two opinions as to the desirability of giving immediate publicity to our work through the medium of the papers, as well as the early publication in the Transactions of the Society; but papers are often too long, or of too abstract a character, for newspaper publication. I believe most of our members feel interested in getting a fair and correct account of our proceedings in the daily press, but we cannot expect this unless we furnish the materials. It sometimes happens that nothing short of a verbatim report of our proceedings could be satisfactory, but this cannot be obtained, except (as is frequently done in London) by shorthand writers paid by the Society. I think, therefore, that we should modify our rules, to admit of papers of immediate interest being handed to the press under certain conditions, or where the length or character of the paper is such as to preclude its publication in full, the writer should append to his paper a concise and clear abstract for the press. By adopting this course, a much more satisfactory report of our proceedings would appear than is possible under the present arrangements.

At our meeting of the 11th of September, in 1871, a paper was contributed by Mr. R. S. Deverell, of Portland, on "Ocean Waves and their Action on Floating Bodies;" and again on December the 9th, 1872, another paper by the same gentleman, entitled "Ocean Wave Power Machinery," was read. The first of these led up to the theory that in the motion of the ocean waves we have a redundant natural force capable of being conserved by proper mechanical arrangement for doing work at the will of man. The second paper dealt with the principles of the mechanical arrangements by which this force could be conserved. Mr. Deverell is a true scientific worker, and having conceived the idea that part of the wave force could be made subservient to man, he has worked steadily at the subject for years, and in order to master it has acquired by hard study a sound knowledge of those branches of physics in which the subject is involved. Some months ago he devised an apparatus by which the movements of a ship at sea could be registered; this was placed in charge of his brother, who went to England in the ship *Norfolk*, for the purpose of making observations with it on the voyage; from the results of these, which are most valuable and interesting, Mr. Deverell deduces the following: "The duration of the voyage was 2,026 hours, during that time the ship made 1,764,088 beam oscillations or rolls, and 1,041,137 fore and aft oscillations or pitches. The average number of oscillations in both directions per minute were 14. The aggregate arc of pendulum registering beam movements was over 15 million degrees, while that of the fore and aft movements was nearly 5 million degrees." Mr. Deverell also considers he has definitely established from these observations the following propositions:

1st. That between ocean limits the swell of the ocean is unceasing.

2nd. That the oscillation of a vessel in an ocean fetch is unceasing.

3rd. That the motion of an independent body within a ship on the ocean is unceasing.

Here then is represented an immense amount of conservable energy, and the question remains, can a practicable method be found for conserving it for use on board ship? Mr. Deverell believes it can, and to a sufficient extent to be useful in auxiliary propulsion. We know from his papers that the power to be obtained is to be derived from the conserved aggregate motion of a freely suspended mass within the ship, and an idea of the extent of this possible motion can be readily conceived from his 3rd proposition and the figures I have quoted. Mr. Deverell expects to be in a position in a few months to detail his method of putting his propositions into practice, and promises to bring it before this Society immediately it is matured. In the mean time the subject is attracting a good deal of attention among naval architects and nautical men in Europe and America, and its further development will be watched with great interest, not only by members of our Society, but the world generally, for any reasonable proposition for the utilization of any of nature's redundant forces must be among the highest aims of scientific workers. I may mention, before leaving this subject, that Mr. Bessemer has purchased from Mr. Deverell the instrument the *Norfolk* voyage observations were made with, for his famous saloon ship, and that this fact has probably led to a report which appeared in print some time ago that Mr. Bessemer and the Admiralty were building ships on Mr. Deverell's principle, but which is entirely without foundation.

There is no instance I believe in the annals of science, where there has been such a general co-operation among the various nations, and such a liberal expenditure of state funds for a single and purely scientific purpose as has taken place with regard to the forthcoming Transit of Venus. True, the phenomenon is one of the rarest and most important of all astronomical events, the proper observation of which would be cheaply purchased at even a greater outlay than will be made on this occasion. The simple result that it is desired to obtain is the *Sun's distance from the Earth;* its distance is probably known within a million miles or two, but these limits are too wide in the present state of astronomy; therefore, by universal consent, the civilized communities have entered on a great scientific alliance, and granted money from their treasuries to enable their astronomers to make the requisite determinations on a scale as nearly commensurate with the present demands of science as the means at command will admit of. In many branches of science there are subjects for investigation, and large fields of research, concerning which further knowledge would be to the advantage of the whole world, and which can only be properly grappled with by the co-operation of observers or workers spread over the whole globe; such undertakings therefore concern all nations alike, and in which all civilized communities should, as in honour bound, and in proportion to their status and means, do their share. This is notably one of these instances, and it is a matter for congratulation that the foremost nations and colonies have cheerfully and promptly set about the business in a manner worthy of the age in which we live. Let us hope that the efforts of every nationality may be crowned with success.

I had the honour of addressing this Society on a former occasion concerning this phenomenon somewhat in detail, it only remains therefore to inform you of the present stage of the preparations. There will be altogether about 70 observing parties—23 or 24 British (including India, Cape, Victoria, New South Wales, as well as Lord Lindsay's Mauritius party), 5 or 6 German, 26 Russian, 8 American, and 6 French.

The British observing stations will be Alexandria, Cairo, Rodriguez, Kerguelen's Land (2 stations), Christchurch (New Zealand). British-Colonial stations—India (3 stations), the Cape of Good Hope, Victoria (4 stations), New South Wales (4 stations), Mauritius (Lord Lindsay's Expedition). The German stations will be Mauritius, Cheefoo (China), Macdonald Island, Auckland Islands, and Ispahan. The Russians will occupy 26 stations, all in Siberia, Japan, and China. The Americans will be stationed at Hobart Town, New Zealand, Chatham Islands, Kerguelen's Land, Crozet's

Islands, Pekin, Nagasaki, and 1 station in Siberia. The French parties will occupy Campbell Island, St. Paul's Island, Pekin, Yokohama, and Saigon in Cochin China.

Most of these observing parties are now in course of taking up their stations, and all the southern parties of British, American, French, and German are expected to be at their respective destinations within the next two months. Our own preparations are in a forward state, and some of the special instruments required, which were ordered from England, have arrived; but our preparations cannot be completed till others, shortly expected, arrive.

An apparatus very similar to that used in England for representing as nearly as possible artificially the various phases of the Transit has been constructed at the Observatory, and is now in this building for your inspection. It is intended that all who are likely to be engaged in observing the transit at any of the four Victorian stations shall be practised thoroughly with this apparatus, so as to train the eye as much as possible for the appearance of the natural phenomenon.

A prominent example of a field for scientific research which concerns all civilized nations alike, and in which the joint labours of all are necessary to further knowledge and progress, is meteorology.

In my last address I referred at some length to the organization in Europe and America of a very complete system of meteorological work, in which immediate transmission of observations from different parts of a country to a central office, there to be combined so as to enable the chief meteorologists to make deductions from them, for weather forecasts, storm warnings, &c., formed the principal basis of operations. This work has been carried on steadily, and with most remarkable and satisfactory results. Some volumes have been lately issued from the meteorological bureau at

Washington, in which are printed the observations received at the central office, and the forecasts deduced from them, which are posted up at all important places in the States, to which is appended the actual weather which occurred, the fulfilment or otherwise of the forecast; and it is remarkable how often the forecasts are verified, more especially in those cases where warnings are most valuable, such as the approach of storms, and very low temperatures. In England and Europe generally, the same system is carried out by a very complete system of storm warnings, which have already proved invaluable, although the system is yet only in its infancy. I advocated in this place last year the carrying out of a somewhat similar system in Australia, and although no final scheme is yet decided upon, the chief features have been discussed by the principal colonial observers, and many points agreed upon.

It must be borne in mind that meteorological observations for obtaining a knowledge of a climate is in a great measure distinct from such as are required for the more general observation necessary for obtaining a knowledge of the great atmospheric movements and disturbances which must form the basis of any forecasting. Our ordinary meteorological observations of pressure and temperature of air, the direction and velocity of its movements at a few places distributed over a small area, like our own colony for instance, would be valueless for such a purpose unless supplemented by similar work from the surrounding colonies. The climatic statistics of a country are of great value *pro tanto,* and so far as experience has gone it appears that no averages can be safely taken as representing the averages to come, so that meteorological observations for this purpose alone must be carried on; but the grander objects of this science are undoubtedly those I have referred to, requiring wider considerations than those involved in the simple climatology of a country. For all that has yet been done in this science, we dare not attempt to prophecy more than 24 or at most 48 hours beforehand; we have nothing to guide us to a foreknowledge of a coming dry or wet season, and despite the auguries of the oldest inhabitants and blacks, or the discussion of part observations, or any theories of cycles, we are as completely in ignorance of the probable weather a few days hence as if we had no barometers, thermometers, or rain-gauges. The meteorological organization I have spoken of, however, shows how much can be done by scientific systematising; there is no theory, no nostrum, no quack weather prophecy, but a sure and certain knowledge obtained from careful observation and clear-headed deduction, and a bold grasp at the more general laws which govern the behaviour of the atmosphere over large areas of the globe. The forecasting—and this should mean forestalling too—of a storm, of great cold and snow, may save much life and property, and has undoubtedly done so in numerous instances—a single instance would probably be ample recompense for a nation's outlay in Meteorology. So far the accomplishment is satisfactory, but it cannot be said that the most, or the best methods of obtaining a more complete knowledge of the atmosphere and its movements have yet been put in action. We content ourselves with measuring its conditions and movements on the earth's surface only; we can certainly see something that is going on above us, but at best very little, for we are quite ignorant of the temperature, humidity, electrical condition of, and frequently of the motion of, the upper strata of air. In Paris, I see they are about to make systematic observations in the higher strata of our atmosphere. One of the balloons used by the beleagured French in the late war, has been converted to more peaceful purposes than that for which it was first constructed, and will now form one of the appliances of the Paris Observatory for investigations of the higher atmosphere. This is a step in the right direction, for what little we do know of these regions only indicates how valuable and necessary it is to know more for meteorological ends. What is principally wanted, therefore, to extend our knowledge of the more general laws governing the aërial ocean around us, is the combination of observations made at various atmospheric levels with those obtained at the earth's surface, which latter should undoubtedly include as much as possible the more critical regions, those parts of the earth *most*, and those *least* heated by the sun. Such operations it is evident can only be undertaken by the co-operation of observers in all parts of the world, aided by arrangement for rapid telegraphic interchange of the observations, among the central observatories or meteorological offices of all countries, and involving as a *sine qua non* money help from states.

State aid to scientific research has been much written about of late in European and especially English papers, and many and strong are the arguments in favour of a systematic granting of money by the state, for the purpose of assisting properly regulated scientific work. A Royal Commission has been appointed in England, to inquire into the present state of science in that country, and the best means of fostering systematic research in its various branches, and it is not at all improbable that a Minister of Science may be created.

There seems to be an almost unanimous opinion that State scientific laboratories for several branches of science should be established and maintained out of the public purse, such as laboratories for investigations in Physical Science, Astronomy, Chemistry, Physiology, and Biology. There can be no doubt that institutions of these kinds, properly endowed, and conducted under the direction of the best men that can be found to undertake the work, would eventually become a great national boon, and result in benefit to the whole community.

One of the members of the English Science Commission, referring to this point, says: "Investigations connected with almost the whole of our material economy are required. There is no question connected with sanitary improvement, with water supply, or sewage, or telegraphy, or the enormous number of the requirements of the army and navy, which would not derive advantage more or less from investigations of a physical nature, such as would be conducted in a physical laboratory. I think that the whole of our naval and military and social economy is dependent upon investigations such as would be carried on in a physical laboratory."

Another, Sir William Thomson, writing concerning the objects to be gained by the establishment of a Council of Science, says: "The immediate utility of the work is undoubtedly a very important object, and perhaps may be considered to be the first duty of the Government; but yet there is another duty which, although we cannot call it the first duty, is certainly not an inferior duty, and that is, to promote the honour of this country. There can be no doubt but that the inhabitants of this country do get benefit from the feeling of satisfaction that naturally results from any great scientific discoveries or great advances in science made by their own countrymen, and especially by the assistance of their own Government. The Royal Observatory at Greenwich is an honour and a glory to this country; and I am quite sure that the money paid for it is very well spent in the satisfaction that the country feels in the honour of having one of the greatest and best, if not *the* greatest and best, of scientific astronomical observatories in the world. This country undoubtedly has a great permanent possession in the name of Newton and in the name of Faraday. The promotion of scientific research in a regular way cannot make Newtons and Faradays, but it can obtain great scientific results by systematic business-like action, carried out through well-instructed and able men. It seems to me to be a duty of the Government to make the national honour in scientific investigation a subject of its solicitude, and an occasion (with due safeguards against abuse) for spending the public money."

In this colony the claims of science are usually promptly and liberally recognised; we have scientific institutions of which older countries might be proud, nevertheless there is much to be done, which it is the duty of every prosperous and intelligent community to set about, and amongst this there is one branch which has—almost before all others—strong claims for state help, I refer to Medical science. This science is one which most nearly concerns the whole community, and yet I believe I may almost put it side by side with Meteorology, as regards the unsatisfactory position it now occupies among other sciences. Astronomy, Meteorology, Mineralogy, and Botany have, in nearly all civilized countries, endowed institutions; but in very few countries do there exist similar institutions for researches in medicine. To some extent, no doubt, hospitals might fulfil these functions, but we must bear in mind that nearly all the medical staff of these institutions give their gratuitous services, and have to make their living in the practice of their professions outside. The science of medicine as at present practised is almost as exclusively as much a money-getting work as law, and the practitioner has seldom the time, if he has the desire, to carry on the original research so necessary to advancement, and for which the science is athirst. Now and then we find men of means devoting some of their time and substance to scientific work and research, and giving the results freely to the world; but the fields selected seldom include Medicine, Physiology, or Sanitary science. The endowment therefore of an institution for systematic investigations into the cause, prevention, and cure of disease involving necessarily investigations in Physiology and Physiological Chemistry by the best men obtainable, whose whole undivided time should be devoted to the work, is a matter demanding the consideration of every well-doing people as a duty owed to themselves, the community generally, and to posterity.

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# Royal Society of Victoria.

## ANNIVERSARY ADDRESS

BY

MR. G. FOORD, F.C.S.

Vice-President of the Society.

(Delivered to the Members of the Royal Society, at their Annual *Conversazione*, held 13th August, 1875.)

YOUR EXCELLENCY, AND GENTLEMEN OF THE ROYAL SOCIETY,

This evening we inaugurate the eighteenth session of our Society. Upon such occasions it has become the custom for the President to address the members concerning the Society's progress during the past year, and its prospects in the immediate future. It has also become an accepted practice in these annual addresses to allude, in brief terms, to scientific topics of general interest, concerning discoveries recently made and researches in progress ; not that a review of the world's scientific life, during a single year, could be attempted with any chance of success, from our stand-point and the limited horizon which it affords, but rather, I presume, in the sense of showing, by a few instructive examples, that the appetite for and pursuit of truth is maintained with unabated vigour; that in each instance the harvest of knowledge duly follows the expense of scientific labour, and that the boundaries of human knowledge are still extending.

Following the established routine, I will in the first place speak, to the best of my ability, concerning the affairs of our Society, commencing with a few observations personal to our President, Mr. Ellery, through whose absence from the colony the task of addressing this assemblage falls upon the present speaker.

Six months since it became obvious that the onerous duties belonging to Mr. Ellery's position as Director of the Melbourne Observatory, overweighted by collateral and extrinsic labours, which latter, to the full extent of his physical powers, he was at all times remarkably ready to undertake, had at length produced some of the signs of overwork. The inroad upon his general health had rendered relaxation and change urgently necessary, and, in consequence, the Government have allowed him a year's leave of absence, under conditions which it is trusted will enable him to return to us at the close of his holiday rejuvenescent and mentally refreshed, fortified moreover by new experiences, and intercourse with some of the foremost of the European workers. It should be remembered that although the Royal Society has no necessarily permanent President,—the election for that office, as for all others, taking place annually—yet Mr. Ellery has so closely identified himself with our work, has taken so watchful an interest in the welfare of the Society, and, in a spirit of self-sacrifice, has been ever so ready to accept the onus of office, that for several years past, the Society has with cheerful readiness re-elected him to the Presidential chair; and on his departure it was felt that honour was done alike to Mr. Ellery, and to the Society, by retaining him in office during his visit to Europe. I think I may venture to add, that it is the intention of the members and officers to do their best during the President's absence, hoping to welcome him back in due time to his accustomed sphere of usefulness among us.

Unfortunately, the temporary loss of our President's services is not the only one to be recorded; we have suffered an incomparably greater loss in the demise of Professor William Parkinson Wilson, an event which occurred at his residence, Wolfdene, Mornington, on the 11th of December last, two days after that of the Transit of Venus. Professor Wilson was one of the earliest members of the Royal Society, he filled the office of Vice-President during many years, and although his name is not prominent in our Transactions, it can most truly be said, that his services to us were throughout of the highest order. His eminent scientific and scholastic attainments are too widely recognised to need comment, but to these were added certain marked attributes, perhaps not so widely known, but which largely increased the value of his help. He possessed that kind of knowledge, not always enjoyed by the learned, but which is essential to the successful conduct of the affairs of every-day life, his perceptive powers were rapid, his judgment penetrating and almost unerring, he possessed in quite a characteristic degree the power of stripping complicated questions of all that was foreign to them, and of presenting them in the clearest and simplest form. At the Society's Council meetings, his presence gave to the business, on all occasions, a tone and precision which I fear, wanting his good counsels, we shall find it difficult to maintain. At our general meetings he exercised the power of imparting the fullest vitality to the discussions. I am speaking in terms of praise, but there are many here who know how mildly these words portray our late friend. To those who may be present and who may not have reckoned the late Professor within the circle of their personal friendship, I may be permitted to add, that he was the soul of honour; "one of the most just men I have ever known" was the expression of his intimate *confrère.* Though kind and courteous, he was at the same time outspoken, tolerant of weakness, yet a cordial hater of shams and subterfuges, a very soldier of truth. Although the places left vacant by the most eminent are sooner or later occupied, it is perhaps too sanguine to hope for any immediate replacement of all we have lost in the late Professor Wilson.

Speaking of the business of the Society, I beg now to announce that much has been done towards placing the printing of our Transactions on an improved basis. Volume XI. of the Society's Transactions has been published, and since its issue, the intention of the Council to print and publish each paper in a separate pamphlet form, as soon as possible after the reading, has been realized. Enough matter, in this state of detached pamphlets, will soon have accumulated for rendering necessary the publication of a new volume. A catalogue of the Society's library has also been made and printed. It is not asserted that all that is desirable concerning our Transactions, our rapidly accumulating library, and our correspondence with Foreign Societies, has been so far methodised as to admit of no further improvement, but I think it may be asserted that the Council is awake to the full importance of these several matters, and is hopeful of gradually amending whatever may be defective, and of supplying whatever is wanting.

In the last Annual address, it was proposed that members reading papers before the Society should furnish a concise and clear abstract for the use of the press. I am glad to be able to state, that this suggestion has been in some measure followed, and that, as a consequence, we have of late been represented with improved accuracy in the public prints.

If proposals for membership may be accepted as showing the esteem in which the Royal Society is held by the public at large, in that sense, it is satisfactory to state that such proposals are put in at almost all the ordinary meetings of the Society. Our members at present numbering over 110.

The financial position of the Society is shown by the balance-sheet presented by the Council in the printed form at the first general meeting of the present session. In that document the balance in the bank is stated to have then been £181 9s. 0d. The statement of assets and liabilities shows the total assets, including the hall, furniture, &c., at £2506 9s. 9d., against liabilities, excluding 73 fifty pound debentures, at £53 12s. 8d., showing a balance of £2052 17s. 1d. Two notes are appended to the balance-sheet; it is in the first place remarked :—

"Your Council has much pleasure in stating that the fencing account has been paid, the printing account has been reduced by £100, and debentures have been paid off to the amount of £200; a considerable reduction in the liabilities of the Society has thus been effected. For the permanent preservation of the building a considerable outlay for cementing must, however, soon be required."

And it is added :—

"We have much satisfaction in stating that the Government has again granted the subsidy in aid of the printing fund, and we have every reason to believe that this course will be continued."

It is to the liberality of the Government in renewing this annual grant that the restoration of regular printing of our

Transactions is in a great measure due. I feel it unnecessary to tax your patience now by observations vindicating the claims of science to the fostering care of the community; but it is, perhaps, not inopportune to remark, in reference to this particular subsidy, that as long as the collecting and recording what is at the same time new in science, and particular to the colony, is disinterestedly pursued, the Society may with confidence accept, nay it is its duty to seek this strengthening Government aid.

Since our last conversazione seven general meetings have been held, at which the following papers were read and discussed :—

On the 12th of October Mr. F. J. Pirani read a paper "On some Processes of Scientific Reasoning," and at the same sitting Mr. R. L. J. Ellery described the photographic processes to be adopted in observing the forthcoming Transit of Venus.

On the 16th of November, Mr. Rawlinson read a paper "On the Discovery of some Keys under 15 feet of Diluvium in 1845 or 1846."

On the 21st of December, Mr. Rusden read a paper on "The Week," which was followed by Mr. R. L. J. Ellery's paper on "Some of the Physical Appearances observed during the then recent Transit of Venus."

On the 12th of April of the present year, a paper written and forwarded by Mr. R. Etheridge, Jun., of the Geological Survey of Scotland was read. It is entitled "On Some Upper Paleozoic Polyzoa from Queensland." At the same meeting there was also read a short paper by Mr. Rawlinson, "On the Importance of a more Close and Systematic Observation of the Atmospheric and Oceanic Phenomena of our Coasts."

On May the 17th, Mr. Foord read a notice of some of the results of the *Challenger* expedition, and this was followed by a paper read by Mr. Cooke on "The Sciopticon," demonstrating the optical and structural peculiarities of that instrument.

On June the 14th, Mr. Alfred M. Smith read a paper on "The Phenomena of Approach and Recession exhibited by Bodies under the Influence of Radiant Energy," and Mr. Harrison explained a form of universal equatorial, as well as an instrument for assisting observations of the planet Mars.

I may now explain, for the elucidation of what follows, that the laws of the Society provide for the formation of eight sections, each devoted to specified departments of scientific inquiry. In accordance with this provision, at a meeting of members of the Royal Society, summoned by the President, and held on the 21st of October 1873, it was resolved to form Section A, devoted to Physical, Astronomical and Mechanical Science, including Engineering, and fourteen gentlemen expressed their willingness to become members. A report of the proceedings of Section A was presented in October last, from which it appears that ten ordinary meetings have been held, and the following papers read:—

On November the 4th, a paper on "Trussed Beams" was read by Mr. Pirani.

On December the 2nd, an essay on "Barometric Levelling" was read by Mr. W. C. Kernot. At this meeting, Mr. Ellery described the methods in use for obtaining uniform rotation, and pointed out the desirability of a more satisfactory solution of this problem. Mr. White invited the attention of members to the question of Barometric Compensation of Pendula of Astronomical Clocks.

On March the 5th, Mr. Kernot submitted a method for obtaining uniform rotation, which Mr. Ellery undertook to test practically, and to report results.

On April the 30th, Mr. Pirani read a paper on "The Laws of Motion. At this meeting, Mr. Ellery reported on his trial of Mr. Kernot's method of obtaining uniform rotation, promising a further trial.

On May the 28th, Mr. Kernot read some notes on "Timber Structures."

On July the 2nd, Mr. Henderson read "Notes on Ventilation, exhibiting a new form of Ventilator." Mr. Kernot gave an investigation of the Strains of an ordinary bow-string Roof-truss.

On July the 9th, Mr. H. M. Andrew read "Notes on Elementary Geometry, being a geometrical investigation of maxima and minima of functions of one independent variable."

On October the 1st, Mr. Cook gave an account of "Some Effects of Lightning at Mr. Clement Hodgkinson's house at East Melbourne." Mr. Henderson introduced the subject of the Dennet Arch, contending that its action was that of a beam rather than an arch, and Mr. Foord exhibited a "Peculiar Elastic form of Carbon deposited from Coal Gas."

The foregoing list accounts for eight out of the ten meetings of this section, the two other meetings being devoted to discussions and general business.

Passing from the affairs of the Society, let us now take a cursory glance at the wider field of general scientific research. In the first place, I propose that we should bestow a few minutes attention upon recent astronomical work, especially that performed at our own Observatory. For this purpose, I avail myself of information afforded by Mr. E. J. White, the Acting Government Astronomer, who states that, "During the last twelve months, at the Melbourne Observatory a very large amount of work has been done. With the transit circle there have been obtained 2,064 observations of right ascension, and 1,150 of north polar distance ; these include, besides the usual fundamental stars, transits of the moon and of moon culminating stars, for assisting in the determination of the longitudes of the stations occupied by the various Transit of Venus parties in this part of the world, and polar distances of stars culminating not far from the zenith for finding the latitudes of the same stations. The Great Telescope has been principally employed in observing the faint nebulæ and clusters of stars in the southern hemisphere. The fine comet of Coggia, which made its appearance here in July of last year, was also carefully examined on eighteen nights, and fifteen drawings of it obtained. It was intended also to use this instrument in obtaining photographs of the sun's disc during the Transit of Venus, but the apparatus was not completed in sufficient time to allow of preliminary practice, so the attempt failed. Advantage has been taken of the favourable position of Mars during his present opposition to get some good drawings of it. A fine series of measures for position of Coggia's comet was taken with the small equatorial. One observation of Encke's comet was also obtained. Besides which, the occultations of all stars by the moon visible here, during the months of October, November, December, and January, were observed with this instrument.

The Transit of Venus was successfully observed, the new equatorial of eight inches aperture being used for the purpose. Observations of the two internal and last external contact were obtained, besides micrometric measures of the distance between the edges of Venus, and the nearest limb of the sun. By means of the Dalmayer photoheliograph, 180 photographs were taken with the Janssen apparatus at and near the time of internal contacts, in addition to 37 pictures of the whole face of the sun with Venus on it. At the other Government stations in Victoria the Transit of Venus was also observed, though the weather was not generally as favourable as in Melbourne. At Mornington, the two last contacts were observed. At Sandhurst, the weather proved very unfavourable, and only the last internal contact could be seen. At Glenrowan, the first internal contact only was observed.

Dr. Galle, of Breslau Observatory, has lately communicated the final result of the observations of the planet Flora, during the opposition of October 1873; the measurements made in the Northern Hemisphere, were compared with similar measurements made at the Cape of Good Hope, Cordova, and Melbourne, and gave the solar parallax equal to 8″873, which is nearly identical with the recent determinations of M. Cornu, from the velocity of light, and of M. Puiseux from the Transit of Venus as observed at Pekin and St. Paul's Island. This value is also so very nearly the same as that determined from the observations of Mars in 1862, and that by Leverrier, from the perturbations of the planets, that it is not at all likely that any material change will be necessary to satisfy the combined observations of the Transit of Venus. At a late meeting of the Royal Astronomical Society, the Astronomer Royal stated that he could easily fix on the foreign astronomer, whom he would like to see entrusted with the final reduction and combination of all the observations of the late Transit of Venus, but as yet it is not known whether any one has been selected for the work.

On the whole the late Transit of Venus has been a great success. In places of the greatest importance astronomically, such as Kerguelen and the Auckland islands, where the probability of bad weather was very great, the sky seems to have cleared in time for the phenomenon almost miraculously, and in most of those places where the low altitude of the sun increased the atmospheric difficulties of observing, the Transit was generally well seen.

Independently of obtaining the distance of the sun from the earth, the late Transit has disclosed physical phenomena of great value. The celebrated Italian spectroscopist Secchi, observing at Maddapore, in India, has determined the presence of aqueous vapour in the atmosphere of Venus, and Janssen, the eminent French observer, found that the internal contact, as observed by eye through a telescope furnished with a bluish shade, took place some seconds before the same phase was depicted photographically, thus showing that the sun built up by the blue rays was smaller than the sun built up by the particular rays which, in the telescope employed, produced white light.

Concerning the Total Eclipse of the Sun in April last, but little can be stated; the expedition to Siam has proved at best, according to accounts to hand, only a partial success; the attempt to photograph the spectrum of the corona, from which so much was hoped, having failed. But even from our failures there is always something to be learned.

Let us now pass from these astronomical subjects to another item of prominent scientific importance, the *Challenger* expedition, rendered additionally interesting to us by the visit of the ship to these shores. It is pretty generally known that earlier cruises and voyages, with objects similar to those of the *Challenger* expedition, have prepared the way for the latter greater undertaking, and that the work still in progress by the *Challenger* is a continuation and expansion of that commenced by the *Lightning* and carried forward with marked success by H.M.S. *Porcupine.* The cruise of the *Lightning* extended over a period of six weeks only, examining the space between Scotland and the Faroe's. Then followed the voyage of the *Porcupine,* over a far more extensive area, its survey extending as low down as the Mediterranean, and its dredging operations proving successful at depths till then unattained, namely 1,500 fathoms, or nearly two miles.

The valuable results of the voyage of the *Porcupine* made it obvious that, with more effective means, still more important conquests and discoveries of the secrets hidden in the blue depths were attainable. Her Majesty's Government wisely agreed to fit out a vessel of size and power commensurate with the work in the larger and more ambitious form to which, by a process of natural growth, it had now expanded. All that science could devise, or skill construct, for contributing to this great object was supplied. Improved apparatus for exploring the floors of the deepest oceans, for ascertaining the force and direction of the oceanic currents, for registering the temperature of the sea at all depths, for bringing to daylight the denizens of even the deepest and darkest abysms, as well as the means of adding to geographical knowledge, and to that of climatology, besides all requisite tools for chemical and physical research concerning the sea in the many aspects, geological, biological, meteorological, &c., in which this great mobile mantle of the earth may be viewed. These and much more were furnished. I dare not attempt to enter into details concerning the admirable appointments provided for this truly national undertaking, nor may I speak of the wisely selected staff of scientific observers, but perhaps I may be permitted to quote the language of Dr. Carpenter, who first, in reference to one section only of the results already achieved states, "That the temperature survey of the Atlantic may be truly characterised as the most important single contribution ever made to Terrestrial Physics, presenting as it does the whole thermal stratification of an oceanic area of about fifteen million square miles, and with an average depth of 15,000 feet." Dr. Carpenter speaks of the Pacific Survey in the same terms of admiration: "Nor are the results of the Pacific Survey less important, they reveal the existence of hitherto unsuspected processes of aqueous metamorphism, at great depths in the ocean, and throw an entirely new light upon the geological problem of the origin of azoic clays and schists."

This liberal promotion of scientific enterprise by the foremost Government of the world, is indeed one of the signs of the times. We have other examples. The Arctic expedition of 1875 left Portsmouth, on its adventurous voyage, on Saturday, the 29th of May, and the enthusiasm and interest displayed on that occasion included every section of society, from Her Most Gracious Majesty to the humblest of Her Majesty's subjects. As Captain Nares is in command of this new venture, it may be hoped that in this instance his skill and care will be rewarded with a success comparable to that which has already attended his command of the *Challenger*, from which he has been so recently transferred.

Other expeditions are contemplated. One by the Norwegian Government is being organised, and is to be under command of Captain Carr Wile, of the Royal Norwegian Navy. Its objects are similar to those of our own *Challenger* expedition: the grounds to be surveyed are situated between Sweden, the Faroe Isles, Iceland, Jan Mayen Isle, and Spitzbergen; the time to be spent on the work is three years. Captain Wile, who is well qualified for this command, having for the last five years commanded the Norwegian Survey steamer *Professor Nanstein*, has recently visited England, with the object of informing himself respecting the *Challenger's* work. A German expedition to the North Pole is also under contemplation at the Admiralty at Berlin: it is probable that this will also start next year.

The preparations for the forthcoming Philadelphia Exhibition demand also a word of comment. Since that of 1851, these International displays have continued in an unbroken chain, and the interest which the first created is still transmitted through the series with all the original vigour. Nations which we have been taught to regard as existing on the boundary line of the modern civilization, are now drawn well into the current of this eager race: the system indeed has become a permanent machinery of education, not alone to the young, but to the peoples as a whole, in all which concerns their material prosperity and the arts of life.

As our time is limited, I feel that I must not tax your patience by further examples; I wish, however, in conclusion, to make very briefly one or two observations, to draw a moral, if I may so speak, from what has been already uttered. The value of scientific research is now too well recognised to need comment; examples of the practical application of its results are of daily occurrence, and everywhere at hand. There is no want of recognition of this patent fact at the present day; nor is there want of appreciation of the expanse of the field still open to inquiry, and still promising great rewards. The want of to-day is of a different kind, referring rather to the organization of the labour, than to the recognition of its value. Much of the work inviting immediate attention is of dimensions too large for individual effort, requiring, not the untiring zeal of a single philosopher, but rather a staff of trained scientific workmen for its performance. Often of national significance in its applications, it becomes, therefore, of national importance that it should be planted and tended by the nation even to fruition. And this does not apply solely to maritime affairs, or to gigantic experiments in gunnery, but equally to investigations which concern hygiene and pathology, and many other subjects of human interest, indeed to those branches of knowledge, abstract or applied, which, although unremunerative to the student, promise beyond doubt, results of great value to the race. This want may be characterised as a more systematic mode of action in promoting and prosecuting scientific research. I have no proposition of my own to offer, as conducive to this desirable end; but an observation which has been very recently quoted in the public prints, and which is attributed to the Hon. George Brodrick, seems to contain a germinal idea, such as may sooner or later prove reducible to practice. Speaking of measures for the reform of the Universities, he argues, "that they should be directed to strengthening them, as fountains of educational and intellectual life, by increasing the professorial staff, by extending their libraries, museums, galleries and lecture rooms, by fostering unremunerative study, as well as scientific training for professions, within college walls, by treating both scholarships and fellowships as designed to raise up an aristocracy of education."

Of how soon the public mind may become ripe for such an advance as this it would be rash to venture an opinion; but it is certainly some advance towards the satisfaction of our wants to have them clearly expressed. Moreover, we need not altogether despair of advances to be made in the immediate future, while we have symptoms of a daily increasing public interest in all that concerns the higher education; while we have examples, such as that recently presented here, of a man coming unsolicited to the front with the munificent contribution of £30,000 in his hand towards our University building fund.

I have spoken pretty freely this evening concerning applied science; one final word may be added concerning the pursuit of knowledge for its own sake, and wholly apart from utilitarian considerations. Just as we desire pictures, statues, ornaments properly so called, just as we cultivate music and flowers for purposes of combined intellectual and sensual pleasure, so the modern mind having awakened to an appetite for every kind of natural knowledge, science must therefore be cultivated to minister to a real mental want, to the hunger and thirst for the knowable.

# TRANSACTIONS.

## ART. I.—*On the Utilization and Disposal of Excreta.*

BY S. W. GIBBONS, F.C.S.

[Read 13th April, 1874.]

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## ART. II.—*On the forthcoming Transit of Venus.*

BY R. L. J. ELLERY, F.R.S., F.R.A.S.

[Read 11th May, 1874.]

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## ART. III.—*On a late Extraordinary Escape of a Miner from Drowning.* BY D. KENNEDY, ESQ.

[Read 8th June, 1874.]

[ABSTRACT.]

The miner, McCaviston was imprisoned for 27 hours at the end of a 140-feet drive, water at the same time standing in the shaft to the height of 52 feet above the level of the top of the drive.

The end of the drive in which McCaviston took refuge, opened into a long chamber crossing it at right angles and forming with the drive a sort of letter T. The length of this chamber was 80 feet; average height, 7 feet; width, 7 feet. At the end of the drive at intersection with chamber, the roof rose 11 feet from the floor. The drive itself has a rise of 4 feet; height, 6 feet 6 inches; width, 5 feet. Consequently when the water rose in the shaft to the top of the mouth of the drive, there was a mass of air in the latter, having at the base an area of 4 feet high by 5 feet wide, thinning away to nothing at the mouth of the drive. At the same time, in the chamber or cross-cut above referred to, there would be a stratum of air above the water level 80 feet long, 4 feet 6 inches high, and 7 feet wide. The water having reached the level of the top of the mouth of the drive, it was now impossible for the confined air in the drive and chamber to escape; and as the water rose in the shaft, so this air became more and more compressed towards the cross-cut. When the water in the shaft was at the level of the top of the mouth of the drive, there was then confined air (not compressed), as follows:—In the drive, 1,400 cubic feet; in cross-cut, 2,520 cubic feet; total, 3,920 cubic feet. When the water rose to its highest level (52 feet, equal to about one-and-a-half atmospheres) in the shaft; the confined air was then compressed, according to Boyle and Mariottes' law, to two-fifths or a little less than one-half of its original volume. The space thus occupied by the compressed air, under a pressure of a column of water equal to $1\frac{1}{2}$ atmospheres, would be 1,568 cubic feet. The measurements of drive, cross-cut, and height of water in the shaft are only approximate, having been given by the mining manager, Mr. Jackson, roughly; but they are sufficiently near for all practical purposes, and fully establish the fact that there was a large quantity of compressed air surrounding McCaviston at the end of the drive.

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## Art. IV.—*Observations on Sand-dunes of the Coast of Victoria.* By R. Etheridge, Esq., Jun.

(Of the Geological Survey of Scotland.)

[Read 8th June, 1874.]

The general characters and nature of the sand-dunes of the coast of Victoria are too well known to the members of the Royal Society to need any lengthened description from me. I shall, therefore, confine myself to a few general observations connected with the subject.

The usual aspect of that portion of the coast occupied by dunes is low and sandy, rising here and there into hills afew hundred feet high, and composed almost wholly of blown sand. Portions of the coast at which these phenomena may advantageously be studied are, amongst others, Anderson's Inlet, Point Nepean, and the coast line at intervals from Cape Otway far into the colony of South Australia. From accounts given by various writers, we may consider the sand of the coast as forming three kinds of hillocks, viz., high well-grassed lengthened ridges; similar detached more or less conical hills; and lastly, shifting dunes, devoid of vegetation, and changing their form and position with every breath of wind. One of the more remarkable instances of the long ridge-like dune is that described by Mr. C. S. Wilkinson, on the west side of the Aire River, near Cape

Otway,* where a bank of sand runs for about a quarter of a mile east and west, at a nearly uniform height of 50 feet, much resembling a railway embankment.

The height of the coast dunes varies somewhat. Around Anderson's Inlet I saw them from 200 to 250 feet high; at Cape Otway the extreme height appears to be about 200 feet; whilst the Rev. J. E. T. Woods has recorded certain dunes on the coast of South Australia, between the mouth of the River Glenelg and Cape Bridgewater, as high as 300 feet, extending three or four miles inland, and fast encroaching on habitable ground.† At Cape Otway the dunes extend some two or three miles inland, frequently in the form of small sandy hummocks surrounding a basin-shaped depression without outlet, resembling the "cups" of the Cape Schanck district.‡

The sand varies in colour from white to yellow, in places very siliceous, whilst at others silex is in the smallest proportion, the general mass then consisting of fine fragments of Echini spires, Polyzoa, pieces of shells, Foraminifera, and sponge spiculæ, with little or no stratification.§

In describing the high sand hills on the eastern side of the Aire River, Mr. Wilkinson says that the sand washed up on the shore is swept away by the strong south-westerly gales, and carried to the north-east, up a gradual but irregular incline, for about three-quarters of a mile, when it falls over a steep bank some 50 feet high, burying trees and shrubs in its progress,|| and thus covering up the face of the country.

Mr. Wilkinson kindly communicated to me some observations taken by Mr. H. Ford, of Cape Otway, relative to the angle of the steepest slope of the sand hills. The result of eleven observations is as follows—30°, 31°, 32°, 30°, 33°, 30°, 32°, 35°, 36°, 32°, 35°. It will be observed that the average angle of inclination is 32°, the greatest 36°, the least 30°. The greatest angles were just at the top of inclined surfaces, where the least thing would set sand in motion.

The sand dunes seldom contain whole or perfect shells, or large organisms of any kind, although Mr. Ford found in the dunes two miles to the east of Cape Otway lighthouse, bones of animals, flint chips, a sharpened stone tomahawk, and

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* Report on Geology of Cape Otway District, 1865, p. 26.
† Geological Observations in South Australia, 1862, p. 219.
‡ Wilkinson, *op. cit.*, p. 28.
§ Geological Observations in South Australia, 1862, p. 189.
|| Wilkinson, *op. cit.*, p. 28.

several bone spikes or needles, relics of the past tribes of the Cape. At about the same distance from the lighthouse, in a mixture of beach material, pebbles, humus, and broken shells, resting on the Carbonaceous sandstone forming the high cliffs of the cape, and apparently intermediate between it and the overlying dunes, I, in company with Mr. H. Ford, obtained a similar bone spike, with numerous seal bones, a ramus of the lower jaw, pieces of vertebræ, bones of the limbs, and a few pieces of ribs, whilst the shells appeared to be those existing on the coast at the present day.

Both at the Cape and along the South Australian coast peculiar concretions are to be met with in the dunes, often assuming fantastic shapes and forms, generally resembling trees with their branches. Indeed, for such they have frequently been taken; for, amongst others, Mr. T. Burr describes calcified stems of trees standing in the position of their growth in the sand-dunes of St. Vincent's Gulf, near Adelaide.* The same phenomena were likewise noticed by the late Professor Jukes at the entrance of the Swan River, Western Australia.† Along that coast, hills 200 to 300 feet high, forming districts stretching as much as ten miles inland, are formed of once drifted sand, now consolidated, and supporting a good forest vegetation. This deposit consists chiefly of fragmentary shells solidified into a compact stone, sufficiently hard for building purposes. Scattered plentifully through such material, Professor Jukes saw similar pipe and tree-like concretions, often ending downwards in tapering forms like stalagmites. According to the Rev. J. E. T. Woods. these "pseudo trees" are composed of a magnesian limestone.‡

On comparing the sand-dunes of the British coasts we find nothing to equal those of the coasts of Australia, although Sir C. Lyell has placed on record a rather interesting case of the shifting nature of sand, which may be of interest. All that now remains of the ancient village of Eccles, on the coast of Norfolk, is the ruined tower of the once considerable chapel, which, extant in 1605 A.D., was in 1839 almost completely buried in large dunes, locally called "Marrams." The action of the wind between this and 1862, a space of 23 years, was such that at that date the foundations of the edifice were exposed, and the surrounding dunes almost

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* Inst. Jour. Geol. Soc., xvi.
† Manual of Geology, 1862, p. 155.
‡ Geol. Observations, 1862, p. 168.

swept away.* M. Elie de Beaumont advanced the theory that sand-dunes might serve as natural chronometers, by which the date of the existing continents may be ascertained; that by observing the rate at which the particles of sand travel, we may calculate the period when the movement commenced.† Sir C. Lyell, however, doubts the correctness of this theory, observing that "this test must be applied with great caution, so variable is the rate at which sand may advance into the interior.‡

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## Art. V.—*On Abyssinian Tube Wells.*

By Francis Corbett, Esq.

[Read 13th July, 1874.]

These pumps were constructed of six lengths of ordinary iron piping for gas pipes, each of six feet long. Into one of these lengths was screwed a piece of solid iron, pointed, about eight inches long, and the shoulder next the pipe was made of a greater diameter than the pipe. This is for driving into the ground, and the diameter being greater than the pipe, it clears the way, especially where the holes are made in the pipe. Just above where this solid point is screwed, holes are drilled in the pipe for the water to enter, just as in any ordinary tubing for a well, for sixteen or eighteen inches in length. The number of these holes must of course be in proportion to the size of the pump, so as to admit as much water as the pump is capable of throwing. Less holes would be required in a small pump, suitable either for domestic purposes, or for a small paddock. The pumps I got Mr. Danks to adapt the pipes for were No. 6 Douglas, the largest size made by that manufacturer. They are as large as can be reasonably worked by manual labour, and the larger the pump the better, as it takes the man less time to fill the troughs. Mr. Danks' arrangement for attaching the different lengths of the piping to one another is very good, as the pipes preserve their full strength. He has a ring or hoop about three inches broad, tapped from both ends, with right and left handed internal screws. The ends of the pipes have screw threads worked on the outside of them,

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* Principles of Geology, 1867, i., p. 513.
† Géologie Pratique, p. 218.
‡ Principles of Geology, 1867, i., p. 516.

about an inch and quarter or inch and half long. The ring is screwed on to the first length of the pipe, and the second length is screwed into the ring, till the two ends of the pipes meet. By this connection the joints of the pipe become probably the strongest parts of it. The first length of the pipe, owing to the addition of the driving solid iron point, is nearly seven feet long. When this is driven into the ground, leaving only a few inches above the surface, the ring is screwed tightly on with a gas-fitter's tongs. I may here mention that I would recommend that two of these tongs should be got, because in screwing the lengths of the pipe on tightly, the part driven into the ground will turn round if not held back. When the ring is screwed fully down, the next length of the pipe is screwed into the ring, and the driving is recommenced till the end of the second length is only five or six inches above the surface, and so the work of driving goes on. I may mention that Mr. Danks recommends, that when screwing in the different joints, the screws should be smeared with white lead. I have adopted his suggestion. In order to protect the top of the pipe as well as the driving block from injury by the blows in driving, Mr. Danks has fitted a cap which screws on to the ends of all the pipes, and offers a level surface to the monkey or block. He ingeniously devised the plan of having a little block of wood inside this cap. When the cap is screwed down tight, the wood presses on on the top of the pipe, and at one and the same time prevents jar on the pipe, and prevents the screws being injured by stripping. Care should be taken never to omit putting this block in, nor to omit screwing the cap well down on it, otherwise the cap may fasten on the top of the pipe, and not screw off again, owing to the thread of the screws being injured. When one length is driven the cap is taken off and screwed on to the top of the next length, after the latter is connected with that already in the ground.

Now as regards the driving. This can be managed by any handy man about a station, with the assistance of two labourers to haul up and down the monkey, &c. The apparatus may be of the rudest kind. My arrangements are as follows: I took three pieces of quartering about eighteen feet long, and 3″ x 3.″ These were erected over the spot selected for the pump, so as to form a triangle to hold a double pulley block for hauling the driving block up and down on. For the driving block I used a piece of a gate post about nine inches square, and four or five feet long. Through this a hole was bored a few inches from one end, and a rope about sixty feet long passed through this hole. Then either end of this rope is passed from opposite sides over each wheel, or sheaf of the pulley-block, so as to come down to the ground at opposite sides, where the men who are to lift the driving block stand. The log or driving block consequently hangs on the middle of the rope when the men pull, and can be lifted about fourteen or fifteen feet from the ground. It is of course necessary to provide for the guiding of the driving block, otherwise when let drop on the top of the pipe, it would fall on one side. My arrangement for this guiding frame is two pieces of hard-wood quartering, fourteen feet long, bolted at each end to two cross pieces of batten, so as to keep them about three inches apart. The lower ends of these are sunk a few inches in the ground to keep them steady, and the upper ends are fixed to the triangle just behind where the block hangs. On the back of the log or driving block, a piece of quartering three inches wide is spiked. This has two cross-pieces of batten bolted to it. The piece of quartering passes up and down with the driving block in the opening between the sides or pillars of the guiding frame, thus keeping the driving block from falling laterally, and the pieces of batten at the back keep it from falling forward when the block falls on the head of the tube. Such is the description of the pile driving machine, which can be constructed in an hour out of the materials which are at hand on most farms and stations.

When the driving apparatus is fixed up the first length of the pipe (that with the point on it), must be placed *perfectly* vertical under the centre of the driving block. To prevent it moving, a piece of batten may be placed at top and bottom between it and the guiding frame, and the man managing the pipe may hold a piece of rope round the pipe, so as to keep it steady in its place during the driving, in order to prevent the top of the pipe going either way when struck by the monkey or driving block, which it is apt to do unless kept perfectly upright. At first the taps on the top of it should be light till the pipe gets well into the ground. When well down, there is little danger of its going to either side, but it is wise throughout to keep it steady under the blows of the monkey. If the first length is carefully attended to and kept perfectly upright, there is little trouble with all the others.

When rock or other hard substance is come to, that is when the pipe ceases to go down easily under the blows of the monkey, it should be driven no more, as the pipe would bend where it is weakened by the holes, if it got many blows after touching the rock.

When the pipe gets down to a depth where water may be expected, it is well to let a plummet down into it to ascertain if there is water. If so, and it has risen high, it may be well to screw on the pump and try if it is merely soakage water, or whether it has come on a spring. With the first pump I put down I found at twenty feet that there was eight or nine feet of water, and I tried the pump on it. I afterwards drove it to a depth of twenty-six feet, and the water rose twenty feet in the tube; notwithstanding, however, their being so much water in the tube, it came up at first only slowly, and there was great pressure on the handle of the pump. It required several hours pumping before the water became clear and came with a free flow. But the success of the pump may be judged from the fact that I fitted first two troughs containing each 594 gallons connected together by a tube, and the two were filled in an hour and a quarter, the pump throwing out the water as fully at the end as in the beginning; showing that the springs were fully equal to the pipe, of which the bore is two inches.

The doubt I had about tube wells being equal to pumps which have a large reservoir of say six feet square, was that there was no reserve of water, and that they would exhaust under half an hour's pumping; but I now see that if you get a good spring it is quite equal to the pump with storage. Moreover, where there is a good spring, you can by the tube well get down to the bottom of it; whereas in well sinking, the men are obliged to cease working before they get down as far as would be desirable, by reason of the flow of water.

At first a great deal of mud comes up, then sand. The water gradually clears till it is as free from sediment as any of the other pumps.

The second pump I put down was in a more doubtful spot than the first. It had to be pumped a good while before water came. For a good while again it only gave about a gallon of thick water a minute. The pressure on the pump was so great that it was quite plain it was drawing the water through the ground, that it was in fact tearing springs open by main force. As the pumping went on, the water would clear for a while, and then apparently a fresh spring would be opened, and thick water would come again; but the flow improved gradually. After nearly an hour's pumping, it yielded a gallon every seven or eight seconds, and after that it required four or five hours' pumping before there was as full a flow of water as the pump was capable of throwing.

The third of the pumps which Mr. Danks has made for me, has been down twice without getting on a spring. It came once on rock at twelve feet from the surface, where there was no spring; next it came on rock at a depth of twenty-one feet. Here there was no water either. So great is the pressure of the pump at the bottom, when the pump is tried to see if it will open any springs, that it drew mud up into the tube to a height of nine feet. It is of course no fault of the pump that it cannot get water everywhere. In these two cases, the loss was only that of three men working four or five hours, whereas sinking two wells and slabbing them, of twelve feet and twenty-one feet respectively, would have been a serious loss. The putting down of the pipe for one of these pumps is less labour than boring, and one ascertains for certain whether there is water or not.

There is not much difficulty in lifting the pumps. Get a piece of quartering for a lever, say 15 feet long; put a bullock-chain round the pipe, with the hook to run on the chain; roll the other end round the lever. When the end of the lever is lifted, the chain tightens on the tube so thoroughly that it will not slip, and the tube will draw with a strong lift of the lever. When the end of the lever is lowered after the first lift of the pipe, the chain round the pipe will slip down; and when the lever is again lifted, it will tighten round the pipe, so that it will take the pipe up gradually without any re-adjusting or re-fixing of the chain.

I have heard it stated that tube wells collapse or cave in after a time. I think, however, considering how clear the water is which comes up in those I have down, that it would take a long time to bring about such a result. Neither can I see why, if any falling in took place, it should not be pumped out as well as the mud and sand were in the first instance. But even if either of those I have did cave in after a few years, it is only a forenoon's work to lift them and drive them again a few yards off—which, of course, I would do, having ascertained that there was abundance of water there. At the worst, only the labour of driving the tube is lost, as the pump tubes can also be put down in an ordinary well if required afterwards. The piping is a little stronger and more carefully fitted than that for an ordinary well.

A No. 6 Douglas pump costs £5 5s., and when a man gets handy at putting them down, fifteen shillings or a pound will cover the expense of driving them. Certainly no one ought to be without a good supply of water in his paddocks in summer when he can bring it up from a depth of 30 feet for, say, £6 10s. Most of the waterholes one sees are so filthy and impure in summer that it is enough to poison the milk, and to bring disease on and poison the blood of the animals who drink it. If animals have foul water we must expect fluke and pleuro. My cattle will not go even to waterholes supplied from springs when they can get the pure water in the troughs; and they drink vastly more of the pure water than they would of the impure.

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## Art. VI.—*On Cremation.* By S. W. Gibbons, F.C.S.

[Read 13th July, 1874.]

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## Art. VII.—*Is the Eucalyptus a Fever-destroring Tree?* By J. Bosisto, Esq.

[Read 10th August, 1874.]

In many places on the continent of Europe and elsewhere, experiments have been made to acclimatise our *eucalypti*, more especially the "*globulus*," or blue-gum species.

The rapidity of its growth, its pretty ovate, and afterwards lanceolate leaf, its early maturity, together with its power to absorb considerable moisture, and to permeate the air with its peculiar odour, led to the belief that this tree, attractive in itself, exerts a beneficial influence upon malarious districts. But this species, if considered apart from its *congéners*, does not supply sufficient information so as to arrive at anything like a satisfactory answer.

In the consideration of the question, is the *eucalyptus* a fever-destroying tree? or, in other words, does it tend to lessen malaria or to destroy miasmatic poison? we propose to regard the whole of the *eucalypt* vegetation.

If we journey from Melbourne or from other centres of population into any part of Australia, or diverge to any point of the compass, we immediately observe the *eucalyptus*, which is but seldom absent until we again enter some city or town; in fact, four-fifths of Australian vegetation consists of the *eucalyptus*.

In the consideration, therefore, of its climatic influence or of its health-producing power over that of all other vegetation existing in other countries, we are able more efficiently than elsewhere to deal with the subject.

Physiologists explain the part taken by plants in general to renovate the atmosphere and to supply to man and all other living creatures a vitalising air, and sanitary reformers have expatiated on the evils resulting from decayed vegetation under all circumstances; but as regards the destruction of malaria by the growth of certain trees, although this means has been recommended from early times, the *rationale* has been left an open question.

Some trees and plants have the reputation of evolving malaria, and in the countries where they grow the inhabitants avoid camping under or about them; in other instances, the dewdrops of the morning from off some plants have been known to irritate the skin in appearance like fever spots, similar to what I have seen produced from our *ficus macrophylla*.

Such instances are traceable to some substance existing in the plant, and have nothing to do with malaria.

Whatever may be the theory adopted as to the causes of zymotic fevers, whether it be "*Liebig's* Albuminoid," or "Pasteur's Animalcular," they greatly abound in many countries.

Australia on the whole may be said to be pretty free from virulent endemic or miasmatic fevers, and the latter may be said to exist only as the *eucalyptus* recedes.

The physical geography of Australia does not differ in its general outline from that of other countries. We have mountains and valleys, high ranges and extensive plains, rivers and creeks, and according to Mr. Selwyn,* "in general structure, character, and composition, in geological sequence, and in physical and palæontological relations, the rock formations in Victoria are in all respects analogous to those of other regions."

But in the *eucalypti* we have a vegetation absolutely

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* **Intercolonial Exhibition Essay, 1866-7.**

Australian, with the exception of its existing in the neighbouring island of Tasmania.

If, therefore, we possess in a very high degree an immunity from fever maladies, can it be traced in any way to this genus of the myrtaceous order?

Baron von Mueller describes over 130 species of this genus as existing in Australia. To an ordinary observer many species are extremely difficult of discrimination; some form together forests of great extent, both on high and low table land, others dense desert scrub, and some are so distributed over areas as to give a park-like appearance.

For the purpose in hand, I intend to refer—first, in general terms to the physical and chemical properties of the the *eucalypti* as a whole, and specially to those species which may properly be said to be the representatives of this class of vegetation.

The physical properties of all *eucalypts* are—that they cast their bark; that the leaves are evergreen and have translucent cells, in some species visible to the naked eye; that the petiole is half twisted, so that the plane of the leaf is parallel to the axis of the tree, thereby allowing free action to the light and heat of the sun *on both sides;* also the roots are dispersive and drain water largely from the soil.

The chemical contents of a *eucalyptus* tree are neither poisonous nor virulent. Besides possessing those invariably met with as general constituents of ligneous vegetation, there is a *tannate gum resin*, a *volatile acid*, and a *volatile oil* peculiarly of *eucalyptic* origin. The first two are to be found in most parts of the tree, but the latter only in the leaves. Now it is in these three bodies I think that we have the key to the question before us, and I conjecture that apart from these no trace can be found of the power of the *eucalyptus* to oxygenate the air beyond that which is possessed by other kinds of vegetation. If the principles of these bodies are retained in the tree until set free by the art of man, then further investigation is useless; but if one or more are given up freely by the natural forces of the tree, or by the aid of light, heat, or electricity as existing in the atmosphere, or by some or all of these forces in combination, then there is every reason to pursue our inquiries.

The question then arises, have we any proof that these volatile bodies are set free in the air by the forces of the plant in union with atmospheric agencies? if we have,

When does it take place?
What is the quantity?
What is the probable sanitary effect?

Before taking up this question with the above queries, I think it but right (although known to most of the members of this Society) to mention that my operations on the *eucalyptus*, both as to its solid and volatile contents, for technical and medical purposes, have extended over many years, and that they have been conducted on the living plant in its forests and in the desert scrub during all seasons of the year, and that the apparatus employed operated on four tons of material daily.

The representative or type species to which I have referred will elucidate the whole question. They are the following eight species :—

1. Viminalis, or manna gum.
2. Odorata.
3. Rostrata, or red gum.
4. Obliquâ, or stringy bark.
5. Sideroxylon, or iron bark.
6. Globulus, or blue gum.
7. Oleosa, or mallee.
8. Amygdalina, or peppermint.

The first two—*viminalis* and *odorata*—represent those species of the *eucalypti* which yield a small per centage of volatile oil.

The four following—the red gum, the stringy bark, the blue gum, and the iron bark—represent those species which gradually increase in per centage of oil until it attains to a fair medium standard; and the last two—the mallee and the peppermint—are those which represent the maximum. The following is the illustration :—

Odorata yields 7 fluid ounces from 1000 lbs. weight of fresh-gathered leaves attached to very small branchlets.

| | | | | | |
|---|---|---|---|---|---|
| Viminalis | yields | the same. | | | |
| Rostrata | „ | 15 ounces. | | | |
| Obliqua | „ | 80 | „ | or | 4 pints. |
| Globulus | „ | 120 | „ | „ 6 | „ |
| Sideroxylon | „ | 160 | „ | „ 8 | „ |
| Oleosa | „ | 200 | „ | „ 10 | „ |
| Amygdalina | „ | 500 | „ | „ 25 | „ |

No *eucalypts* exceed the *amygdalina*, and no vegetation contains so much volatile oil in the leaves as is found in most of the species just named. The eight species I have just given, not only represent the oil yield from the minimum to the maximum, but also the volatile acid and the tannate gum resin, as well as locality, from mountain to desert.

First, then, concerning the volatile oil. If we break up a leaf of any of the *eucalypti* during any part of the year, its usual aroma is present, and the oil cells appear the same in condition, but when submitted to a practical test the quantity is found to vary. Soil or locality does not appreciably affect the quantity obtained from a species when operated upon during the same season of the year.

The range of those species represented in the *viminalis* and *odorata* as yielding oil sparingly is limited in comparison with those producing larger supplies; these have a wide range.

Gum trees when in full vigour have a large amount of leaf surface, and it is necessary to note that the variableness of the supply of oil does not arise from any diminution of leaves on the branchlets during any part of the year. The oil variation throughout some years is under 20 per centum, and in others it varies very considerably, as we shall see presently. Then again the variation does not follow in a cycle of time from its maximum to its minimum, but is intermittent. To account for these peculiarities with exactness, is a task I shall not attempt; still, I may point out that the root habit of a species, the temperature of the ground, and that of the air, have much to do with it.

For example, the *eucalyptus amygdalina* is a tree varying in size from that of an ordinary willow to that of the giants of the forest, some being over 350 feet in height; it occupies chiefly the higher portions of undulating forest land, and the sides of ranges, and does not extend over 100 miles inland; the ground where it grows retains a little moisture throughout the summer months, September to April, the roots run chiefly lateral, and are seldom lower than three feet from the surface; they are surrounded with a soil evenly cool, but the temperature of the air has its usual summer range; during these months the supply of oil from week to week is very even, but as the cooler or winter months approach, the ground becoming moist from rain, and the temperature of it and the air lower, the supply of oil falls off.

Again, the mallee scrub is the opposite of all this. Properly this scrub consists of three species—the *oleosa,* the *dumosa,* and the *socialis,* but I have brought them under consideration as one, the *oleosa.* They are the dwarfs of the *eucalypti,* but seldom growing higher than 25 feet, and are more like saplings than trees; they occupy a dry, flat, hungry country, with but little growth of grass under them, chiefly dwarf heath bushes; there is little rain, but when it comes it is generally in torrents; the soil is a reddish sand, in combination with salt clay; this during the long droughts becomes exceedingly hard, so much so that a pickaxe is required to turn the soil. The roots run somewhat in a horizontal direction, and the rootlets spread out travelling downward; and as salt water is to be obtained always at from 25 to 40 feet, they are found resting on the moisture of the salt soil, just above the sandstone rock, which generally commences about 12 feet above the salt spring. The temperature of the surface ground, and also that of the air, is very high throughout the summer. The leaves supply a greater amount of oil during the winter, or rainy months, than during the hot, or summer months.

These two examples of opposite conditions at one and the same time present themselves to my mind thus—

That too much rain *out* of season renders the *amygdalina* and the other sea-ward species *poor* in volatile oil; and that the early and latter winter storms of the interior, place the desert species in the same oil condition as those of the *amygdalina* and its allies. Hence the mallee supplies an abundance of oil during the moist season, and the coast species during summer.

We have, therefore, a *eucalyptus* vegetation charged to its utmost from September to April around all our populated districts, and we have another in the desert species charged in like manner from May to October. In other words, as midwinter approaches, the coast species are increasing in volatile products and the others are decreasing.

In proof of this I give the following: In December and January the desert *eucalypti* are sending forth at the top of their thick foliated branches, new sprigs filled with new leaf development, and notwithstanding their small and delicate structure, they are full of oil cells with scarce a trace of oil in them; and in a degree a similar impoverished condition exists in the old and matured leaves. (Specimen shewn.) This again is the very opposite to the *amygdalina,* the *globulus,* and others, July and August being the months when this vegetation is in the same condition. (Specimens shewn.)

These facts to some extent account for the scarcity of oil at the times mentioned, but it is worth recording that the vigour of the *eucalyptus* is greater in some years than others; some years very little new growth takes place in comparison with other years; and that when the *eucalyptus* is less vigorous in growth, the oil-cells are charged more equally throughout the whole year.

But to illustrate this further: In July, 1873, the mallee was in fine oil condition, each two tons of rough cu branches, with their leaves, gave two gallons of oil. The ground was well saturated with water, and the surrounding country had a good overflow from the river Murray and its tributaries. The dry season set in immediately after, and the temperature of the air rose rapidly to summer heat, ranging from 68° to 92°.

In November, the country became greatly parched, and the only fresh water obtainable was that from the Murray. The oil product was reduced to fourteen pints, being a loss of two pints per two tons weight of material.

At the commencement of December, the yield had fallen to twelve pints, and at the close of the year to nine pints, the oil product gradually diminishing to the end of summer—the end of March—when the supply fluctuated from eight to four pints, the dry season still continuing.

The *amygdalina,* in the Dandenong Ranges, 280 miles S. E. of the mallee, and approaching the sea coast, produced in the same winter, month of July, only one-fifth of its full summer supply.

The two preceding years were similar, but did not vary so rapidly. On the other hand, in the year 1861, when my experiments with this mallee vegetation were occasional, it yielded as much volatile oil in December as when it was at its height, in July of 1873; and the coast species kept up a good supply with little change throughout the whole year.

The mallee country, as we shall see presently, plays a very important part in the climatic influences of Australia. But to proceed with the evidence that the *eucalypt* volatile bodies are set free in the air, we will examine the leaf and its surroundings more fully. The suspension of each leaf from the branches, as before stated, is in a line with the axis of the tree; in such cases, "there is no difference in the anatomy of the two sides.*" The stomata are on each side, and the oil cells run right through. The leaves being evergreen, are performing functions necessary to sustain the health and vigour of the tree throughout the year. Light affects both sides alike, and the temperature of the day regulates the exhalation of moisture from each leaf; and, as a light volatile body will ascend with watery vapour at an ordinary temperature, the oil dew exuding from each oil cell by the advancing forces, is so conveyed into the air.

The sense of smell bears ample testimony, when in gum tree forests, of the presence of its volatile bodies; for there is no mistaking the aroma, as it is different from all others.

The night and morning dews of the mallee country are frequent in spring and summer; this is in part owing to the suspension of water in the air during the hot days from the River Murray and its tributaries, as they pass for a considerable distance through this scrub; but the greater amount of dew moisture is owing to the exhalation of the leaves, for it must be remembered, that although the surface soil is dry and hard, the roots go down to the moist under soil obtained from the salt water springs. During the severe droughts to which this country is subject, the trunks of these dwarf trees are *full* of moisture, but so poor of sap constituents, that in one of the species in particular, when the trunk is cut close down to the roots, and placed in a bushman's pannikin, a cool and refreshing draught of water is obtained, to the great relief of a weary wanderer in this lone and dreary scrub.

So far our evidence of oil-evaporation may be stated thus: That the desert scrub gums, after a winter of average rainfall, supply the air with a continuous and even quantity of aromatic vapour, and keep up a vigorous vitality throughout the summer, or dry season; and that a short season of rain, and a long dry one, diminish the formation of oil, and so lessen the exhalation. On the other hand, the seaward species increase their quantity after a short winter.

Next concerning the volatile acid.—*Eucalyptus* leaves (especially those of some species) when submitted to the process of ordinary distillation by steam or water for volatile oil, throw off a volatile acid which greatly affects the copper head of the still, so much so, that on lifting it off we find the under surface covered with what is like a coat of

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* Lindley, "Elements of Botany," page 45.

slate-coloured paint. After the copper head has been in use for some time, this paint-like substance dries into scales having a slate-pearly appearance. (Sample on the table.) If the distillation has been by water, and the mother liquor remaining in the still is subjected to a little evaporation, this acid may be detected in the vapour by litmus paper. (Experiment shown.)

Should the evaporation be carried to further concentration, the acid aroma becomes palpable around the locality of operation; persistent, and very refreshing; in short, there is no expelling this acid out of the gum-resinous extract orming in the pan. The aroma of the acid may be detected in the air along with that of the oil, when travelling in the bush. (A specimen of the strong acid on the table.)

The special features of this acid as existing in all *eucalypts* are, that in those species supplying oil most abundantly, the acid is *not so prominent* as it is in those yielding the medium quantities; whilst those species which contain oil sparingly, contain also but little of the acid. In like manner, this applies to the resin bodies, and these facts are worthy of particular note, as they go to show, first—That those species yielding largely of oil are not so abundant either in resin or acid, and that those of medium oil yield are well charged with both. In proof of this, the *amygdalina*, our largest oil-producing species, during its active period of supplying the volatile oil, does not throw off much resin; but when it begins to lodge in the interstices of the bark and wood, and exudes outwardly, the oil is diminished in quantity in the leaves.

The *globulus*, or blue gum, yields a continued steady supply of oil and acid throughout the year; but when the tree is extra resiniferous, the acid is abundant, and the oil small in quantity.

The *rostrata*, or red gum, is another illustration. It produces a very small quantity of oil, but the volatile acid is very abundant, so much so that the red gum wood owes its aroma entirely to this acid.

The *sideroxylon*, or iron bark, are trees of good dimensions, and supply oil abundantly; but the leaf surface on each tree is small in comparison with other species. Here the resin is so abundant, that its enormous bark is everywhere studded with gum resin.

All these characteristics and others of like nature point to the following conclusion—that the volatile oil is the base of the other products peculiarly of *eucalyptic* origin; and for the following reasons—that those species which are great in the production of oil, supply it vigorously to the atmosphere, giving but little time for the formation of substances such as resins and acids, requiring the absorption of oxygen by the leaf to form them. On the other hand, those species less vigorous in oil production, allow time for the purpose, hence they become well stored with resin and with the acid.

We come now to consider the extent of this vegetation.

First, in Victoria. The whole colony, to quote from Mr. Skene's report to the Commissioners of the Exhibition of 1861, consists of 55,644,000 acres, tabulated as follows:

| | | |
|---|---|---|
| Dense mallee scrub - - | 5,560,000 | acres. |
| Mountainous ranges, densely wooded with gums - | 6,225,000 | „ |
| Opened timbered country - | 38,922,000 | „ |
| Leaving for open plains devoid of timber - - | 4,470,000 | „ |
| For morasses, lakes, and lagoons - - - | 402,000 | „ |
| And for tea tree scrub melaleuca | 65,000 | „ |

First—the mallee. The area* of 50 square feet of average scrub yields at its maximum one gallon or eight pints of oil. The whole of these dwarf *eucalypts* consequently retain in their leaves at one time, 4,843,872,000 gallons.

Second—Mountain ranges densely wooded with gum, *i.e.*, chiefly consisting of red gum, blue gum, stringy bark, white gum, and iron bark. The area of 1000 square feet supplies one gallon or eight pints of oil. The whole of this vegetation, therefore, retains in its leaves at its maximum 271,161,000 gallons.

Third—Open timbered country. Taking this as containing all the other exogenæ of Victoria, we may safely assess it as containing one-fourth of the *eucalypti*. Averaging every four acres as supplying one gallon, we have 9,730,500 gallons of oil. In other words, the desert species contains 4,843,872,000 gallons, and the seaward species 280,891,000 gallons.

If we now take into consideration the extent of the mallee country in the territory of New South Wales and South Australia—the exact area I have not at present at

* The area here given is extremely liberal, as in some parts it gave two gallons.

hand, but am credibly informed that it is at the lowest calculation 20 times the area of ours—we have 96,877,440,000 gallons of oil held at one and the same time in a belt of country massed together, over which the hot winds pass; and considering also that the same condition exists throughout the major part of Australia with the other *eucalypts* as that which exists in Victoria, we cannot arrive at any other conclusion than that the whole atmosphere of Australia is more or less affected by the perpetual exhalation of these volatile bodies.

What then is the probable physical effect? The elements composing the volatile oils from the *eucalypti* are three—O., H., and C.

Dr. J. H. Gladstone, of London, gives the following formula to the *eucalyptus amygdalina*—$C_{10}\ H_{16}$; to some of the others the like or a multiple of that; and to eucalyptus oleosa (mallee) $C_{10}\ H_{16}\ O$.

The sp. grav. of these oils at 60° F. range between 0·881 to 0·923.

Such volatile bodies when existing in the atmosphere are so minute and so diffusive, that they may be expressed as the fragrant breath of the tree; requiring thousands of its compound particles to form one minim. Under such a condition, they are in a state of preparation for a change in their molecular condition. The researches of Schönbein and others relating to the change the oxygen of the atmosphere undergoes by electricity and by other known oxidising agents, suggested a similar province for the aroma of plants and flowers; and in an address delivered by Dr. Andrews last December, before the Royal Society of Edinburgh, he states that "volatile oils, like phosphorus, have the power of changing oxygen into ozone while they are slowly oxidising."

Unless some such change took place in the air, the aroma of the oils of the *eucalypti* would be always present, and to such an extent as to become quite unpleasant. Ozone, or whatever may be the active substance in the atmosphere, is known to act in a similar manner on iodide of potassium and some other chemicals, and Dr. Day, of Geelong, whose researches on this subject are well known, has demonstrated that the *eucalyptus* oils absorb atmospheric oxygen, transforming it into peroxide of hydrogen.*

* Dr. Day, of Geelong, recommends as an excellent and very agreeable disinfectant, deal sawdust, mixed in the proportion of abont one ounce of

If the change effected be the production of ozone, and the latest known experiments on the subject, confirmed by Dr. Andrews, appear to leave no doubt that this is the case, then another link is added to the evidence that the *eucalyptus* vegetation has an important action on climatic influences. Dr. Andrews remarks, that "no connection has yet been proved to exist between the *amount* of ozone in the atmosphere and the occurrence of epidemic or other forms of disease;" but remarks, "its absence from the air of towns and of large rooms even in the country is probably the chief cause of the difference which every one feels when he breathes the air of a town or of an apartment however spacious, and afterwards inhales the fresh or *ozone-containing air* of the open country." Let a small quantity of any of the *eucalyptus* oils, but especially the oil of *eucalyptus amygdalina*, be distributed sparingly in a sick chamber, or over any unpleasant substance, or add a small quantity to stagnant water, and the pleasure of breathing an improved air will immediately be manifest. The application of this to the climate of Australia has great force, for it is acknowledged that we possess about us, both in bush and town, a large amount of active oxygen, made frequently doubly so by our vigorous vegetation.

As evidence on this part, let me refer to the circular issued last May by the Central Board of Health to the medical profession, inviting "further information respecting the continued fevers now prevailing in and around Melbourne."

The following is one of a list of questions forwarded:

"7. Have seasonal peculiarities influenced the fevers?"

Speaking as one outside of that profession, the following may be stated—That the leading oil-producing species of the *eucalypti* were, during the season prior to last May, extra poor in volatile oil, and if any connection exists between the amount of ozone in the atmosphere and the occurrence of epidemic or other forms of disease, we have given ample evidence that large quantities of the oxidising agents usually known to exist in Victorian air during that season were absent.

Having arrived at the close of the three queries set

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ol. eu. amyg. to the bushel; and remarks that after keeping it mixed for four months, he found it to contain a much larger quantity of peroxide of hydrogen than it did when first mixed, and that it continued to accumulate.

down at starting, the question now lies before us—Is the *eucalyptus* a fever-destroying tree?

We have observed that the physical geography of Australia differs in no way from that of other countries.

That the vegetation is specially its own.

That it contains peculiarities and principles adapted to benefit a country.

That to judge of its effect on climate, malaria, or fever germs, the physical and chemical characters of this vegetation must be considered.

Physically.—1st. Its powerful root action as an absorbent of humidity from the earth, by being an evergreen, and so continuous in its work.

2nd. Its leaf formation and presentation.

3rd. The abundance of leaf surface.

4th. Its leaf evaporation of water, oil, and acid, under a perpetually genial temperature.

Chemically.—1st. Its volatile oil.

2nd. Its volatile acid.

3rd. Their power of producing peroxide of hydrogen.

And finally—The evidences of the abundance of these volatile bodies, both in the plant and in the air. In the plant—By experiments conducted on one or more of the species throughout all seasons of the year, and almost continuously since 1853. In the air—By the sense of smell and by morphological deductions.

From all this we gather that there is an active agency existing in our vegetation over that of other countries. That whatever change may take place in the condition of the atmosphere, arising from the free and large supply of these chemical bodies in the air, it is from all known evidence of an invigorating and healthy nature and character.

The various fever types as found existing amongst us at times appear malignant, arising either from importation or from the existence of bad sanitary regulations; but medical testimony is that their virulence is meteor-like, "dies at its opening day." No credit can be taken for any improved sanitary condition of our surroundings by ourselves in our towns and cities, the influences operating there *entice* the poison fever germ to fructify and abound.

"Death lives where power lives unused," and were it not that such happy and benign influences, as those exerted by the *eucalyptus* vegetation, existed around us *independent of ourselves,* we might mourn our fate.

In conclusion, may we not say with some authority that the evidence set forth in this paper on our own vegetation is in favour of the *eucalyptus* being a fever-destroying tree?

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## ART. VIII.—*On Some Processes of Scientific Reasoning.*

BY F. J. PIRANI, M.A., C.E.

[Read October 12th, 1874.]

Mr. President and Gentlemen,—

I have ventured this evening to offer a few remarks on "Ideal Construction" and "The Introduction of Metempirical Elements," processes of reasoning so named by Mr. G. H. Lewes in a recent work,* the importance of which has been overlooked by most writers on Inductive Logic, although it has been recognised by several Mathematicians and Physicists. In the course of my remarks, I shall have to briefly discuss the nature of some of the fundamental ideas of Mechanics—a subject on the borderland between Physics and Metaphysics, and one of great difficulty, if we may judge by the controversies it has occasioned amongst philosophers. But as science advances, it is well to examine its foundations from time to time, so that we may ascertain whether they are solidly built, and whether they are capable of bearing the weight of the continually increasing superstructure.

The method of Ideal Construction may be thus described:—The definitions and axioms of any branch of science, or, at all events, of any branch of science which has reached the Deductive stage, do not refer to the objects to which the results of the science are eventually applied, but to ideal conceptions of objects resembling the real ones, but of a nature much simpler and more capable of mathematical treatment. The conclusions arrived at by deductive reasoning, absolutely true for the ideal objects, will only be approximately true for the real ones, although sometimes the degree of approximation will be such that our senses are incapable of distinguishing it from absolute coincidence.

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* "Problems of Life and Mind," vol. i.

The Science of Geometry certainly pursues the method of Ideal Construction. Few mathematicians will agree with Mr. Mill that Geometry deals with the forms of real material objects. The subject-matter of Geometry is not the forms of real objects, but Ideal Conceptions derived therefrom. No material object fulfils the mathematical definition of a sphere —that all points on its boundary are equally distant from a certain point within the sphere—and consequently none of the propositions proved for geometrical spheres are rigorously true for material objects ; the more nearly a material object fulfils the definition of an ideal sphere, the more nearly are the properties of ideal spheres true for it, and the difference between some real objects and ideal spheres may be so small that, as far as our senses can detect, they rigorously possess the properties of the ideal conceptions. So, there is no such thing in nature as a straight line,—no lines such that if they coincide in two points, they coincide everywhere between those points,—although there are many material lines whose difference from straight lines is imperceptible to the senses.

The one Science which is as true of reals as of ideals is Arithmetic, or, at all events, that branch of Arithmetic which deals with Integral Number. Ten material bodies fulfil the definition of ten as accurately as ten ideal spheres and the deductions of Integral Arithmetic are absolutely true for external objects.

I now pass to the science of Dynamics. The fundamental conceptions of this Science are those of Matter and Force. I do not intend to discuss the various theories which have been held as to the nature and origin of these conceptions, but will endeavour, to the best of my ability, to give a clear account of my own opinions on the subject. Without entering into the general subject of the nature of Knowledge and Belief, it will be permitted me, I think, to divide Beliefs into two classes—Beliefs which have received verification from experience, and Beliefs which have not received such verification, either because they are, from their nature, incapable of it, or because the requisite experience has never presented itself. Would it be allowable to define the term Scientific Knowledge as denoting those Beliefs which have been verified by experience?

Now, let us take such a belief as this—a table is before me;—how can I proceed to test that belief? I may look at the table; I may touch it, and in other ways apply my senses to test my belief. But what is proved when I look at the table? All that is proved directly is that certain states of consciousness, those involved in directing my eyes towards the table, are followed by certain other states of consciousness, the sight of the table. J. S. Mill, G. Grote, and others have very ably argued that all our knowledge is of states of consciousness and relations of co-existence and sequence between them. Certainly, such knowledge is the only sort of knowledge which admits of verification by experience, which can prove nothing directly, except relations between states of consciousness or phenomena. It must, however, be admitted that all our beliefs involve more than beliefs in such relations; that we have a very strong belief in the existence of something underlying phenomena, and which, in some sense, produces them. This underlying something is what is denoted by Matter. Mr. Mill himself admits that all our language involves the belief in Matter as something different from phenomena; and, truly, he would have a difficult task to perform who would endeavour to describe physical phenomena in intelligible language, which involved no beliefs except beliefs in relations between states of consciousness. So then, such a statement as, "A table six feet long is in this room," implies a large number of relations between states of consciousness, and also the existence of something different from those states, and which, partly, at all events, is the cause of them. The former portion of the belief admits of verification; the latter does not. If "matter" were suddenly annihilated, and some powerful spirit were to cause states of consciousness to succeed each other in our minds in the same order as they did before, we could not detect the difference. In dreams and hallucinations states of consciousness of a purely subjective origin excite the belief in External Matter as vividly as those presented in waking life.

In the use of words which involve the belief in matter, we have an example of the process which Mr. Lewes terms the Introduction of Metempirical Elements into beliefs, that is elements whose presence cannot be tested by experience.

Let us next consider the idea of Force. The origin of this idea is to be sought in voluntary muscular motion. If I move my arm, and introspectively observe the phenomenon, I find it may be divided into three parts.

1. The *volition* to move my arm.

2. The *effort* to move it.

3. Its motion.

Any one of these three may be isolated from the others. If I am paralysed, I may *will* to move my arm, but am incapable of exerting any *effort* to move it. If my legs are tied down, and the soles of my feet tickled, there will, quite independently of, and even in opposition to my will, be an *effort* to move my leg, which is not followed by sensible motion. If somebody else takes hold of my arm and pulls it, we have motion without being conscious of volition or effort.

Motion, however, is only one of the effects which effort can produce; there are others, *e.g.*, if I press my two hands together, I have effort producing pressure. Now, these effects which conscious effort can produce may be produced otherwise, as by tying a weight to my arm. Force is the name for anything which can produce the effects Effort produces; in fact Effort is a species of Force, though it does not follow that all Force is Effort. We may speak of a weight as a Force, or, as is sometimes done, we may speak of the weight as having a Force inherent in it. However we may picture Force to our imagination, it is a *metempirical* conception. All we can know of Force by experience is the phenomenal effects it produces. Yet, although a metempirical conception, the idea of Force is a most valuable one, and enables us to describe phenomenon much more clearly and concisely than could be done without employing it.

Having attempted an exposition of the nature of our conceptions of Matter and Force, I now proceed to show how Ideal Construction is employed in Dynamics.

Dynamics is generally divided into four parts—Dynamics of a particle, of a rigid body, of a fluid, and of a gas. Into each of these divisions Ideal Construction enters. There are no objects in nature which fulfil the definitions of a particle, rigid body, fluid, or gas. Yet there are many objects which, to our senses, differ so little from these Ideal conceptions, that the conclusion of Abstract Dynamics may be applied to them without practical error. We may also notice the Ideal conceptions of perfectly smooth bodies, flexible strings, &c. In dealing with the subject of *Impact*, an Ideal construction is employed, viz., the Idea of bodies which after coming into contact with each other, *immediately* rebound. As a matter of fact, an interval of time always elapses between impulse and repulse; yet this interval is so short that it may practically be left out of account.

An ideal conception which enters into nearly every branch of Physics is that of an homogeneous body. A body may be homogeneous in various ways; if all the parts of a body have the same density, it is homogeneous as to density; if they have all the same chemical composition, it is chemically homogeneous. A body would be said to be absolutely homogeneous, or homogeneous in every respect, if any two parts of it differed in no properties except shape, size, and position, and such properties as are dependent on these. There is, however, no such thing as an homogeneous body, nor is there even any body which is homogeneous in respect to any particular quality. It is equally true that there is no body which is heterogeneous according to any simple mathematical law;—an ideal construction which is sometimes employed to give results more in accordance with facts than those obtained from the conception of simple homogeneity.

In those higher branches of Dynamics which deal with solids as not rigid, but susceptible of change of form under the action of Force, that is as elastic bodies, the conception of a particular sort of homogeneity, or of heterogeneity according to a definite law, is introduced. Such conceptions enable us to obtain results more consistent with facts than those derived from the conception of an absolutely rigid body; yet, partly from the mathematical difficulties of the subject, and partly from the irregular heterogeneous constitution of real objects, many practical problems of strain and stress in solids remain unsolved.

The Science of Heat assumes bodies to be homogeneous as to the powers of conduction, radiation, &c. Such assumptions afford examples of Ideal Construction. This Science also gives a very excellent illustration of the Introduction of Metempirical Elements.

Before the kinetic theory of Heat was accepted, what was meant by saying that a body was hot? The primary meaning was that a particular sort of sensation, that of heat, was produced in a person's mind when the body was placed in contact with, or brought near to his skin. But when it was discovered that all bodies which produced this phenomenon produced other peculiar phenomena when brought into proximity to other bodies, it was found convenient to introduce the Metempirical conception of Heat as an unknown something whose presence produced these phenomena, just as Force denotes the unknown something which produces the phenomena of motion and pressure. We have, however, no such subjective knowledge of Heat as we have of one species of Force, viz., Effort. I must here notice an unfortunate ambiguity of language which employs the same word to denote the subjective sensation, heat, and the objective cause of that sensation. "Hot" has very different meanings in the sentences, "I am hot," and "this stone is hot." There is a similar ambiguity in the use of the words light, sound, &c.

Heat was by some conceived as a substance possessing all the qualities of a fluid except the quality of weight. This conception, was, however, inadequate to explain all the phenomena, and it and other ways of conceiving heat have now given place to the Empirical conception of Heat as a vibratory motion of particles.*

What has been said about Heat is, *mutatis mutandis,* applicable to the sciences of Light and Sound. As an example of Ideal Construction in Light, I may instance that of a body homogeneous in refractive power, or of a body heterogeneous in respect to that quality according to a simple law. How inaccurately deductions from this conception represent some physical phenomena is exemplified by the impossibility of determining with a close approximation to accuracy the effect of refraction on a heavenly body near the horizon. On the other hand, the results of mathematical calculation represent with practically perfect accuracy its effect on a body near the zenith.

The old metempirical conception of Light resembled very closely the metempirical conception of Heat; and the modern empirical conception of Light, as a vibratory motion of particles, resembles the empirical conception of Heat; indeed, it is now generally believed that Light and Heat are identical—that the same vibrations which, under certain conditions, produce the phenomena of heat, under other conditions produce the phenomena of light. There is not perfect agreement amongst physicists as to what it is, the

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* In calling this conception Empirical, of course I do not mean that the vibration of molecules is a phenomenon which could be perceived by the senses, but that it differs from sensible phenomena in degree, and not in kind. It is empirical in the same sense as a million miles or the millionth part of an inch is empirical.

motion of whose particles constitutes Light. Some consider Light as the vibrations of ether—a substance different from any substance known empirically — while others consider it as the motion of particles of ordinary matter; others, I believe, hold a combination of these theories, and consider that the vibrations of ether may be communicated to the particles of ordinary matter.

Acoustics calls for no special consideration; like all other physical sciences, it employs the method of Ideal construction. Some of its conclusions agree very closely with real phenomena, while others do not accord very accurately with experience. The metempirical conception of Sound gave place, very early in the history of the Science, to the empirical conception of a vibration of the particles of sounding bodies.

The Ideal constructions employed in Electricity and Magnetism are of much the some character as those employed in the Sciences of Heat and Light. As one example I may mention that of soft iron, an abstraction convenient for expressing certain general laws of electricity, which are not accurately true for real iron. There are also metempirical conceptions of Electricity and Magnetism as the unknown causes of electric and magnetic phenomena. These two are, however, now considered to be one and the same. Electric and magnetic phenomena are intimately connected, and, whatever Electricity itself may be, we have no need to assume an additional entity as the cause of magnetic phenomena. None of the attempts to replace the metempirical conception of Electricity by an empirical one, similar to that to which Heat and Light have been reduced, can at present be considered perfectly satisfactory. The conception of Electricity as an imponderable fluid, although applicable to many problems, presents considerable difficulty. The most plausible theory seems to be that put forward by Mr. Clerk Maxwell, who considers the attraction between two electrified bodies to be caused by some sort of strain of a medium between them, rather than to any affection of the bodies themselves. From the action of magnetism on polarised light, he is led to believe that the ultimate cause of electrical phenomena is "the rotation of very small portions of the medium, each rotating on its own axis." *

* Clerk Maxwell's "Electricity and Magnetism," vol. ii. p. 408.

Chemistry is almost entirely based on Ideal construction. We popularly employ the term "gold" to denote various objects which possess certain properties of weight, color, &c., but the gold of the chemist is an ideal conception bearing the same relation to real gold as a geometrical sphere does to a real sphere; in fact, I believe I am correct in saying that no chemical element or definite chemical compound exists in nature, or can be produced artificially, in a state of absolute purity. The law of chemical combination in definite proportions is not accurately true for real substances, although in many experiments the deviation from the law is practically insensible. The same is true of the relation between the combining equivalent and specific heat of a gas, and, in short, of all numerical chemical laws.

Chemical affinity is a conception which is at present of an entirely metempirical nature. The phenomena of chemical composition and decompositions cannot be explained by the laws of ordinary physics, and it is convenient to assume an "unknown something," called Chemical Affinity, as the cause of these phenomena. Chemical Affinity is sometimes used in another sense, as a name for the peculiar relations between phenomena which it is in its other meaning the cause of—an unfortunate ambiguity—but the word has many companions in misfortune.

I may here allude to the fact that the separation of the different branches of Science from each other is purely an artificial one. All the relations between real material substances are complicated relations, involving dynamical, thermal, electrical, and, probably, chemical phenomena; and the perfect solution of the simplest mechanical problem would involve the application of all the Sciences which respectively deal with these phenomena. It is only by adopting the method of Ideal Construction that the different Inorganic Sciences can be separated from one another.

Passing now from inorganic to organic phenomena, in the Ideal Vertebral Skeleton of Owen we have a capital example of Ideal Construction. However, Biology has at present scarcely reached the deductive stage, and until it has become, to some considerable extent, a Deductive Science, it cannot be expected to illustrate the full value of that method of reasoning.

In Biology, we have the introduction of a metempirical element, which has been the cause of very violent controversy;—I refer to the idea of Life, Vitality, or Vital Force.

Now, the only phenomena exhibited by organic bodies which our senses can perceive are mechanical, thermal, electric, and chemical phenomena; but the *relations between organic phenomena* are different from the relations between physical and chemical phenomena. Although physics and chemistry may be competent to explain the actions which go on in a dead animal, they are incapable of explaining those which go on in a live one. If, then, we assume Vitality as an "unknown something" which is the cause of those changes which Mechanical Force, Heat, Electricity, and Chemical Affinity cannot be the cause of, we are only adopting a method which has been adopted and found useful in the lower divisions of Science. But let us remember that what Vitality is we know not, any more than we know what Matter is, or, than three hundred years ago, we knew what Light was. It is possible that as the metempirical conceptions of Heat and Light as abstract entities have been replaced by the empirical conception of vibratory motion, so Vitality may some day be replaced by an empirical concept; but, at all events, the day when this can be successfully accomplished seems to be far distant.

And as of Life, so of Mind. The relations between the phenomena exhibited by what are called intelligent beings are ultra-biological, as the relations between the phenomena exhibited by all organic beings are ultra-physical and ultra-chemical, and the introduction of a metempirical conception Mind or Intelligence as the cause of the ultra-biological relations is a Scientific process. But although the objective study of intelligent beings has as yet given us no certain information as to what Mind is, we have a subjective knowledge of, at all events, one species of Mind, as we have a subjective knowledge of one species of Force. We must not, however, too rashly assume that all Mind is the same as our Mind, as we must not assume that all Force is the same as that species of Force which is subjectively known as Effort. It is possible that some day Mind, as considered objectively, may be replaced by some empirical conception of vibration of nerve substance;—Mr. Herbert Spencer especially has made a very able attempt to accomplish this;* but that Mind as known subjectively is nothing but such vibrations is, to me at all events, an utterly inconceivable proposition.

* *Vide* Herbert Spencer's "Principles of Psychology."

However, I fear I am getting into cloud-land, and, in conclusion, I think I am warranted in saying that I have shown that both Ideal Construction and the Introduction of Metempirical Conceptions are processes of frequent employment and of great value in Science, and that the thanks of both physicists and logicians are due to Mr. Lewes for having explicitly called attention to them.

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## Art. IX.—*On the Photographic Processes to be adopted in Observing the Transit of Venus.*

By R. L. J. Ellery, F.R.S., F.R.A.S.

[Read 12th October, 1874.]

## ART. X.—*Notes on the Discovery of some Keys in the Shore Formation of Corio Bay, near Geelong.*

BY T. RAWLINSON, C.E.

[Read 16th November, 1874.]

In a conversation with Mr. Alex. F. Mollison, some few days ago, he informed me of a statement made to him in England, by Mr. C. J. Latrobe, formerly Lieut. Governor of Victoria, of a singular incident which occurred about 1845 or 1846, namely, the discovery of some iron keys in the vicinity of Corio Bay, embedded in what presented all the characteristics of an old sea beach, and overlaid by 15 feet of diluvium, at a level of 10 feet above the present high water mark in the Bay.

Mr. Mollison was at Geelong the day after the discovery, and personally examined the locality, and to this extent can confirm the statement made; and owing to his knowledge of the occurrence so far, he, on the occasion of a recent visit to England, requested Mr. Latrobe to narrate the circumstances in writing for him. Mr. Latrobe complied with this wish about four years ago, by dictating to his daughter the particulars as set down in the accompanying paper.

The high character of the narrator, his known keenness of observation, and his shrewdness in sifting facts, combined with the confirmation of the statements to a certain point by Mr. Mollison, a well-known colonist of many years, gives an importance to the narrative which it would not otherwise possess unless so vouched for; and beyond all this there is the want of motive for Boucher to attempt trick or deception in practising on Mr. Latrobe's credulity. To reject the statements made, vouched for as they are by persons of undoubted integrity, involves to my mind a much greater degree of hardihood than their acceptance. The statements may be at present inexplicable, but I have yet to learn that this is a valid reason for their rejection.

The above considerations have induced me to think the matter worth laying before the members of the Royal Society, as a record of a singular experience, wholly irrespective of its value from a scientific point of view.

Mr. Latrobe's narrative of what came under his own notice is one thing, his hypothesis to account for what he saw is quite another affair, and the latter being but a matter of opinion, cannot influence the value of the statement which I now propose reading.

Mr. Latrobe's statement, copied from an original document in the possession of Alex. F. Mollison, Esq., 2nd November, 1874, by the reader, Mr. Rawlinson.

"*The Boucher Lime Kiln, near Geelong, and a Memorandum about Three Keys found there.*

By C. J. LATROBE, C.B.

Formerly Lieut. Governor of Victoria.

"I believe it was either in the year 1845 or 1846, during one of my occasional visits to Geelong, that I, understanding from Mr. Addis, our Crown Lands Commissioner, that a man, of the name of Boucher I think, who had a license for lime burning on the shore half a mile or more below Geelong, had made a new excavation for a lime kiln, I proposed to walk down and see it, as I thought it would give me some further information on the geological structure of that portion of the coast line.

"We walked over the open down, descended the abruptly swelling banks to the sea-side, a little beyond the first point to the southward, and then proceeding along the shore, entered the excavation from below over the rubbish which had been thrown out.

"A labourer on the spot was sent up to the hut above, to inform the lime burner of our visit.

"As soon as I entered the circular excavation, which was about twenty feet deep, my eye was immediately attracted by the appearance of a line of calcareous matter, presenting itself about the level of my head, and I saw at a glance that it was composed of decayed calcareous shelly matter, the upper line of which was thickly strewn with sea-shells of different species, exactly similar to those which lay on the beach, a few yards below us. Many of these were so little altered as to be scarcely decayed, even preserving their enamel.

"I directed my companion's attention to the fact, and to the certainty that at no very distant period this line of shells must have formed the beach. This stratum was so far consolidated as to render its removal, except by the pick, very difficult.

"I was working with my knife, to detach some of the shells, when the lime-burner joined us. On seeing how I was engaged, and overhearing the conversation with my companion, he said, 'I found a bunch of keys yesterday, just where your honour is picking the shells.' 'Keys?' I said. 'Keys, your honour,' he replied. 'What can you mean?' I enquired. 'Yes, here,' he said, laying his hand just upon the shellbed. I asked him 'Where are they?' 'Up at the hut, your honour,' he replied. 'Let me see them,' I said. He immediately left the excavation and ran up the bank to his hut, returning a minute or two afterwards with two keys, each about two inches in length, which he handed to me, saying that there had been three, but that the children had been playing with them, and he could only lay his hand upon the two. There could be no question but that they were keys, very little, if any way corroded with rust, very similar to those of the present day, except that they were a little longer in the shank, and the wards smaller than is now usual. The latter were not only distinguishable, but were partially filled and encrusted with the calcareous matter upon which they had lain. They were just of the description still used for a box or trunk, or seaman's chest, and I should judge from the form that they were not more than a hundred or one hundred and fifty years old at most. The position in which they were found gave me the impression of their having been dropped on the beach at the time when the shellbed formed the shore line.

"I am thus circumstantial, in order to convey to the mind the feeling of certainty that I have entertained from the first, that there could be no doubt as to the fact, that these three keys (probably only originally tied together) were found at the time and in the position I have stated.

"I immediately took a rough measurement of the overlaying soil, which consisted of a compact bed of dark brown sandy loam, tinged with iron, underlying a thin layer of vegetable mould. This overlay was about 15 feet in thickness, and the height of the old shelly beach above the present high water mark about 10 feet, and the distance from the actual shore being about 40 feet inland. I was very careful to see that the sloping down of the land above showed no marks of a land slip, or wombat holes, or springs, or any interstices through which the keys might have reached the position in which they were found. In fact, I came away thoroughly convinced that none such had existed, but that at the time the keys were deposited the matrix was an open beach, forming the then shore line.

"Now, presuming that the facts above related be incontestible, two things are to be accounted for—

"1st. The existence of a shore line so many feet above that now existing.

"2nd. The overlapping and overlaying of that shore line by the undulating down, descending to the shore from the interior.

"With regard to the first hypothesis, many may be tempted to account for it by referring it to upheaval of the coast, an occurrence of which in past periods at least the whole southern Australian coast line affords so many undoubted proofs, and it may be said there is no reason why such should not have occurred here in very recent times; but the second difficulty, however, presented by the overlapping of the adjacent country, cannot be thus accounted for.

"Port Phillip was first discovered by Lieut. Murray, in 1802, and actually entered by Flinders the same year; and as the latter mentions visiting Indented Head, and even Station Peak, he may have visited Corio Bay.

"The first settlement was made by Col. Collins, in 1803, on the Nepean side.

"Possibly Lieut. Grimes, who was sent from his camp to report upon the extent and character of the bay, may have made the circuit, as it may be supposed the runaway Buckley must have done before he permanently took up his residence with the tribe of blacks frequenting the vicinity of Corio Bay.

"No actual survey was made before the visit of the 'Rattlesnake,' under Captain Hobson, in 1836, Batman having in the previous year formed his first station on Indented Head. It is not impossible that runaway convicts or shipwrecked mariners may have visited these shores prior to the recorded discovery, and visits as above-mentioned.

"I remarked above that the first idea which might present itself to the mind on viewing the signs of a former higher level in the beach line in this and other localities in Port Phillip, would be that there had been a sudden or gradual upheaval of the land; but I have been led to reject this idea, and to ascribe the appearance of this elevated shore line to an alteration in the level of the waters of the bay, and their subsidence caused by the outbreak of the waters through the great gap in the coast line, now existing between Point Lonsdale and Point Nepean.

"There is every sign of the violent disruption of this part of the enclosing barrier, and *that* one might be led to suppose within a very limited geological period.

"No one who has remarked the phenomena of the *ripple*, and of the continuous line of foam (it might almost be said 'breakers') which extends from Point Nepean to Point Lonsdale at times, when the wind and tide coincide in causing an extraordinary rush of the Port Phillip waters, or returning tide through the opening, can doubt that the foundations are still existing, and that they present proofs of a disturbance of no ordinary character.

"Although the soundings ordinarily given at Port Phillip Heads and the entrance of the bay show no very great variation of depth, being generally from 9 to 16 fathoms inside the bay, I would not only refer to the discovery since my time of isolated pinnacles of rock rising here and there much nearer the surface, and only detected by accident, but also to the positive existence of cavities marking a most extraordinary disturbance of the sea bottom.

"The survey of the 'Rattlesnake' in 1836, points out the existence of such a hole just inside the ripple, towards the Point Lonsdale side, the depth being 24 to 28 fathoms, adjacent to soundings showing from 6 to 10 fathoms only.

"In the year 1854, in the month of February, I was with the late Captain Ferguson upon the 'Pacific,' crossing from Shortland's Bluff towards Point Nepean, making for the Quarantine Station, or Capel Sound. The tide was running out with great violence, and the wind failing us as we approached the Point Nepean side, we found that we could not with safety continue our course, and that it was absolutely necessary for us to cast anchor where we were until the turn of the tide, or the south wind would allow us to proceed.

The anchor was let go in what we supposed to be about 10 fathoms, but to our great amazement the cable ran out, and did not take the ground until it marked a depth of 35 fathoms. We found that we in fact must have cast anchor in the middle of an enormous depression, like a crater of, as we found, but limited area, and a pretty arduous task it was to heave anchor and disengage ourselves from this pit when the tide turned.

"It may be gathered from the foregoing that I am inclined to the opinion that before the epoch of the disruption of the coast line at the present Heads, the waters of this large interior bay were at a higher level, and I believe it probable that the former outlet for its surplus waters is to be found in the line of the present low marshes and lakes which extend from Corio Bay to the Barwon Heads.

"The two keys in question were long in my possession, and the original pencil memorandum and sketch (but unfortunately not the precise date) still remain so.

"The circumstances of the finding were of course well known among my friends, and if I remember right, were the subject of a correspondence with my friend Ronald Gunn, one of the few scientific men with whom I was then acquainted in Australia. I have an idea that the keys were given to the Mechanics' Institute, which unfortunately received from me before it went to the bad, many objects of interest which are now seemingly lost. I do not recollect that there was any mention of the finding of the keys at the time in the Melbourne papers, but think it possible that as it excited some curiosity among a few at the time, such mention may have been made in the Geelong paper, then conducted by Mr. Harrison.

"My only companion at the time was, as I have said, Mr. Commissioner Addis, now unfortunately no more.

"I may still add, that circumstances during my residence in the colony led to my becoming much better acquainted with the character of a large extent of coast line, and of the extraordinary phenomena it displays, than might have been supposed.

"Many portions of the coast, from the mouth of the Glenelg to the Albert River in Gipps Land, came under my personal observation; and some divisions, for instance that from Portland to Cape Bunbury, east of Cape Otway, were in fact explored chiefly on foot, and under circumstances which have left an indelible impression upon my mind.

*(Signed)* "C. J. Latrobe."

Such is the copy of Mr. Latrobe's narrative to Mr. Mollison, with verbal alterations only, such as are commonly requisite in oral statements when committed to writing, but every fact remaining intact, as dictated by Mr. Latrobe to his daughter.

I now propose to briefly discuss the paper, and review the causes, as suggested by Mr. Latrobe, in explanation of the alleged facts as narrated.

The hypothesis of the waters of Port Phillip Bay having at one time been impounded to a height of 10 or more feet above their present level, is set at rest by an examination of the shells (see note annexed) from the elevated beach line; for if the waters were ever impounded, as suggested, the gulph must have been a fresh water lake, and the shells would be of the usual lacustrine character, common to such waters; but as the shells prove to be marine, it is clear that the impounding theory must be abandoned.

It must also be, I think, admitted, that with such an extensive area of inland waters as those of Port Phillip, any intermittent theory of alternate opening and closing, according as the dry or wet seasons prevail, is untenable, owing to the enormous scouring power existent in such a channel when once opened out.

The second hypothesis, of recent upheaval, is countenanced by various facts known to exist along our coasts; and some years back this question was discussed by the members of the Royal Society, in connection with the alleged elevated coast lines at Williamstown. The upheaval theory accounts for some of the difficulties; but there are yet two serious ones left, namely, the time and the causes required to produce the deposit of the 15 feet above the old beach line, and the additional elevation of 10 feet of the old beach above the present sea level, in the period within which it is possible that the keys could have lain there.

Always supposing that Mr. Latrobe's examination of the superincumbent strata was sufficiently minute to preclude the possibility of the accidental lodging of the keys where found, and dismissing as to the last degree improbable, the possibility of Mr. Latrobe having allowed himself to be imposed upon, the question naturally arises as to where the keys could have come from originally, or by what means could they have been lodged in such a locality at so remote a period, as to allow of so great an accumulation above them as described, namely, 15 feet.

The earliest known visit to Port Phillip was about 1802, and the time which has elapsed since then appears very inadequate to produce so great results under present known conditions; and admitting the statements made as within the range of possibility, I do not see any alternative but to extend the period for from 200 to a little over 300 years back, during which period the Buccaneers had made their presence felt in the Pacific; we know that some of them visited Australia in their wanderings, and it is almost a certainty that many of them left little trace of their presence, except in traditions of lost ships and ruined towns.

It may appear visionary to travel so far on mere conjecture for a cause, but the whole of the circumstances are so exceptional, that suggestions may be hazarded which could not be tolerated under other conditions, and in doing this I beg to remind the members of Hamlet's warning to his friend—"There are more things in heaven and earth than is dreamt of in our philosophy."

In New Zealand, not far from Hokitiki, there has been seen the decaying remains of a ship's keel, with a tree growing through it, and evidences of copper fastenings found in the vicinity, but no trace of its origin, or how it came to be embedded in an inland basin far away from the sea. Whether the ill-fated bark was driven in on an earthquake wave, or on one of the more terrible rollers which at times break against Tristan da Cuna, and in the bay of Panama, coming in like a wall 20 to 30 feet high, and tearing ships from their moorings, rolling them over as if but a child's toy-boat, who can tell? Some such fate has been the closing scene doubtless of many a gallant expedition in an unknown sea, divided from civilisation by half a world; and the discovery of the lost keys on the old Corio beach is full of suggestions as to their possible history, and that of their adventurous owners.

Since writing the above it has come to my knowledge that the subject matter of the discovery of the keys was communicated to the proprietors of the *Argus* many months ago; but even with this knowledge I yet think the records of the Royal Society the proper storehouse for narrations such as the foregoing.

2nd November, 1874. THOMAS. E. RAWLINSON.

In a personal inspection made of the shore of Corio Bay since the above notes were penned, and after an inspection of the geological maps of the district, I incline to the opinion that there may have been an outlet for part of the bay waters across the low lands from Corio Bay *viâ* Connewarre and the Barwon River to Bass's Straits, as suggested by Mr. Latrobe, and as indicated by Mr. Selwyn on the geological maps; but it must have been under very different conditions to those conjectured by the former, namely, a disruption of the coast line between Point Nepean and Point Lonsdale, because the deposits are marine, and as a consequence the land must at that time have been submerged to a considerable depth below the present level of the sea.

Between the Geelong wharves and Limeburners' Point there is still the remains of an old excavation, showing in section the exact features as sketched and described by Mr. Latrobe, although the Limekiln is a thing of the past. Above the limestone is a thin bed of broken shell, Turritella and others, and coarse sand, and above this a bed of clay and two thin succeeding beds, surmounted by surface soil. The whole of the beds present the usual features of an aqueous deposit.

Towards Limeburners' Point the limestone rises considerably, and the superior beds are reduced to one bed of clay about 4 feet thick, and about 2 feet of clay and vegetable soil above, and from this point the whole surface declines to the eastward to below the level of the Samphire flats, between Point Henrytown and Connewarre.

Assuming that the land was submerged sufficiently to permit the tidal flow of waters across the estuary beds of Connewarre, it is probable that owing to the then changed physical features of the country, a large body of water may have entered Corio Bay from the north-west along the valley west of the You Yangs, now drained by the Moorabool and Duck Ponds rivers; and such being the case the several deposits above the limestone of Corio Bay at Boucher's Kiln can be accounted for, the only really serious element of difficulty remaining being the brief period of time within which such a considerable upheaval (nearly 30 feet vertical) is possible, although the extent of such a movement in the time is not an insuperable objection.

On the table I submit sample of materials from the old beach, and of a boring pholas embedded in the limestone, the shell being as perfect as if dead only a few years.

No. 1 is a sample of the old sea beach shells from the locality of Boucher's Kiln, as described.

No. 2 is a sample of the old sea beach shells from Limeburners' Point.

No. 3 is a sample of the soft white limestone, with pholas shell as described.

THOMAS E. RAWLINSON.
6/11/74.

Sections to illustrate paper:

Mr. Latrobe's sketch, section of Boucher's Kiln.

No. 1. Section from Mud Island to Two Sisters.

No. 2. Section from Low Light, Shortland's Bluff, to Quarantine Station.

No. 3. Section about one-third distance from Point Lonsdale to Shortland's Bluff to Point Nepean.

No. 4. Point Lonsdale to point Nepean.

No. 5. Sketch, Plan of Entrance to Port Phillip and of Corio Bay.

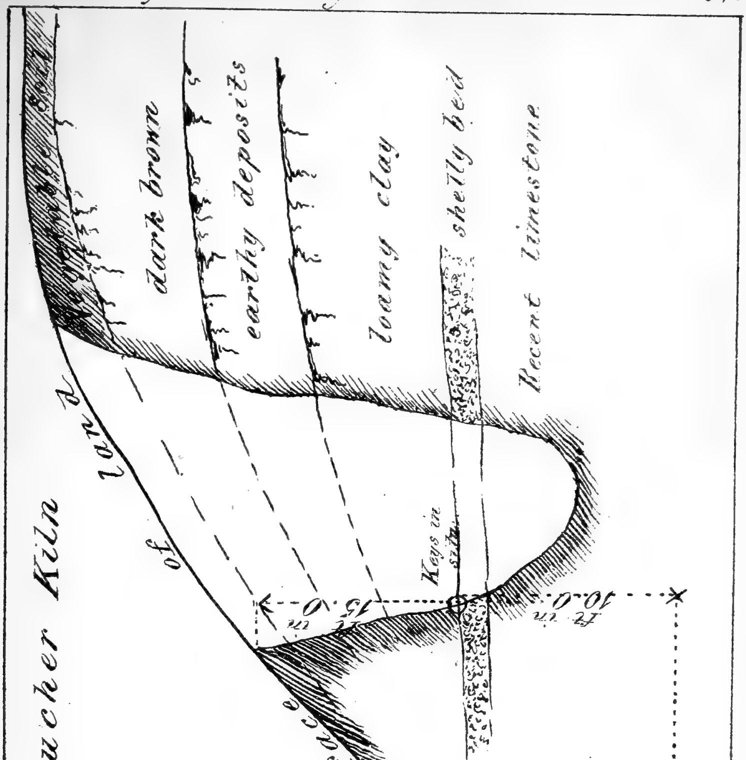
N.B.—In the discussion on the paper the President, in reply to a question, stated "there was no doubt as to the shells of the old beach exhibited being marine." This decision is conclusive against Mr. Latrobe's. theory of an inland lake.

One member stated that the circumstances of the discovery of the keys were notorious at the time, and much discussed, as he knew from having heard his father frequently allude to the circumstances; and this is the more valuable, as being still further an additional confirmation of the accuracy of Mr. Latrobe's notes of byegone events.

It was pointed out that owing to the peculiar formation of the superincumbent beds at Boucher's Kiln, and their limited extent, an indent or short gully probably existed at this point, and this would account for the lowness of the limestone rock at this place, and the three distinct layers of clay and loam between it and the soil, each deposit being made at intervals of time, as the upper surface showed a black line of deposit straight on the upper surface, and evidence of settlement on the lower edge, into the fine deposit below. Still water in a shallow gully would be quite sufficient to account for the several deposits, and under such conditions the accumulations would be rapid, owing to precipitations of mud from the surcharged waters of the valley north-west of the You Yangs.

To accompany
Mr. Rawlinsons notes
on lost keys in Corio Bay.

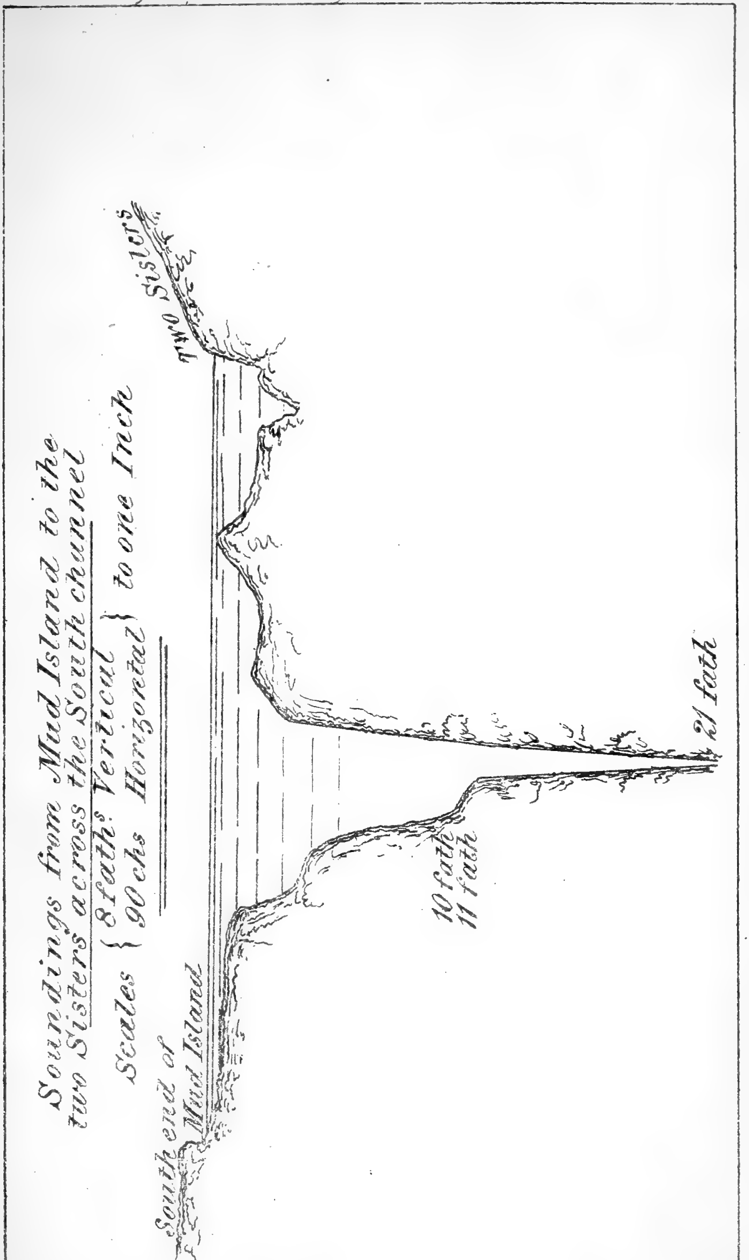
No.




T E Rawlinson delt.

To accompany
Mr Rawlinsons notes
on lost keys in Corio bays

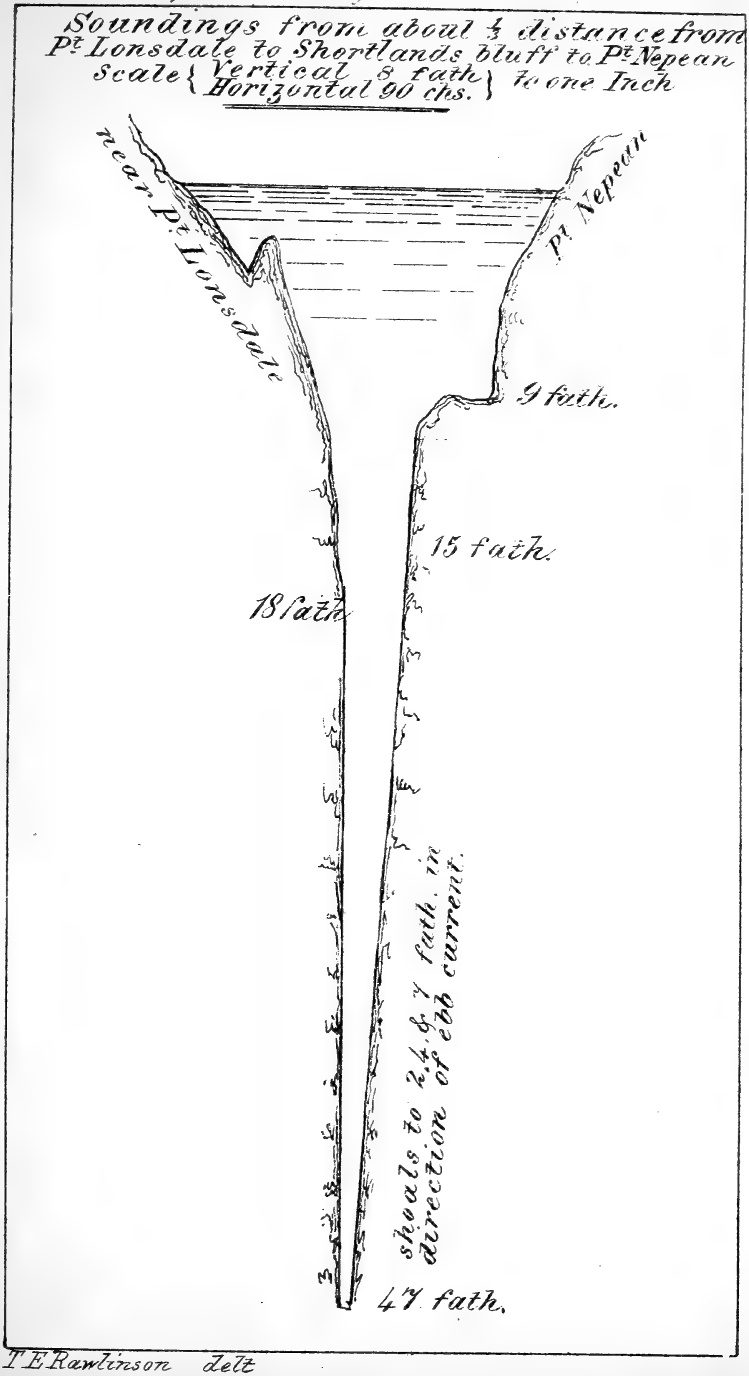
No 1




T.E.Rawlinson delt

To accompany
Mr Rawlinsons notes
on lost keys in Corio Bay

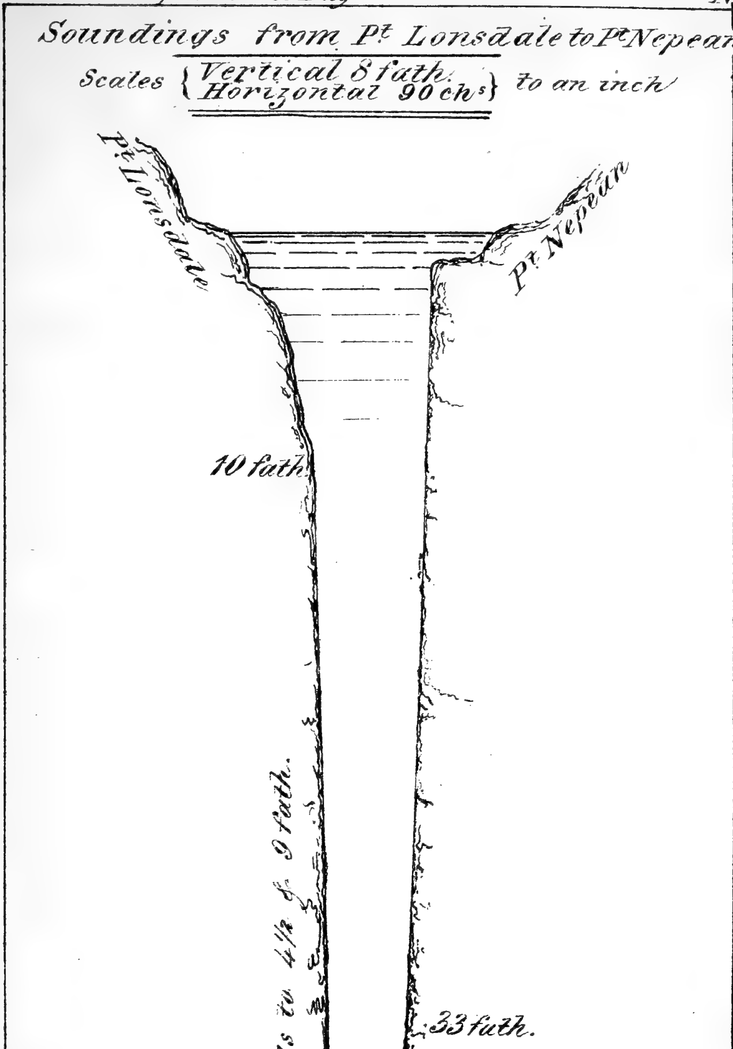





T E Rawlinson delt

To accompany
Mr Rawlinsons notes
on lost keys in Corio Bay

No 4

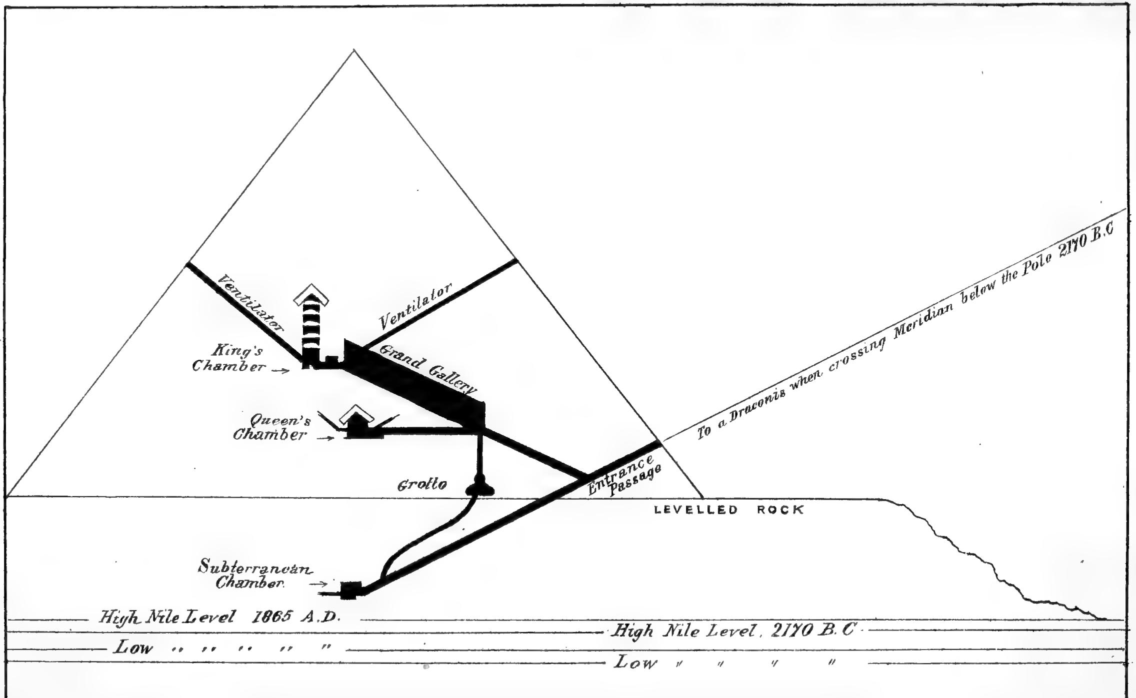



T. E. Rawlinson delt.

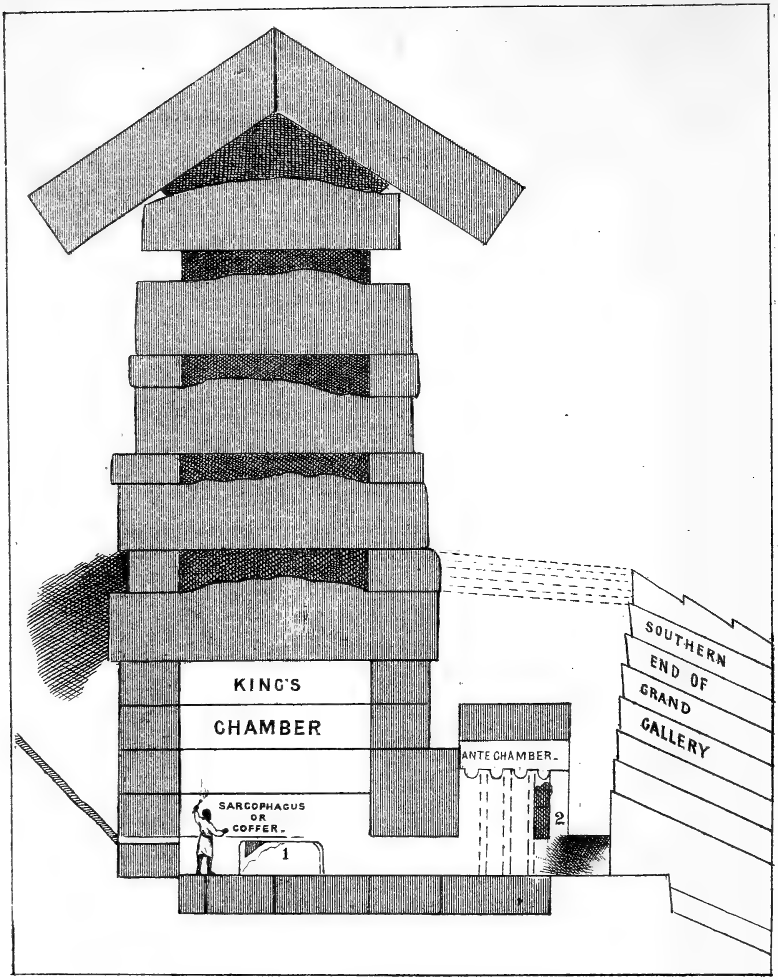
To accompany
Mr. Rawlinsons notes
on lost keys in Corio Bay.

No. 5


T. E. Rawlinson delt.



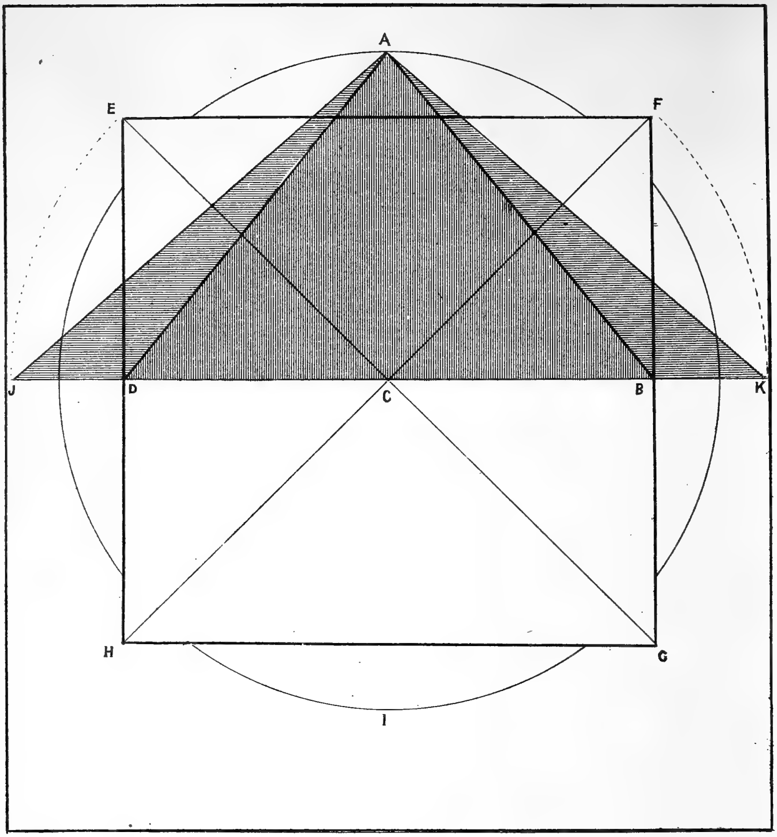

**VERTICAL SECTION OF THE GREAT PYRAMID OF JEEZEH.**
(FROM PIAZZI SMYTH'S "Our Inheritance in the Great Pyramid.")




**VERTICAL SECTION OF KING'S CHAMBER AND ANTE-CHAMBER, SHOWING (1) THE COFFER, CONTAINING 71,250 CUBIC INCHES, AND THE CUBIC GRANITE BLOCK (2) CONTAINING 17,812·5.**

**ENGLISH QUARTER, 17,745,536.**

Rough Sketch of Plate XI. in PIAZZI SMYTH'S work, "Our Inheritance in the Great Pyramid."




THE GREAT PYRAMID OF JEEZEH.

| | |
|---|---|
| A C | HEIGHT OF PYRAMID. |
| D B | DIAMETER OF PYRAMID = 365·242 PYRAMID CUBITS. |
| E F G H | BASE OF PYRAMID. |
| A B C D | DIAMETRICAL VERTICAL SECTION. |
| A K C J | DIAGONAL VERTICAL SECTION. |

**A C** *is to twice* **D B** *as* $\pi$, *or as* **1** *is to* **3·14159,** *or as the diameter is to the circumference of a circle.*

*And* A D B, *the right section of the Pyramid, is to* **E F G H**, *the area of the base, as* $\pi$, *or as* 1 *is to* 3·14159, *or as the diameter to the circumference of a circle.*

*And* A C, *the height, is the radius of a circle equal in circumference to the external lines of the square base.*

*Thus actually squaring the circle as accurately as possible.*

See PIAZZI SMYTH'S "Our Inheritance in the Great Pyramid."

The nature of the superincumbent beds being clay, points decidedly to precipitation in still waters, or those having little current, and such being the case, the keys, if lost overboard from a boat, would in the course of time sink by their own weight through the soft impalpable mud to the denser material of the old beach overlying the limestone.

Several instances were given of such settlement.

T. E. R.

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## Art. XI.—*The Week.*

By H. K. Rusden.

[Read 21st December, 1874.]

Circumstances have lately led me to investigate the subject of The Week, so far as the limited time and opportunities at my disposal permitted, and as a result I have a proposal to make, involving I conceive an improvement, equally important, desirable, and practicable. Before however explaining it in detail, it will be proper to glance at the natural history of the present conventional institution.

Materials for this investigation I have found to be meagre and scattered. I think, however, that there exist sufficient data to justify the decisive conclusion that the septenary cycle comes to us from the remotest antiquity; that is—from a period altogether prehistoric. The wide distribution of the week over Southern and Northern Asia, and also in Northern Europe, long before our era, is, I believe, unquestionable. This in itself would have little significance, were it not for a curious point of resemblance, which is unaccountable on any other theory than that of a common origin. It is very remarkable that the Scandinavians, the Chaldæans, the Persians, and the Hindoos, have always named the days from the planets, and in the same very peculiar order; peculiar in its curious variation from their relative astronomical order—real or supposed. The true order would be of course Sunday, Wednesday, Friday, Monday, Tuesday, Thursday, Saturday; after the Sun, Mercury, Venus, Moon, Mars, Jupiter, and Saturn. The Ptolemaic order would be Monday, Wednesday, Friday, Sunday, Tuesday, Thursday, Saturday. The deviation of all weeks from both these arrangements is identical and universal, and should therefore be ascribed to a common source. Friday is the day held sacred by the Mahometans since the 6th century, and by the Hindoos for many thousands of years. Saturday is the Sabbath of the Jews, who were therefore supposed, according to Plutarch,* to be worshippers of Saturn. Sunday is held sacred to rest or recreation wherever the Christian religion prevails, and has been so since the 3rd century; and as most nations have worshipped the sun, it has probably been the most generally observed in ancient times.

Though the septenary cycle has been used by most branches of the Aryan family, it seems singularly to have been unknown to the Greeks, and to the Romans and ancient Etruscans; who used respectively cycles of eight and ten days; the two former until about the 2nd century after our era†. But though the dominion of the Romans in Britain lasted till the 5th century, it is evident that our ancestors did not acquire the week from them, but had obtained it previously from Scandinavia, as is partly proved by our present names of the days, which belong to the old Scandinavian mythology. Indeed it seems not quite clear whence the Romans acquired it. They did not get it with their amended calendar from Egypt in Cæsar's time, and it seems that they *could* have got it from the north as easily as from the east; for the Saxons and Kelts and other northern peoples had it long before their contact with the Romans.‡ Dio Cassius§ reports that the Romans derived it shortly before his time (born 155) from the Egyptians, who he says named the days from the seven planets—or bodies then known—of our solar system. But the Egyptians are positively asserted|| to have more anciently used a cycle of ten—not seven—days; and if they thus only acquired the week so lately from the east, the probabilities of the Romans having obtained it from the north are increased. The Egyptians had not even any original astronomy of their own, as Sir G. C. Lewis shews in his *Astronomy of the Ancients,* chap. v., nor were the Chaldæans—from whom

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* *Symposia* 5. Other points of resemblance between the Jewish and other mythologies are too striking for mere coincidence. Abraham corre sponds with Brahma as well as with Saturn, Samson with Hercules Jephtha's daughter with Iphigenia, &c., &c.

† See Adams' *Roman Antiquities*, pp. 84 and 331.

‡ Rees' *Cyclopædia* (week) and *English Cyclopædia.*

§ *History of Rome*, vol. xxxvii. See Sir G. C. Lewis, *Astronomy of Ancients*, p. 304.

|| Humboldt's *Cosmos*, vol. iv. p. 412, quoting Lepsius in a note.

they appear to have acquired what they possessed—the inventors or discoverers of it; nor were they the first to misapply it to purposes of astrology, or to name the days from the planets. Humboldt confidently says that shortly before our era, the Egyptians had not named the days from the planets, the signs of which were then perhaps only recently known to them. But Humboldt does not apparently consider, and perhaps could scarcely have been in possession of the ethnological and philological evidence, which modern research has revealed, of the great antiquity of a comparatively perfect civilisation and astronomy elsewhere, of which the relics only were found in India and Chaldæa. He, however, mentions that the Peruvians had a nine day cycle, with a day of rest in each; and that the Aztecs used weeks of five days, which they named from deities, one of whom, Wodan, was the counterpart of the Scandinavian Woden, from whom our Wednesday is named. The Indian Wednesday, Budhavaram, is thought to be derived from the same original as ours.

Mr. Proctor shows* that none of these peoples had any original astronomy, any more than the Egyptians; and I find elsewhere† that they reckoned eclipses, &c., by rules, of the origin and basis of which they had no knowledge. But Mr. Proctor shows also that all their old astronomical records present indications of having been derived from a far superior but extinct civilisation, of which no historical vestige remains, but which must have had its seat in a much more northern latitude. He says, that the length of the winter and summer days given in the oldest Brahminical and Persian records—the oldest Babylonian star risings obtained by Ptolemy—and the measurement of the earth adopted by ancient astronomers, all correspond to a latitude of about 45° north. Finally he adduces reasons—from old Chaldæan representations, which he reproduces, of Venus, Jupiter, and Saturn, as Mylitta, Bel, and Nisroch or Asshur; and from the fact of a plano-convex rock crystal lens having been discovered by Layard at Nimroud—for believing that these ancient astronomers probably possessed telescopic appliances of sufficient perfection to enable them to discern the crescent form of Venus, the satellites of Jupiter, and perhaps even the ring of Saturn.

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* *Saturn and his System,* (appendix on Chaldæan Astronomy).

† Bailly's *Histoire de l'Astronomie.*

From Sir Wm. Drummond's* work on the *Zodiacs* I am compelled to quote—though through an admittedly reliable channel—at second hand (which I regret, as I thereby lose the references to his authorities which he always gives).† He says: "The fact however is certain, that at some remote period there were mathematicians and astronomers who knew that the sun is in the centre of the planetary system, and that the earth—itself a planet—revolves round the central fire; who calculated, or like ourselves attempted to calculate, the return of comets, and who knew that these bodies move in elliptical orbits, immensely elongated, having the sun in one of their foci; who indicated the number of the solar years contained in the great cycle, by multiplying a period (variously called in the Zend, the Sanscrit, and the Chinese *ven*, *van*, and *phen*) of 180 years by another period of 144 years; who reckoned the sun's distance from the earth at 800,000,000 of Olympic stadia" (=91,931,818 miles at $606\frac{3}{4}$ feet to the stadium), "and who must therefore have taken the parallax of that luminary by a method, not only much more perfect than that said to be invented by Hipparchus, but little inferior in exactness to that now in use among the moderns" (much *more* exact, as it now appears, for Sir W. D. knew nothing of the late corrections of the estimated distance in question, which he only knew as $95\frac{1}{2}$ millions of miles); "who could scarcely have made a mere guess when they fixed the moon's distance from its primary planet at 59 semi-diameters of the earth; who had measured the circumference of our globe with so much exactness that their calculation only differed by a few feet from that made by our modern mathematicians; who held that the moon and other planets were worlds like our own, and that the moon was diversified by mountains, and valleys, and seas; who asserted that there was yet a planet which revolved round the sun beyond the orbit of Saturn, who reckoned the planets to be 16 in number, and who reckoned the length of the tropical year within three minutes of the true time; nor indeed were they wrong at all, if a tradition mentioned by Plutarch be correct."—*Drummond on the Zodiacs*, p. 36.

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* Sir Wm. Drummond died in 1828. He was a Fellow of the Royal Society, and British Ambassador at the Two Sicilies and at Constantinople. He wrote a *Review of the Government of Sparta and Athens*, *Herculanensia*, *Odin*, *Origines*, *Œdipus Judaicus*, and this work on the *Zodiacs*.

† See Godfrey Higgins' *Keltic Druids*, p. 50, and De Morgan's *Budget of Paradoxes*, p. 164.

With respect to the extent to which the Copernican or Pythagorean system was received about the time of our era, it will suffice to refer to St. Augustin (*De Civitate Dei*, lib. 16, ch. 9, vol. vii. Paris 1685) and Lactantius (*Institutiones Divinæ*, lib. 3, ch. 24, vol. i. Deux Ponts 1786), who both found the doctrine so prevalent as to require their special and too successful opposition and condemnation.*

I believe that M. Bailly,† the historian of astronomy, is the author of the specific hypothesis of an antediluvian highly civilised people, who, as he says, "brought the sciences to perfection; a people who in the great enterprise of discovering the exact measurement of the earth, dwelt under the 49th degree of latitude." He is often quoted without specific references, and his works in our Public Library are without that indispensable feature in the eyes of inquirers—a good index. The cycles were special subjects of investigation with Bailly. He held that the week was certainly antediluvian, concluding that it was impossible that the seven days composing it could have been dedicated to the same planets in Egypt, India, and Chaldæa, in identical order in these and in many other places beside, unless it had been derived from some older common source. As regards the prehistoric high civilisation his position seems impregnable. But his theory that it was destroyed or scattered by the traditionary flood seems irreconcileable with facts. In the first place the date assigned to Noah's flood, 1655 B.C., is not nearly so old as the Chinese and the Brahminical eras, which also imply a much older separate civilisation; and as Bailly remarks, they evidently exhibit the *débris* rather than the *elements* of science. But if the careful labours of Piazzi Smyth at the Great Pyramid have not been altogether thrown away and misrepresented too, the construction of that most ancient of monuments alone bears ample and irrefragable testimony to the existence—when it was designed—of astronomical and mathematical science,‡ far excelling any which obtained for thousands of subsequent

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* See Patrice Larroque's *Examen Critique des Doctrines de la Religion Chretienne*, 4th ed. Paris, 1870. Vol. ii. p. 68. See also *Supernatural Religion*, p. 87, Australian Edition.

† Maire de Paris, Garde honoraire des tableaux du Roi. L'un des quarante de l'Academie Royal des Inscriptions et Belles Lettres, de celle des Sciences, et de l'Institut de Bologne, des Academies de Stockholm, de Harlem et de Padoue, et de la Société des Antiquités de Cassel.

‡ See Plates I., II., and III., pp. 27 and 28. I take Professor Smyth's best attested facts, but do not accept his theories.

years, but which must have been entirely obsolete and forgotten before the other pyramids in its vicinity were built; probably about 4,000 years ago. The Great Pyramid should thus be clearly antediluvian.

It seems also above all improbable that any flood should destroy so entirely all relics of a civilisation established—not on a low level—but on the elevated lands of high Asia. It seems to me that subsequent experience of the decadence of other civilisations gives a better key to the obliteration of that, which—I think with M. Bailly—certainly existed over fifty centuries ago to the north of Bokhara and Samarcand. We have every reason to believe that the esoteric system of the monopoly of knowledge by a small number of persons, prevailed in the greatest exaggeration in the most distant times. The vitality of the principle—which, though exploded in theory and in conscious practice, has still in a modified form its advocates—is a guarantee of its antiquity. I believe that that monopoly of knowledge and thence of wealth, necessarily produced an antagonism of classes, which, in the inevitable ultimate collision between them, resulted in the annihilation of the instructed few by the exasperated ignorant many; and that this same cause has always been the main factor in the evanescence and destruction of past civilisations. This is in any case a most important problem, which has met with wonderful neglect. But is it not absolutely accordant with the allegorical Oriental habit, and the esoteric system too, to understand this great deluge as an irresistible flood of barbarism and ignorance overwhelming all extant human wisdom? Have not such deluges been too frequent within historical time? Can the old legend be thus explained in a form in which—in strict accordance with the spirit of the record—the misrepresentation of natural catastrophes as possible manifestations of divine anger, is transformed into important historical admonition? I think so. I think—passing over many equally significant instances, such as the Egyptian, Persian, Tyrian, Greek, and Roman extinct glories, to one within our more immediate knowledge,—that the French revolution, which was essentially an outcome of a like antagonism of classes, similarly produced, and capable of entirely overwhelming a less distributed civilisation, was merely history repeating itself for perhaps the thousandth time; and that the only security *we* possess for the stability of *our* civilisation, lies in the wider and wider dissemination of knowledge, which prevents its destruction in social cataclysms, and also tends to lessen the antagonism of classes.

From this primeval high civilisation, antecedent to that deluge, we derive I think, besides this significant lesson, the weekly cycle, the Great Pyramid, the Sanscrit language, the Zodiacal signs and constellations, if not the symbols of both—the still extant esoteric system of Freemasonry—Chaldæan and Indian astronomy—the Aryan race and civilising instinct—and in fact the germs of civilisation generally. It may be said that the invention of the week belongs to a very early period and rude condition in the history of Astronomy; being probably but a subdivision of the lunar cycle. Doubtless so it is. But that marks some progress made, especially as I think the week was a subdivision of the sidereal revolution of the moon in 27·32166 days, not of the synodical one of 29·53059 days; which is the more obviously observable cycle, though not approximately divisible by four; and which forms the apparent basis of the Julian and other months of 30 and 31 days. The Kelts, I find, had not only the seven-day week but twelve months also;* and I have met with a statement† with regard to astronomy, to the effect that Rudbeck calculated from the displacement of a festival recorded as being anciently fixed at 20 days from the winter solstice, that the Swedes 2,300 years B.C. knew the right number of days in the year, though they had not provided the intercalation necessary to compensate for the fractional excess. Nevertheless, the coincident order of the Scandinavian days, and the Aryan roots in the Keltic languages, prove their indebtedness to the same stock as the Indian and Chaldæan civilisations. For further instance, it can scarcely be a mere coincidence that the British measure of capacity—the *quarter*—that of which it is a quarter having otherwise completely eluded research, corresponds closely with the cubic measure of which the standard is extant in the antechamber of the Great Pyramid, and which is an *exact* QUARTER of the contents of the great coffer or sarcophagus in the King's Chamber.‡ Professor Piazzi Smyth considers that he has identified many other interesting items of our inheritance in the Great Pyramid.

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* See Toland's *History of the Druids.*

† Bailly's *Histoire de l'Astronomie Ancienne*, p. 324.

‡ See Plate II. p. 27.

I have alluded to the curious order in which the days of the week succeed each other, which is found consistently the same wherever the weekly cycle is known, and which does not correspond at all to the real or supposed astronomical order of the planets after which the days are named. Dio Cassius says that the order of the days had relation, 1st, to the musical intervals; or 2nd, to the astrological allotment of the planets to the hours of the day; or 3rd, to their distribution among the signs of the Zodiac. It is a curious fact, that the astrological appropriation of the hours of the day, as well as of the days themselves, to the seven bodies of our then known solar system—as being peculiarly under their influence—should furnish the method of connection between the universal order of the days, and the order of the planets in the Ptolemaic solar system. For the astrological order was of ancient date in Ptolemy's time, and his solar system was therefore scarcely his, but was based upon that of the Astrologers. In the absence of any other known or probable basis for the connection of the order of the week days with that of the planets, I conceive that it had its origin in the pernicious esoteric system, by which everything was rendered enigmatical and obscure to all but the initiated.

I am not aware of any particular probable site of the high civilisation thus inferred by Bailly, Drummond, and Proctor, as the common source of its various posthumous offshoots in different directions. According to Mr. Proctor, it should be five degrees farther north than Samarcand (39°56), and it seems to me that the most moderate guess at its date must be at least 6,000 years ago, and that it is probably much further back. Bunsen* reckons the immigration of the Aryans into India at from 80 to 100 centuries B.C., and Laplace mentions two epochs, 2,000 and 15,000 years ago, at which the significance of the signs of the Zodiac in the position of the heavens was so marked as to suggest their introduction then. He says†—referring to the greater period —"Capricorn, or the constellation of the Goat, appears to be more properly placed at the highest than at the lowest point of the sun's course." I know not whether he included in his scheme the fact of Canopus (in Arabic the *south* star) having actually been about that time a south pole star,‡ or

* Brande's *Dictionary* (Aryan).
† Laplace's *Systéme du Monde*, p. 316.
‡ Dupuis' *Origines des tous les Cultes*, vol. iii. p. 426.

that the Samaritan Pentateuch commences with the words, "In the beginning the GOAT (Azima) created the heaven and the earth,"* which is neither absurd nor unintelligible if read—"When the Zodiacal signs were first distributed, Capricornus held the dominant position indicated by Laplace." These are merely coincidences with Dupuis' great work, which I remarked on reading Laplace's statement. Laplace had doubtless far more substantial reasons for his opinion. It is, perhaps, right to mention that Laplace respectfully differs from Bailly as to the antiquity of astronomy; but with all deference to his weighty authority, I cannot but think that the philological evidence discovered since his time, more than outweighs his objections.

The suicidal esoteric system seems to have subsisted in this primeval civilisation in the most exclusive form, and to have effectually prevented the spread and survival of more than mere fragments of the knowledge upon which it was based. But I believe that ethnology and philology both point to the same approximate site for the original home of the Aryan family and speech. The patriarchs of the Brahmin race seem to have been those who survived the collapse of their ancestors' civilisation, and are admitted to have brought with them to India (but how long afterwards must be mere matter of conjecture), amongst the relics of their former state, the Sanscrit language, the weekly cycle, and a half-understood or forgotten astronomy; together with the most radical distinctions of classes known.

I think it reasonable to suppose, that if the Brahmins exhibit signs of the most direct derivation from the primeval civilised race, they were probably the immediate survivors of the social convulsion, which is supposed to have almost annihilated the antecedent civilisation. The customs (and among them notably the week) which appear to be due to the same source, and which still survive among the descendants of the Kelts and Scandinavians, I should judge to have spread westward long before the extinction of the civilisation which gave them birth. Those which survive in China were probably received thence at even an earlier date. The Chinese appear to me to exhibit the *rudiments* rather than the *débris* of an astronomical science, and never to have advanced beyond them, though they have always made and recorded observations. The authors of the Chinese calendar

* *Ib.* vol. v. p. 67.

may have emigrated from, or only had communication with, the Aryan patriarchs, after the division of the year into months of the length of the sidereal lunar revolution, the division of which by four gives the ordinary weekly cycle. For although it is generally stated, mainly I believe on the authority of Freret* in the last century, that the Chinese have a cycle of ten days instead of seven, and though Laplace ascribes to them a cycle of 60 days, as well as 60 years, still on referring to Sir John Davis' work (an unimpeachable authority I believe) on the Chinese, I find (vol. ii. p. 73) that he, after admitting points of resemblance between the astronomical systems of India and China, indirectly shows that the Chinese have at least an equivalent of a septenary cycle. He says "the Chinese reckon *five* planets, to the exclusion of the sun and moon, but they give the names of one of their twenty-eight lunar mansions" (into which their Zodiac is divided) "successively to each day of the year in a perpetual rotation, without regard to the moon's changes; so that the same four out of the twenty-eight invariably fall on our Sundays, and constitute as it were, perpetual Sunday letters. A native Chinese first remarked this odd fact to the author, and on examination it proved perfectly correct." This coincidence appears to me to arise from the simple fact that their cycle is a multiple, and therefore a full equivalent of ours; and as they make no intercalations of less than a full month of 28 days, the coincidence is perpetual. Though the Chinese thus have not a perfect septenary cycle, still their system without doubt, regarding other coincidences, originated—though at a very distant date—from the same source as ours, with which it synchronises so well. Laplace says the seven day week was known to them from the most remote periods. Their monthly cycle, and their sixty year cycle, are probably as old as their era, or 45 centuries, if not as old as Fo Hi, or 52 centuries past.† There is certainly no geographical or chronological improbability in the derivation of the Chinese calendar from the locality indicated, and I think that the division of the 28 days cycle—based doubtless on the sidereal lunar period in preference to the synodical period—is strongly suggestive of a common origin with the seven day week, after the more accurate determination of the moon's revolution.

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* See *Encyclopædia Britannica*, art. Chronology.

† See Meadows' *The Chinese and their Rebellions*, p. 329.

Not only, however, is the great antiquity of the weekly cycle sufficiently and conclusively established, but its wide expansion over the world, even to islands of the southern oceans, argues a far more ancient origin than that to which it has been commonly referred. If, as modern criticism claims to have shown, the Hebrew Scriptures were not compiled before the time of Ezra, or Hilkiah, or Samuel at farthest* (that is the 5th, the 7th, or the 11th century B.C.), the Sabbath (and the Jews had no specific names for the other days of the week†), which is not mentioned from the 40th to the 15th century B.C., was actually not instituted—even for the Jews—according to their own records, until at least 15 centuries (and probably many more) after the septenary cycle was in use by the Chaldeans, the Hindoos, and probably the Scandinavians and Chinese. But even supposing for the nonce that Moses himself really had instituted the Jewish Sabbath, *his* reputed date is only the 16th century B.C., while Fo Hi's in China was the 33rd; the Kali Yug in India was the 31st; the Scandinavian was the 23rd; and Egyptian records, according to Bunsen, extend back to the 35th, when the astronomy from which their eras were all derived was forgotten and lost. It has always been a standing difficulty—why, if the Sabbath was, as such, instituted at the supposed creation—or 40 centuries B.C., its observance should never have been inculcated even on the Jews for more than 20 centuries after. The accommodative principle upon which the recorded six days of creation have been expanded into as many geological periods, only magnifies this difficulty indefinitely.

This rough sketch of the materials for forming an opinion respecting the age and origin of the week, is far from exhaustive, or even satisfactory in itself; being based necessarily upon anything but original authorities. But it is, I think, amply sufficient for my purpose, which is simply to show that though doubtless Sunday was always as sacred for us in Europe as Friday is for a Hindoo or a Mahometan, or Saturday for a Jew; yet there is evidently nothing intrinsic in the day itself, or in the septenary cycle, or in the origin of either, to determine their perpetuation otherwise than as they concur with human convenience. But if there were other grounds for preserving either intact, still after

* See Horne's *Introduction*, and Sir Isaac Newton's *Observations on Daniel*.

† Humboldt's *Cosmos*, vol. iv. p. 413. *English Cyclopædia* and Horne's *Introduction*.

the numerous changes and alterations of calendars by every people, the identification of any particular day must now be purely arbitrary, and the real original seventh day it must now be a matter of impossibility to distinguish.* No objection therefore on that ground can be valid against a further alteration of the day or week, provided that preponderating reasons can be adduced on other grounds in favour of it. In fact, the only way possible now, to make sure of sometimes hitting on the right original seventh day, if any, is to alter the cycle to another number of days, which would of course make the new Sunday, or Sabbath, or day of rest, occasionally coincide with the original one.

I now come to the proposition—the making of which is the object of this paper. This is, to shorten the week from seven to five days, as the Romans formerly found it convenient to reduce theirs from eight to seven. I am satisfied from a variety of reasons that the present week is too long. I think that people work much harder now than they did when the septenary cycle was first instituted, and that six days of such continuous hard work to one of rest is too much. This is proved by the innovations made upon the Saturday, which is now neither one thing nor the other. It is admitted that it is no business day; that for business purposes it is practically worthless. People attend at their offices as a mere matter of form, though as a business day they allow that it is a delusion and a mockery. But as a holiday it is worse than a delusion; it is a snare. It is no holiday. For no one worth noticing gets it all, and very many—particularly those who most require it—never get it at all. It is clear that the eight hours movement is of very partial benefit, and the fact that numerous classes are entirely and hopelessly excluded from it, makes it extremely desirable to devise some method of affording them equivalent advantages. I cannot see that this can be done, unless by a change like that which I propose. In any case, the only thing that the half-Saturday does plainly and completely, is this; it

* I find that it is a disputed point when the Hebrew calendar was formed. It has been referred by some to our year 500, by others to 325, by others 300, while some contend for an older origin. (*English Cyclopædia*, art. Calendar.) I am willing to concede a possibly much greater antiquity for it than is even claimed, and I offer the following as a rational solution—in strict accordance with the known style of esoteric Oriental tradition—of a part of Genesis (ch. 5), which has hitherto defied reconciliation with experience or probability. I think it not unlikely that the exceptional longevity attributed to the antediluvian patriarchs, and which Professor

furnishes ample proof that the week is felt by every one to be too long.

Now the lunar synodic cycle is twenty-nine days and a little over a half. A weekly cycle therefore of six days, or five days, would synchronise with the lunar cycle much more nearly than any division of twenty-eight could possibly do; if it were any object to conform to a lunar period at all. I recommend the quinary rather than the sexenary cycle. It would concur better with the denary scale now in use in notation and computation; it would leave no odd day over in an ordinary year; and I believe it would better proportion hard labour to rest. If any man works his best for four full days continuously, I think that he will be quite ready, and that it will be good for him, to rest on the fifth. This is all that would really be necessary, except the rigorous preservation of the fifth day as a day of rest from labour; and of intellectual cultivation, for which one day in five would be little enough, though infinitely better than any evening after a hard day's work.

But the proposed change would not be nearly such a startling innovation as it might at first sight appear. By having a complete universal holiday, on one day in five, instead of one day and a half (but the half-day neither universal nor complete) in seven, there would be really a difference of but one seventieth. That is, there would be in seventy days—at four working days and one rest day to the week—fourteen complete days of rest; and at five and a half working days and one and a half rest days to the week, fifteen days of rest. My plan would thus subtract just one-seventieth of rest from those who get more than they require, but would secure to those who really want it the real equivalent of the half day which *now* they cannot get.

But the advantages of making the months of a uniform length of thirty days or six weeks each, leaving an odd week, and in leap year also an odd day, for an annual festival to welcome the new year, are so very clear and great, as to

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Owen has concluded to have been physiologically impossible, may really be a symbolical record of the numerous attempts to discover the true length of the annual cycle; and that Enoch the *perfect* man who was *taken* and accepted by God, and who lived just *three hundred and sixty-five* years, represents the epoch when that was discovered to be the true number of days in the year, and the calendar was thenceforward upon that basis taken and accepted as perfect. I am of course aware that the record refers to no specific date, and that it was promulgated and perhaps written after the 10th Century, B.C.

induce me to include this amendment also in my proposal. I think it would be a great convenience and advantage to be able to know at once the day of the week by that of the month; or the day of the month by that of the week. Commercially and privately, the vast simplification of all calculations of interest, wages, &c., by making all the months of a uniform length, would prove of immense advantage. Indeed, at present, in the calculation of interest, the great inconveniences of reckoning by the week or month, are so obvious, as to lead to their abandonment altogether; and interest tables are always constructed for the number of days alone, which has then to be adapted in each case to the actual period required. The constantly recurring complex computations rendered inevitable by the weeks and months being non-coterminous, and the months being of various lengths, involve an enormous amount of unnecessary labour, which my proposal would entirely obviate.

I will offer one or two simple illustrations of the advantages of the change. Say—on what day of the week will fall the 3rd of next September or October, or the 23rd of those months? It would take some time under present arrangements to ascertain this simple information, without an almanac; and even with one the easiest plan would be to refer to it for each required day separately. By my plan you would know at once, without reference or calculation, that the 3rd, 8th, 13th, 18th, 23rd, and 28th of every month must always fall on the 3rd day of the week, and the like would be as easily known of every other day of the week or month. Say—next, to what does five shillings a week for nine months amount? or for one month? You cannot give it at all, until the month or months are specified, and then the amount will vary for other nine months, or another month. Whereas by my system of having six weeks in each month, you would know at once that five shillings a week is thirty shillings a month, and adding one week to the twelve months it is £18 5s. a year. The enormous saving in trouble, time, and labour, which would thus constantly accrue, must be obvious. Nearly all the ordinary every day calculations of wages, &c., would be saved entirely, and after the first year almanacs would be almost superfluous.

I think it would furnish also a very good opportunity for discarding the present old pagan names of our days, by substituting others for them, such as "Oneday," "Twoday," "Threeday," "Fourday," for the current heathen names of the week days, and some appropriate distinctive name instead of Sunday, which has of course been a complete misnomer ever since the worship of the sun on that day was abolished. "*Restday*" would too readily suggest idleness as the proper use of it, and ignore the fact that the best mental rest is variation rather than cessation of occupation. I think that "*Goodday*" would best express the intended value and right use of it. I also think that the odd intercalatory day every fourth year should be a "*goodday*" added at the end of the year.

Such an alteration would interfere with the calendar no further than as it would prove a convenience. All dates, historical, legal, or commercial; all anniversaries and calendrical epochs, are fixed by the day of the year or month, not of the week, and therefore would not be affected. In fixing the date of Easter-day, it would give two-sevenths more precision. It would, in fact, greatly facilitate every computation in which portions of a year, month, or week, were factors. Indeed it is difficult to see whom or what it would affect otherwise than advantageously. The proportion of weekly to daily wages would adjust itself at once. To those engaged in ordinary necessary labour on Sundays now, it could, of course, make no difference; while to those engaged in the special ministrations and exercises which are regarded as peculiarly appropriate to the Sunday, it would afford additional opportunities, in the twenty-one more Sundays, or total of seventy-three in the year, of performing duties for which time is all too short, and must appear to those who sincerely delight in them still shorter. From this class, therefore, I count upon the strongest support.

I contemplate one possible effect with much complacence. If our Jewish brethren would also adopt my suggestion, on account of what I cannot but regard as its manifest advantages, how gratifying it would be to know that they were enjoying their holiday at the same time as ourselves. I protest that I never meet a Jew going to or returning from his synagogue on Saturday, without feeling a strong impulse to apologise for doing my secular business upon his Sabbath, while he is debarred from doing his upon our Sunday. The present one-sided distinction always strikes me painfully as a relic of ancient illiberality and alienation of feeling, which should surely now be obsolete, and I cannot but think that the adoption of a common day of rest would tend much to promote the social feeling to which it is so desirable that there should be no exception. The fact that these excellent fellow-citizens have hitherto had practically only five working days a week to our six, is demonstrative proof that six working days in seven are not indispensable. Four working days in five are obviously a larger proportion by 3-35ths, than five in seven. But should the sect to which I allude decline to adopt the quinary week which I propose, were *we* to do so, there would still occur on every seventh Goodday and fifth Sabbath, a synchronism of practice which would surely promote a sympathy of feeling. The prospect of the attainment of such objects is surely a strong ground of recommendation of my scheme.

I propose thus simply to have a week of five days, instead of seven. This would give exactly 73 complete weeks in a common year, and one day over in leap year. I also recommend the allotment of an equal number (30) of days, or six weeks, to each month, leaving over one festival week, say at the new year, with an extra "Goodday" added every leap year. I presume that an act of the Legislature would be necessary to give effect to the proposal, but public opinion must, of course, precede legislative action. I have thought it better to make the suggestion first to this Society, in order that it may be at once subjected to the skilled criticism of those competent to say whether any inconvenience could possibly result in connection with the calendar, so that objections on that score, which is really of primary importance, might be disposed at once one way or the other. When no rational objection can be discovered to a proposal of this kind, it is not unusual to allege that, however desirable it may be in theory, it would nevertheless be bad in practice, or that it would be *impracticable.** Such an argument of course yields entirely the question of expediency, but is itself obviously no better than the opposite simple assertion; and if reasons be on the other hand advanced to show that similar innovations have formerly been successfully made, it stands refuted until at least the experiment be tried. But in this case far more difficult innovations, even involving an alteration of the calendar, have at different times been made with perfect success by Julius Cæsar, Pope Gregory XIII, and others. But more, the week itself was actually altered by the Romans, Greeks, and many other peoples; and, in

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* For the refutation of this "Fallacy of Confusion," see Bentham's *Book of Fallacies*, ch. 9.

fact, as there is no record of any attempt to alter the week having ever failed, the allegation of impracticability is so far proved to be utterly baseless. The probability is that there would be no difficulty whatever.

I think the perfect practicability, as well as the many and manifest advantages of this scheme, would be apparent on the printing of the first almanac in conformity with it. But the greatest of its benefits could not possibly be appreciated until after it should have been carried into practical execution. I mean the great relief to those who really labour hardest and who cannot now secure opportunities for self-improvement.

Doubtless some people can congratulate themselves upon having rest and leisure enough. Some, there is shrewd reason to suspect, have too much of both. My proposal accommodates even them, by reducing their superfluous leisure by one-seventieth. But it is not made expressly in their interest. I make it in the interest of those who, by the force of circumstances, have too little; who not only labour hard on five days and a half in every week, but cannot secure time for self-improvement on the other half of the Saturday which their more fortunate neighbours have and do not appreciate, and which they are never likely also to get, unless it be guaranteed to them by making it as inviolable as Sunday itself.

I append a table showing the names of the days of the week in ten different languages, and three diagrams from Piazzi Smyth's *Our Inheritance in the Great Pyramid,* giving sufficient proofs of the science displayed in the construction of that ancient monument.

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NAMES OF THE DAYS OF THE WEEK IN

| *English.* | *French.* | *Latin.* | *Italian.* | *Spanish.* | *Portuguese.* |
|---|---|---|---|---|---|
| **Sunday** | Dimanche | Dies Solis | Domenica | Domingo | Domingo |
| **Monday** | Lundi | Dies Lunæ | Lunedì | Léones | Secunda feira |
| **Tuesday** | Mardi | Dies Martis | Martedi | Martes | Terza feira |
| **Wednesday** | Mercredi | Dies Mercurii | Mercoledi | Miercoles | Quarta feira |
| **Thursday** | Jeudi | Dies Jovis | Giovedi | Jueves | Quinta feira |
| **Friday** | Vendredi | Dies Veneris | Venerdi | Viernes | Sexta feira |
| **Saturday** | Samedi | Dies Saturni | Sabbato | Sabado | Sabbado |

| *German.* | *Dutch.* | *Arabic.* | *Brahman.* |
|---|---|---|---|
| Sonntag | Zondag | Youm el ahad | Addita varam |
| Montag | Maandag | Youm eth thani | Soma varam |
| Dienstag | Dingsdag | Youm eth thaleth | Mangala varam |
| Mittwoch | Woensdag | Youm el arbaa | Bouta varam |
| Donnerstag | Donderdag | Youm el khamis | Brahaspati varam |
| Freitag | Vrijdag | Youm el djoumaa | Soucra varam |
| Samstag | Zaturdag | Youm el effabt | Sany varam |

Based upon Arago's *Pop. Astronomy*, vol. ii. p. 727.

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## Art. XII.—*Notes on some of the Physical Appearances Observed in the late Transit of Venus.*

By R. L. J. Ellery, F.R.S., F.R.A.S.

[Read 21st December, 1875.]

In these brief notes relating to the physical appearances observed during the transit of Venus, of December 9th, I do not intend to refer, except in a cursory manner, to any of the more mathematical data of the occurrence, for these are not yet fully reduced, and will be only valuable when combined with similar results obtained at other parts of the earth's surface.

The weather in Melbourne, and indeed nearly throughout all Victoria, was very unpromising in the morning of the occurrence; but fortunately the clouds broke away in Melbourne at the very nick of time, so that the first internal contact and some of the preceding phases were well seen. The previous rain and subsequent occasional showers had the effect of rendering the atmosphere exceeding favourable for observation, and, so far as the earlier phases of the transit were concerned, the atmospheric conditions were unusually good; for any one accustomed to observing the sun will know that it is only on such favourable occasions when the sky is seldom clear of clouds that its edge can be observed sharp and clear without what is termed "boiling," so that what was otherwise an unpromising state of the weather, was actually most favourable for observation of the physical appearances of the transit. I dwell upon this fact, because I am of opinion it gives so much more weight to the accounts of the different observers who saw the phenomenon under such conditions.

The first phases seen at the Observatory, or indeed, so far as I am yet informed, anywhere in Victoria, were when the planet was about half or more on the sun's limb. I was observing with an eight-inch refractor, and at my first glimpse Venus was about five-sixths of its diameter on the sun. The first thing that struck me was the remarkable distinctness with which the *whole* disc of Venus was seen, that portion *outside* the sun's limb being nearly as distinct as that *within*. It appeared of the same tone, but was *margined by a bright thin edge of light.*

I propose to give now the statements of other observers with respect to this phenomenon, before referring to any of the subsequent phases.

The late Professor Wilson, observing at Mornington with our beautiful four and a-half "Simm's" Equatorial, remarks respecting this phase :—"About five minutes before internal contact there was an appearance I do not recollect having seen described. The circle of the dark body of Venus was continued and completed outside the edge of the sun, marked out by a narrow luminous arc. There was no doubt about this appearance. I quite satisfied myself that it was not a mere mental continuation of the circle."

At Glenrowan, Mr. Gilbert, observing with four and a-half inch refractor, by Cooke, noted about two and a-quarter minutes before estimated internal contact "the limb of Venus visible outside sun's edge, which appeared luminous, the margin being quite distinct where the luminosity was densest."

Mr. Thomas Harrison, observing at the Observatory with a two three-quarter inch refractor, remarks :—"I several times fancied that the disc of Venus appeared darker than the surrounding glare of the sky, and seemed to trace the dark outline even when the light streak was not visible. The light line or streak outside the planet's disc (represented in sketch), although not of the thickness shown, was scarcely as bright as represented."

Mr. Anketel M. Henderson, observing with a Browning eight and a-half inch Newtonian, notes regarding this phase: —"It cleared about 11.40, and I got my first observation. Definition perfect, not the slightest tremor. At 11.53 or thereabouts I was surprised by seeing the portion of Venus outside the sun distinctly visible on a faint phosphorescent looking background. It remained visible for about 45 seconds, when clouds interfered."

C. Todd, Esq., of Adelaide, observing with an eight inch refractor, by Cooke and Son, remarks:—"For some time after internal contact at egress the portion of the planet which had moved off the sun was distinctly visible, appearing as though seen through a nebulous and luminous haze of a purplish hue, extending beyond and around the edge of the planet, and inclining to violet towards the sun."

I have no notes (except the last) of the visibility of the disc of Venus outside the sun's disc at egress. I could get no trace of it myself, although the sky was clear, and I looked carefully for it.

At Glenrowan the transit was seen earlier than at Melbourne, and when the planet was about two-thirds on the sun, Mr. Gilbert remarked, "N.W. limb slightly luminous." A sketch was given to illustrate this, from which it would appear that that portion of the planet nearest the centre of the sun exhibited on its edge a luminous segment, in the drawing not unlike one of the polar spots on Mars, but less marked and defined.

We now come to the appearances presented at internal contact.

Regarding this phase I find I noted as follows:—"This phase was remarkably well seen, and was almost tangential, and free from any haze, ligament, or other disturbance, the sky remaining clear in the region of the sun till after internal contact was well over."

About 2 min. 30 sec. before contact, limb of sun appeared to bulge out so as to embrace Venus, the outwardly bent cusps continuing around Venus like a thread of silver. The next phases noted were near the time of the first internal contact, when a slight flicker between the limbs of Venus and sun was occasionally visible, then a hazy junction like thin smoke was noticed, and finally a very faint smoky thread appeared to join the two edges. This suddenly disappeard at 0 h. 1 min. 9·4 sec., Melbourne time.

Mr. White, observing with a two and five-eighth inch refractor, remarks:—"At about three minutes before the time of the first internal contact, when I first watched with the altazimuth, Venus was nearly on the sun's limb; the part off the sun was partly embraced by two bright horns stretching out from the surface of the sun. At the phase marked 'estimated tangential' Venus appeared to be attached to the sun by a very broad ligament nearly as black as the planet itself, and the position of the planet was such that if the dark face had been quite circular it would have formed a tangent to the sun's limb. At the phase marked 'Chinaman's cap' the ligament narrowed very much on the side of Venus, the broad part being still attached to the sun's limb. At the phase marked 'bright streak of light' a bright arc of light appeared between the broad part of the 'cap' and the sun's limb. The sun was now clouded for about a quarter of a minute, and when the cloud had opened the 'cap' had disappeared, and Venus had become truly circular, and was well separated from the limb of the sun."

At Mornington the late Professor Wilson noted a *fluffy connection,* which is undoubtedly the same phase I noted as *smoky connection.*

At egress the atmosphere was more disturbed in Melbourne, and the phenomena about internal contact were more marked and troublesome. First, a haze or smoky appearance between limbs of sun and planet was noted, then a distinct darker thread in centre of haze, then a tremulous or flickering junction of limbs, and finally a distinct and final junction. The sun's edge was very tremulous, but the sky quite clear.

Professor Wilson stated of this phase that "the sun's edge was boiling. Venus did not look round, but as you might imagine a spherical balloon not quite blown up; the edge looked crumpled. A small dark object was seen flickering backwards and forwards between Venus and edge of sun; this increased, and there was no other phase to which I could attach a definite time."

At Sandhurst, the appearances of internal contact at egress were noted by Mr. Moerlin, observing with a six and a-half inch refractor. (Cloudy weather prevented observation of ingress observations.) "As the planet moved gradually near the sun's limb, the sun's limb and planet appeared sharp and well defined, and the streak of light between the two was distinct and unmistakable. As it came nearer and nearer, the same appearance was witnessed without any change whatever, the streak of light between the two became smaller, and all at once a sort of triangular-shaped connection between the two took place, an appearance which I have seen with the artificial transit, but to a more limited extent, the base of the triangle on the sun's limb and the apex on the planet as thus :—

The difference in the appearance from what I had seen with the artificial transit consists in the much larger base. When this phenomenon first appeared the time was taken by Mr. Pirani, by chronometer 806 (Daniel's), viz., 3 h. 26 min. 54·3 sec. The planet every once in a while jumped off the apex of the triangle, and the rim of the sun's disc could be distictly seen between the two; the distance, however, betwen the triangle and the planet—when jumping—growing less. I now looked out for the tangential contact, watching at the same time the gradual diminution of the separation between the planet and the apex of the triangle; the clouds became thicker, but still permitted me to see the phenomenon distinctly, and what I considered the tangential contact was observed at 3 h. 27 min. 17·8 sec. The jumping or separating of the apex of the triangle and the planet ceased a few seconds before what I considered the tangential contact."

Mr. Todd says, respecting this phase, that "it was quite clear at egress, which was well observed. No black drop, but the continuity of the sun's disc was first broken by an exceedingly fine black line, or rather a minute speck, which appeared as the smallest possible protuberance on the edge of the planet, but the apparent contact occurred 12 seconds later. The planet was seen to be sensibly but very slightly distorted immediately joining the sun's limb, the circular outline of the ball being apparently drawn out into a thick band. This, however, was so slight, that it might easily have escaped notice."

Mr. Gilbert, at Glenrowan, reports of the appearances at internal contact of egress:—"The ligament commenced to form at 11 h. 58 min. 53 sec. a.m., Melbourne time, being exceedingly well defined a minute afterwards; the ligament snapped very suddenly about 0 h. 0 min. 44 sec. p.m. Shortly after this clouds came over, but still it was sufficiently clear to note anything of interest. About 2 p.m. noted that the planet appeared of a violet colour from the limb, extending a quarter of its diameter inwards; colour most dense at the limb of the planet, the centre being almost black. During the whole of the time the planet had a granular appearance."

Observations of the appearance of Venus during the middle phases of the transit, for the purpose of ascertaining if there were any indications of an atmosphere about Venus, and for noting any peculiarity of appearance of the planet's disc, were obtained by most of the observers. No evidence of a satellite was noted by any. Nearly all noticed a blue colour about the outer circumference of the disc of the planet, many of them stating it to be very marked, always *blue* or *indigo*. A light shade (by some called *grey*, by others *white*) was also clearly seen on the central portion of the disc, some observers stating it was condensed at the centre almost to a nebulous point of light. The Rev. J. Clarke, at Williamstown, observing with a eight and a-half inch Browning Newtonian, describes the appearance of a *brownish halo* encircling Venus while traversing the sun's disc. I made a very careful scrutiny, and the blue colour of the outer portions, and hazy light, denser towards the centre of Venus, were very well seen. I also noted a "blurring" or "loss of definition" of the "Rice grain" or "willow leaf" structure of the solar surface immediately around Venus. This blurring was not symmetrical, but projected towards the sun's south limb. Perhaps Mr. Clarke's halo may have some connection with this.

These are the most noteworthy facts recorded during the observation of the transit. They afford plenty of pabulum for speculation, but I simply place them in their bare form before you, partly with a view to inform you of what was seen, and partly that they may, with any remarks they may elicit, be recorded in our transactions whilst the circumstances are fresh in our memories.

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## Art. XIII.—*Notes on Some Upper Palæozoic Polyzoa, from Queensland.*

By R. Etheridge, Jun., F.G.S.

[Read 12th April, 1875.]

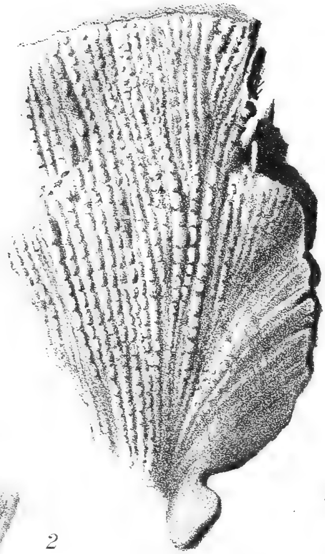
The geographical distribution of fossil species being a point of some importance in palæontological inquiry, I have the pleasure of forwarding to the Royal Society a few notes on the occurrence of certain species of polyzoa in the upper palæozoic rocks of Queensland, which have hitherto been recorded from similar deposits in New South Wales and Tasmania. The specimens in question form part of a collection of corals forwarded to me by my friend Richard Daintree, Esq., F.G.S., with a view to their identification, and for which I take this opportunity of returning him my best thanks. The specimens of polyzoa are all in the form of casts, but from the manner in which some of the pieces of matrix are crowded with the polyzoal remains, one of the species at least, *Polypora ampla*, Lonsdale, must have existed in considerable quantity. I have been enabled to recognise three species, viz., *Polypora ampla*, Lonsdale, *Fenestella fossula*, Lonsdale (a form allied to), and an undetermined species of *Fenestella.*

For the very truthful drawings accompanying these notes I am indebted to my friend and colleague, C. R. Bone, Esq., draughtsman to the Geological Survey, London.

### Polypora ampla, *Lonsdale. Figs.* 1 *and* 1*a.*

*Description.*—The polyzoarium is regular and infundibuliform, with the celluliferous surface looking inwards; the interstices are straight, broad and flat, branching dichotomously, with the celluliferous surface covered with numerous rows of alternating cell apertures, and they enlarge considerably previous to bifurcation; the dissepiments are short; the fenestrules large, with the margins sometimes a little crenulate from the projection of the lateral rows of apertures; the cell apertures themselves are round, with slightly projecting margins; the reverse face is granular.

*References.*—*Fenestella ampla*, Lonsdale, Darwin's *Geol. Obs. Volcanic Islands,* 1844, Appendix p. 163; *ibid.*, Morris, Strzelecki's *Physical Descr. N. S. Wales, &c.* 1845, pl. 9,



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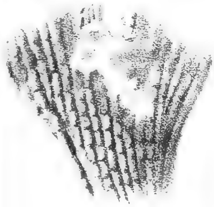

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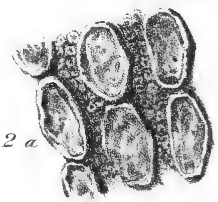

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f. 3; *ibid.*, McCoy, *Annals Nat. Hist.* 1847, xx. p. 226; *ibid.*, Dana, *Geology U. S. Expl. Expd.* p. 710, pl. 11, f. 1; &c. &c.

The foregoing description is partly taken from Mr. Daintree's specimens, and partly from Mr. Lonsdale's description; the latter adds that the dissepiments are occasionally celluliferous, and the rows of cells on the interstices separated by slightly flexuose tuberculated ridges. These characters are not displayed by the present specimens, which, three in number, all possess the regular and uniform habit of growth and large size, so well exhibited by Prof. Morris's figure in Count Strzelecki's work. According to Mr. Lonsdale, the numbers of rows of cells vary from two to ten, the latter occurring on the widened portions of the interstices previous to bifurcation. In the Queensland specimens I have not been able to detect more than four rows, usually there are three. This species was originally described as a *Fenestella*, but the increased number of rows of cells, and other minor characters, will I think necessitate its removal from that genus, and place it in Prof. McCoy's genus *Polypora*.

*Localities.*—Blackfellow's Diggings, Rockhampton, Queensland (*Daintree Collection*). The other localities at which this species has been found are Spring Hill, Mount Wellington, and Eastern Marshes, Tasmania (*Morris*); Muree, Bell's Creek, and Loder's Creek, New South Wales (*McCoy*); Glendon, New South Wales (*Dana*).

### FENESTELLA FOSSULA (?) *Lonsdale.*

Accompanying *Polypora ampla* are two specimens of a much more finely reticulated form, preserved in a similar manner as casts, but not in a sufficiently good state of preservation to permit of any detailed description being given; but the general habit and mode of growth would lead to the belief that they are Lonsdale's *Fenestella fossula.*

*References.*—*F. fossula*, Lonsdale, Darwin's *Geol. Obs. Volc. Islands*, 1844, p. 166 App.; Morris, Strzelecki's *Phys. Descr. N. S. Wales, &c.*, 1845, p. 269, t. 9, f. 1; McCoy, *Annals Nat. Hist.* 1847, xx. p. 226; Dana, *Geology U. S. Expl. Expd.* p. 710, Atlas, t. 11, f. 3. *F. fossula et F. densa*, Etheridge, *Quar. Jour. Geol. Soc.* 1872, xxviii. p. 332, t. 25, f. 1.

*Localities.*—Blackfellow's Diggings, Rockhampton, Queensland (*Daintree Collection*). *F. fossula*, Lonsdale, is recorded from Mount Wellington, Tasmania (*Morris*); St. Patrick's Plains and Raymond's Terrace, New South Wales (*Morris*); Bell's Creek and Darlington, New South Wales (*McCoy*); Glendon, New South Wales (*Dana*); Smithfield Reef, Gympie Goldfield, Queensland (*Etheridge*).

FENESTELLA. *Figs.* 2 *and* 2*a.*

*Fig.* 2 represents another species of *Fenestella* from Gympie, as a cast in yellow sandstone, evidently the remains of a large and handsome species. The fenestrules appear to have been oval, and tolerably large in proportion to the other parts; the interstices bore two rows of cell-apertures, separated by a small flexuous keel, from four to six cell-apertures to each fenestrule. In places a third row of cells is developed, especially previous to the bifurcation of the interstices or stems. This species has somewhat the appearance of Lonsdale's *Fenestella internata* (Darwin's *Geol. Obs. Volc. Islands,* App. p. 165; Strzelecki's *Phys. Descr. N. S. Wales, &c.* p. 269, t. 9, f. 2); but it is apparently too large, and there are too many cells to the fenestrule. As there is only one specimen, and that a cast, I refrain from giving to it any new specific name.

*Locality.*—Gympie, Queensland (*Daintree Collection*).

EXPLANATION OF THE FIGURES.

*Fig.* 1. *Polypora ampla,* Lonsdale, natural size.
,, 1A. A portion of the same, enlarged.
,, 2. *Fenestella,* natural size; Gympie.
,, 2A. A portion of the same, enlarged.

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## ART. XIV.—*On the Importance of a more close and systematic Observation of the Oceanic and Atmospheric Phenomena of our Coasts.*

By T. E. RAWLINSON, ESQ.

[Read 12th April, 1875.]

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## ART. XV.—*On some of the Results of the Challenge Expedition.*

By GEORGE FOORD, ESQ.

[Read 17th May, 1875.]

## Art. XVI.—*The Sciopticon.*

By W. M. Cooke.

[Read 17th May, 1875.]

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## Art. XVII.—*Notes concerning the Phenomena of the Approach and Recession of Bodies under the Influence of Radient Energy.*

By Alfred Mica Smith, B.Sc.

[Read 14th June, 1875.]

[ABSTRACT.]

The subject of this paper, the author said, is far from being a new one, having engaged the attention of several physicists of repute during the last eighty years. It has recently been brought very prominently before the scientific public by the elaborate experiments of Mr. William Crookes, F.R.S., who has attacked the question of the causation of the motions concerned with persevering industry, and with the aid of refined apparatus of a character wholly beyond the reach of the earlier investigators. Mr. Crookes' results and the expression of his views have led to the performance of experiments and the expression of theoretical views, on the part of Professor Osborne Reynolds, of The Owens College, Manchester; Professor Reynolds' views and deductions appearing to differ widely from those of Mr. Crookes. The question of the causation of these remarkable motions remains therefore yet an open one. The quantities dealt with are small in amount; the experimental means are delicate and susceptible of influence from very slight disturbing causes; the whole question is subtle, bordering closely on the confines of the unknown in molecular physics. But the subject, although a difficult one, is also confessedly one of high moment and great interest, and as after many experiments the author had arrived at certain results, some of which appeared to be not wholly devoid of interest, he ventured to select a few therefrom to place before the Society, in the hope that they might contribute some small amount of collateral testimony to be added to that already adduced. It was further added,

in apology, that while what he had to advance in this paper was but a mere fragmentary contribution, he was not without hope, leisure permitting, of prosecuting the inquiry by further experiment.

A *résumé* of the earlier phases of the inquiry was then given and the experiments of the Rev. A. Bennet * were quoted: Mr. Bennet having been the first, as far as known, to record the fact that a light substance delicately suspended in air moved towards warm bodies.

The author then passed to the modern phases of the inquiry, as represented by the investigations of Messrs. Crookes and Reynolds. Mr. Crookes characterises the results of the earlier workers as collectively unsatisfactory and contradictory, and then proceeds to carry out a very large number of most delicate and ingenious experiments with the assistance of all the refinements of modern science. His apparatus in its simplest form consists of a light stem of glass with pith-ball extremities, delicately suspended horizontally within a glass globe. When a ray of heat or light is allowed to fall on one of the balls, that ball swings towards the source of heat or light. When, however, the globe is exhausted of air and the ray again directed on to the ball, the ball then swings away from the source of the ray. Before the exhaustion is complete, when the vacuum gauge is within about half an inch of the barometer, a neutral point is reached at which the balls remain inert under the influence of these rays.

The refinements and ingenious devices introduced by Mr. Crookes into the method of conducting this fundamental experiment were dwelt upon at considerable length, and his application of the chemical vacuum prepared by the method of Dr. Andrews fully described.†

After most elaborate experiment, Mr. Crookes expresses his views as to the causation of these phenomena in the following terms:—"My own impression is that the repulsion accompanying radiation is directly due to the impact of the waves upon the surface of the moving mass, and not secondarily through the intervention of air-currents, electricity, or evaporation and condensation." (*Philos. Mag.* vol. xlviii. p. 94.)

The experiments and views of Professor Reynolds‡ were next entered upon, this physicist referring the cause of these

* *Chem. News*, vol. xxxi. p. 1. † *Ibid.* p. 33.
‡ *Philos. Mag.*, vol. xlviii. p. 146.

motions to the effects of evaporation and condensation. He found that when he inclosed a little balance within a water vacuum of from $\frac{1}{2}$ to $\frac{3}{4}$ inch pressure and approached a flame, the nearest pith-ball was driven away; but that when a piece of ice was brought near the ball swung towards the ice. Professor Reynolds finds this behaviour to be directly deducible from the Kinetic theory of gases. A material surface in the act of throwing off vapour is itself repelled by the reaction, whilst a similar surface condensing vapour has the pressure on that surface diminished, and is consequently drawn forwards.

The author then proceeded to describe a few of the experiments he was led to make whilst examining these phenomena, in the following detail :—

"In order to examine these motions in air at the ordinary pressure, a large glass shade, about two feet high and eleven inches in diameter, was employed. This was inverted and the open end covered with a glass plate. By the aid of a fibre of raw silk, there was suspended horizontally within it a balance consisting of a glass stem carrying cylinders of pith at the ends, and hanging about $13\frac{1}{2}$ inches from the glass plate.

"*Experiment* 1.—When a flame or other source of heat is brought near this glass shade, the nearest pith approaches the source of heat. It swings steadily towards the flame, at a more or less accelerating speed, until it nears the flame, when it begins to slow. It usually passes some degrees beyond this point, due to momentum as it might be, but returns and comes to rest within some degrees of the flame. The behaviour, however, varies somewhat, the balance in some cases slows and stops before the pith ever reaches the flame, sometimes it keeps slowly vibrating from side to side of that position, but when it comes to rest it is in almost every instance from 5° to 10° on one side of the flame.

"This suggests the action of two or more opposing forces simultaneously at work upon the pith, the balance taking up a position determined by the resultant of these forces.

"*Experiment* 2.—Another observation that supports this view of the case is this :—'When a basin of water is placed within the glass shade, the atmosphere of the interior soon becomes saturated with water, and whenever the temperature sinks below the dew-point, the inner surface of the shade becomes bedewed with moisture. If now the flame be approached when the shade is in this condition, the nearest pith first of all recedes from the flame, but very soon turns and swings towards it in the usual manner.'

"It occasionally happens, when the flame is placed exactly equidistant from the two pieces of pith, that the balance remains in unstable equilibrium for four or five minutes, until, probably, some little accident, such as a current of outside air inpinging on the glass, gives one or other pith the advantage.

"The two opposing forces that suggested themselves were:—Air currents within the shade, setting towards the flame and causing the pith to approach, and evaporation from the surface of the pith or glass tending to withdraw the pith from the flame.

"*Experiment* 3.—With a view to connecting air currents with the production of these motions, the following experiment was devised.

"A pith-ball balance was suspended within a dry flask, and a piece of phosphorus introduced. A thin vertical stream of fume rose from the phosphorus. When a flame was then placed near, the fume took the direction of the flame before the balance itself became sensibly affected, and flowed in a circle rising on the side next the flame and descending on the opposite side. When, again, the relative position of the flame to any part was altered 180°, the direction of the ascending current of phosphorus fume was reversed, it then ascended on the side next the flame in its new position, and soon the pith swung round to that part. The setting up of the current was antecedent to the rotation of the balance, and the reversal of the current was antecedent to the reversal of the direction of the balance.

"*Experiment* 4.—In order to examine further the action of convection currents, another medium was employed.

"A balance made of a glass rod drawn out so as to leave heavy ends, was suspended horizontally in a vessel of water by a fibre of silk. When a flame was placed near it and allowed to remain for some time, the rod slowly but steadily swung round, until it pointed straight at the flame, in which position it remained stationary.

"As evaporation has no place in this experiment, the position taken up by the rod with reference to the flame is quite what might have been expected—setting in the line of least resistance.

"The course of the current may be rendered visible by dropping a little colouring matter into the liquid just over the end of the balance furthest from the flame; the colouring matter will then be seen to descend perpendicularly, move along the bottom towards the flame, and rise up the side of the vessel next the flame, as in the last experiment.

"These two experiments render it highly probable, I think, that convection currents play an important part in the production of the phenomena under discussion, so far at least as they apply to air at the ordinary pressure.

"If, as had been suggested, evaporation from the surface of the pith was involved in these motions, it was conceived that some confirmation of this might be obtained by a comparison of the effects of heat on the same balance in moist and dry air, other conditions being as nearly as possible the same.

"With this object in view a balance consisting of a platinum wire carrying a pith ball at each end was suspended horizontally within a round-bottomed glass flask. The pith balls weighed about a grain each, and the platinum stem considerably less than a grain.

"*Experiment* 5.—The flask, after having been well air dried and warmed, had boiling oil of vitriol poured into it, and was then closed with an indiarubber stopper carrying the little balance. When a flame was approached, after the air within the flask had reached the ordinary pressure and temperature, the nearest pith came towards it as usual. The pith almost never reached so far as the flame however, but, after several vibrations, took up a position about 20° short of the flame.

"*Experiment* 6.—The oil of vitriol was next replaced by water, which was caused to boil in the flask for some time and then allowed to cool down. The inner surface of the glass soon became bedewed with moisture. When the same flame, under the same conditions as in the last experiment was presented, the nearest pith moved towards it as usual. But the motion was in this case much more rapid and the swing farther; the pith usually went well past the flame, repassed, and then vibrated slowly about 80° from the starting point, or within 10° of the flame.

"The difference in the motions exhibited in these two cases of the moist and dry air, may be looked upon, I think, as favouring the notion of evaporation as a cause operating in the production of these phenomena.

"As, in the second case, the air was already saturated with moisture, evaporation could not take place so readily as in the case of the dry air, and, consequently, the force causing recession being weaker would enable the balance to swing nearer the flame.

"In considering, in the next place, the effect of condensation as a cause of approach, it was thought that if a balance could be placed under such conditions that rapid condensation or absorption would ensue under the influence of heat, the effect might be so exaggerated as to be made very conspicuous. For this purpose the property that oil of vitriol possesses of rapidly absorbing moisture was taken advantage of.

"*Experiment* 7.—A balance was constructed of a platinum stem, with small plates of pumicestone at the ends, and suspended horizontally within a flask by a fibre of silk. So long as the pumicestone was dry the balance swung, but slowly, towards the flame; when, however, it was moistened with oil of vitriol the motion was greatly accelerated. In addition to this increased rate of motion towards the flame, the following interesting behaviour was observed. The heavier end always came towards the flame, even when the flame was placed opposite the lighter. It then rapidly still further increased in weight, by the attraction of moisture, until sufficient had accumulated to form a drop. Directly this drop fell, the end next the flame rose, being then the lighter, and forthwith commenced to swing round until it had changed positions with the other end, which, in its turn, increased rapidly in weight, let fall a drop, and immediately thereupon began to swing round as before. This periodic exchange of positions continued so long as the drops continued to fall.

"The question as to why the lower end of the balance should always approach the flame, now offered itself for solution. It was conceived that it might depend upon the relative amount of condensation that was taking place on the two ends; or again, that it might be a direct result of the action of convection currents. In the endeavour to settle this point a number of experiments were instituted.

"*Experiment* 8.—A very delicate balance, consisting of a fine glass stem carrying small pith-discs at its extremities, was suspended horizontally within a moist flask. A flame was placed near and the movement of the balance attentively watched, when it was found that its behaviour corresponded with that of the balance in the last experiment. The end next the flame was observed to rise slowly; on its attaining a position a little above the level of the farther end, the balance swung round, the two ends eventually changing places; this change of position being repeated at intervals as before. Since in this arrangement, however, the alteration in the relative level of the two ends was gradual, and not sudden as it was in the oil of vitriol experiment, the exchange of position between the ends was likewise less sudden, one or more false starts being sometimes made before the change was effected. When time was given this change never failed to take place.

"In the attempt to eliminate as far as possible the effects of condensation, and so to examine the effects due, as was supposed, to air currents alone, on a balance with ends at different levels, another form of experiment was thus arranged.

"*Experiment* 9.—A balance was prepared consisting of a glass stem furnished with a disc of paraffin at the end of one arm, and having the end of the other arm bent in the form of a hook. The hook served to support a number of little glass riders. By adding or removing these little weights the balance could be adjusted so as to swing in any position. It was then suspended within a dry flask.

"When the paraffin disc was highest it retreated rapidly on the approach of heat, as of the finger held close to the glass. When weights were removed from the other end and the disc was lowest it swung rapidly towards the finger. When the balance was as nearly as possible horizontal the nearest end always approached the heat. A source of cold on being brought near produced just the opposite effects.

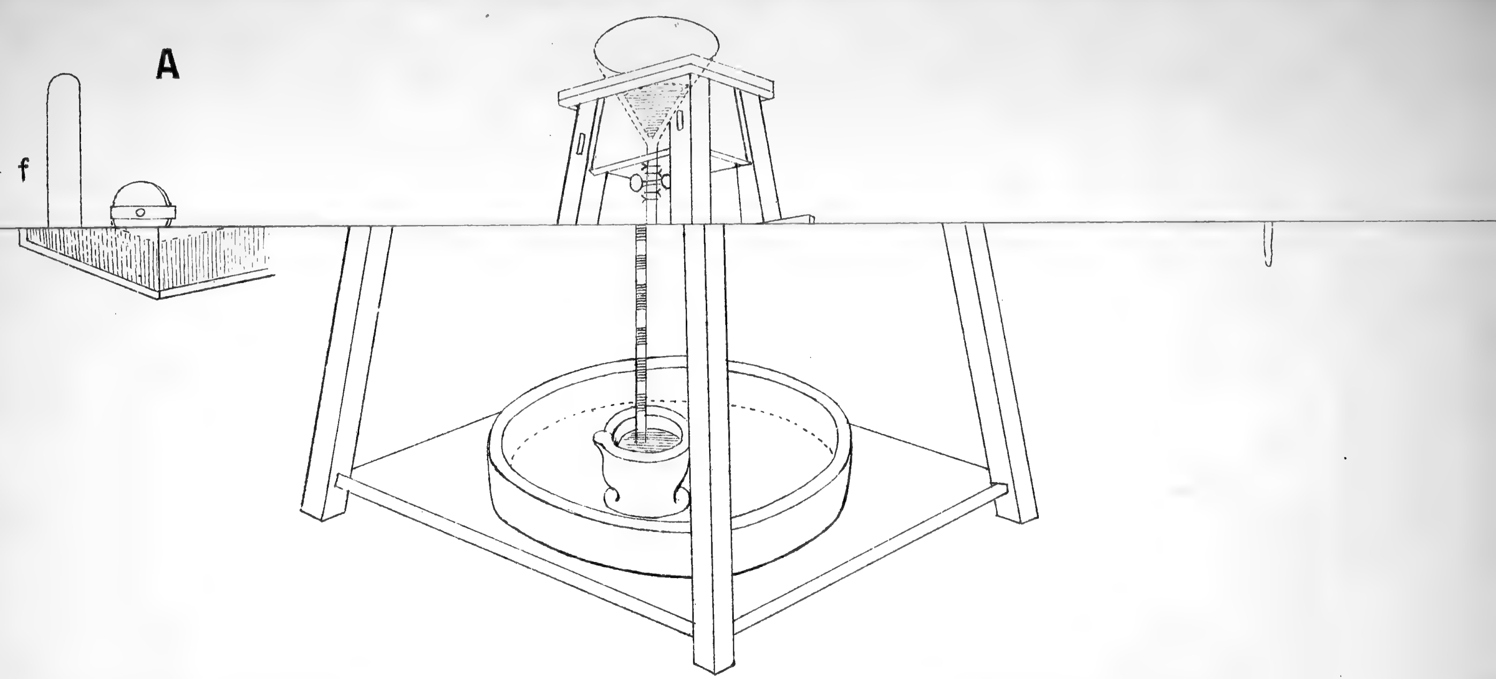
"When balls of paraffin or pith were used the same results were obtained; and again, when the glass flask was replaced by a tin vessel, only in the latter case the movements were rather more rapid.

"If we consider the course of the air currents within the flask, their effect of difference of level will receive a ready explanation.

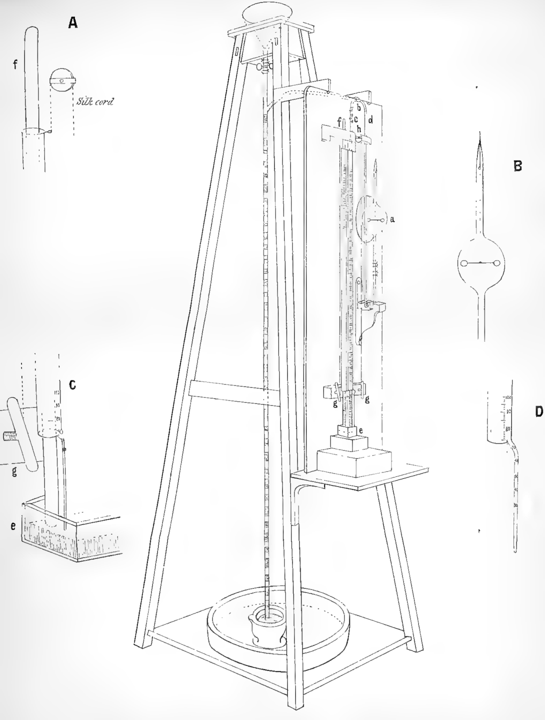
"It has already been shown that the currents rise on the side next the flame, and descend on the other side. As suggested by Mr. F. J. Pirani, during a conversation with him on the subject, these circular currents will not be parallel to one another, but will converge towards the flame. If we suppose the flask to be divided by a horizontal plane passing through the centre of the flame, then it will be evident that in the lower segment the currents will converge towards the flame, whilst in the upper segment they will diverge from it. The centres of flame and balance being in a horizontal line, if one end of the balance be above this line, it will be within the currents diverging from the flame, and will consequently be swept away. If below the line, it will be under the influence of currents converging towards the flame, and will therefore be swept to the point nearest the flame, and held there in position. With a source of cold instead of heat, these effects will be reversed.

"For examining these phenomena in a vacuum, the Sprengel pump used was one constructed by Mr. George Foord, of the Melbourne Mint. It is fitted in a pyramidal frame of wood (*see figure*), and has a six feet fall tube. The exhaust tube is connected with a T shaped branch, which, in its turn, is joined at one of its extremities to the apparatus containing the balance, the subject of experiment, and at the other with the mercurial gauge. In the cistern of the mercurial gauge is immersed the lower end of a barometer tube, so that gauge and barometer, which are of the same calibre, stand side by side. Over each slides an outer glass tube, graduated to millimetres, which may be raised or lowered so as to allow a pointer of glass, in which the lower ends of these outer tubes terminate, to touch the surface of the mercury. This lower point is the datum line of the graduations. The glass scale tubes are raised and lowered by a very simple mechanism of silk cords, pulleys, and keys of glass, round which the cords are wound, in a manner comparable to the tightening and relaxing of the strings of an ordinary violin. All the junctions of the pump are of stout black indiarubber. The instrument is very effective.

"The balance employed consisted of a very fine platinum wire with pith-balls at the ends, suspended within a glass bulb, which was connected with the Sprengel pump by its lower extremity (see figure). In constructing this, a bulb is first blown in the centre of a piece of carefully-selected glass tubing. One end of the tube is then drawn out to a point; towards the other end it is contracted in two places, one to give the indiarubber tubing by which it is to be attached to the Sprengel a better hold, and the other as a preparation for the sealing off. The little balance is tied by a loop at its centre to a long fibre of cocoon silk, a minute touch of cement being placed on the knot to prevent the silk shifting. The other end of this fibre is tied to a




SPRENGEL PUMP
—WITH TUBES IN POSITION.—




SPRENGEL PUMP
—WITH TUBES IN POSITION.—

piece of platinum wire ending in a loop, which has been cemented with gold, so as to leave no rough edge where the silk fibre might become fast. The fibre is chosen of such a length that when all is in position the balance will hang in the centre of the bulb. The tube is now inverted, point downwards, and the platinum wire first introduced at the wider end, then the balance, supported by a wire with a hook at the end, is carefully allowed to slide in until the free end of the platinum wire emerges from the pointed end of the tube. The projecting wire is then caught hold of, and the wire with the hook removed. The tube is now inverted into position, and the balance adjusted so as to swing in the centre of the bulb by raising or lowering the wire at the top, before sealing it into the glass. The contraction towards the lower end, in anticipation of the sealing off, is still further narrowed when it is ready for attaching to the pump. After exhaustion it is sealed off.

"My experience of the phenomena, as exhibited by the arrangement described, may be stated very shortly. Although indications of recession on the application of heat were certainly obtained when the gauge was within eight millimetres ($\frac{1}{3}$ inch) of the barometer, still these movements were exceedingly feeble and uncertain. I found that the exhaustion might reach to within $\frac{1}{25}$ of an inch of the barometer, or even so near as to be indistinguishable from it by the cathetometer, and yet when heat was applied no certain indications of recession could be detected, nothing further than an occasional slight twitching taking place, and this even when a part of the glass was heated until painful to the touch. I could only obtain indications with certainty when the pump was made to work vigorously for some time after the void was to all appearance as good as the barometer vacuum. But so long as the pump was working, with such a perfect vacuum, the behaviour of the balls under the influence of heat was very erratic. The balance would suddenly start off, making several revolutions each way, slowing as the balls passed the flame, then swing to and from the flame regularly for some time, soon to repeat these spasmodic movements.

"It was found on some occasions, when the Sprengel was working under these conditions, that the approach of a stick to within an inch or two of the glass caused one end of the balance to swing towards and from the stick through 40°. A test tube of hot water then caused the nearest ball to swing towards it first, then back again, continuing this vibration. When a sheet of white paper was waved near it the balance was caused to swing round several times.

"Such irregular behaviour on the part of the balance at once suggests electrical action as a disturbing cause, and that there is abundance of electrical disturbance within the tube is very certain. Indeed, very little experience of the action of the Sprengel pump is sufficient to show that besides its function of an air-pump it is also an electrical machine. In warm weather especially sparks can be drawn by presenting the knuckle to the surface of the mercury in the lower reservoir, and in a dark room, when a tolerably attenuated atmosphere is reached, flashes of sheet lightning are seen to quiver from time to time through all the airways.

"There can be little doubt that these discharges are implicated in some of the irregular behaviour of the pith-balls, which has just been described, so that for delicate experiments we must either have the tube hermetically sealed off and detached from the pump after exhaustion, or at least allow it sufficient repose for the restoration of the electrical equilibrium.

"When these precautions are taken the behaviour of the balance under the influence of heat or cold is perfectly consistent and regular; the balls receding from a source of heat and approaching a source of cold.

"Touching the question of the causation of these phenomena, in the first place I think it will be ceded that we may have approach without attraction properly so called, and divergence without repulsion,—the weathercock is not attracted in the direction of the wind, but is forced into the position of least resistance.

"There are some beautiful experiments that bear upon this point, by Dr. Frederick Guthrie, in reference to the approach of vibrating bodies towards one another, as though in obedience to an attractive force. He shows how a delicately poised piece of card or handful of cotton wool moves towards a tuning-fork during the vibration of the latter. Also, how a paper drum, suspended horizontally, approaches a drum made by stretching parchment across the wide end of a funnel, when the latter is made to vibrate by rapidly forcing air into and drawing it out of the funnel.

"He also advances in clear terms an explanation of these phenomena, which, as they involve a general principle, I am tempted to quote :—

"'The experimental results appear to me to point to the following conclusions :—

"'Whenever an elastic medium is between two vibrating bodies, or between a vibrating body and one at rest, and when the vibrations are dispersed in consequence of their impact on one or both of the bodies, the bodies will be urged together.

"'The dispersion of a vibration produces a similar effect to that produced by the dispersion of the air current in Clement's* experiment, and, like the latter, the effect is due to the pressure exerted by the medium, which is in a state of higher mean tension on the side of the body furthest from the origin of vibration than on the side towards it.

"'In mechanics—in nature there is no such thing as a pulling force, though the term attraction may have been used in the above to denote the tendency of bodies to approach—the line of conclusions here indicated tends to argue that there is no such thing as attraction in the sense of a pulling force, and that two utterly isolated bodies cannot influence one another.

"'If the ætherial vibrations which are supposed to constitute radiant heat resemble the ærial vibrations which constitute radiant sound, the heat which all bodies possess, and which they are all supposed to radiate in exchange, will cause all bodies to be urged towards one another."'†

"Clearly, then, we may have these rotations and approximations due either to currents or periodic vibrating impulses, without the necessity of supposing either special properties of attraction or the existence and exercise of any new force.

"When a gaseous atmosphere is present, it seems to me that the existence of currents adequate for producing the phenomena of approach is an obvious fact; and, when moisture is present on solid surfaces, as in the case of the bedewed glass shade, that the recession can result from its evaporation. In short, that these two operating influences are antagonistic to one another, and that we may have one or the other effect, according as one or other of these influencing causes is in the ascendant.

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* The experiment of Clement shows that when a continuously renewed current of air passes between two parallel discs from the common axis towards the circumference, the discs are urged together.

† *Proceedings Royal Society*, vol. xix. p. 41.

"We pump out a portion of the air from the containing vessel, and then the vapours and gases condensed in the pores or on the surface of the balance come into play.

"And now the question arises whether, by any degree of pumping, even with the aid of dessicating contrivances, such as that employed in the method of Dr. Andrews, we can ever completely rob the surface and pores of a solid body of all vaporizable matter. It is to be remembered that the treating of the pith-ball before the experiment, so frequently described by Mr. Crookes, implies a suspicion of something condensed in its pores; and the possibility of that something, as fast as it is expelled from the one, being rapidly condensed into the pores of the opposite ball, is too obvious to need remark. Even charring the balls will be accompanied by the formation of tarry matters of various volatility.

"There is a paper by Mitscherlich, published in the *Annales de Chimie et de Physique*, for January, 1843, which has an interesting bearing upon this question. He shows that charcoal has the power of absorbing carbonic acid, and compressing it within the pores with such force that it occupies only one fifty-sixth part of its ordinary volume, one-third of this being condensed within the pores in a liquid condition. But it takes 36·7 atmospheric pressure to liquify carbonic acid. The charcoal then holds the carbonic acid with a grasp equal to 36·7 atmospheres. As the most perfect air pump can only remove the pressure of one atmosphere, how can it be expected to cope with such a force and remove all the gas from the pores of the charcoal? But this is only one instance of a general property of all porous bodies to condense gases and liquids within their pores. Nor are porous bodies the only ones that possess this power, for it is well known that in some cases solid metals have the property of occluding gases within their substance with stupendous force and with enormous condensing power. We know that these gases can be expelled by ignition, that is to say, by heat, but it is not easy to see how the removal of one atmosphere of pressure from porous or even metallic bodies, even with accessory dessicating appliances, can remove all vaporizable constituents from their pores or surfaces, which antagonise a force out of all proportion greater than that lifted off by the pump.

Mr. Crookes finds the ultraviolet rays to be also capable of producing effects of recession. This I have not put to experiment. But these rays admittedly have the power to shake asunder the constituents of certain chemical compounds, and may have other powers of a mechanical, chemico-mechanical, or other hitherto undiscovered nature.

"The very doctrine of the equivalency and convertibility of the natural forces implies, that we may have any kind of energy as the educt of any other kind. These same rays of high refrangibility are those which are absorbed by the leaves of the plant, and constitute the force by which the timber is grown, thereby effecting an enormous store of mechanical energy.

"Dr. Guthrie's experiments would appear to prove that, with an intervening vibrating ponderable medium, approach between bodies freely suspended is a natural consequence. But whether this applies, in an equal sense, in the case of a vibrating imponderable æther is not so apparent.

"We know that the latter are potent in effecting molecular motions, and we know that molecular motions anticipate the motions of the mass, as instanced by nitro-glycerine.

"But, with reference especially to these recessions of the balance, what we want to know at present is,—What would be the behaviour of a body, freely suspended, and proved to be wholly freed from all vaporizable constituents, in a perfect void, under the influence of the several varieties of radiant energy?"

In closing, the author begged to record his best thanks to Mr. George Foord, of the Melbourne Mint, for having most kindly placed his private laboratory at the author's disposal, whilst conducting these experiments, for the pains he took to construct with his well-known skill the most delicate of the apparatus employed, and for his advice and sympathy throughout the enquiry.

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DESCRIPTION OF PLATE.

*a* Bulb to be exhausted of air, containing balance—the subject of experiment.

*b* Tube from Sprengel branching into *c* and *d*.

*c* Branch tube leading to bulb.

*d* Branch tube dipping into mercury in trough *e* and constituting gauge.

*f* Barometer standing side by side with gauge.

The scales of barometer and gauge are on tubes external to each, adjusted by the keys *g* and cords passing over pulleys at *h*.

*A. B. C. D.* Enlarged drawings of details.

NOTE.—For clearness, certain minor details of construction are omitted in the drawing.

## Art. XVIII.—*A Universal Equatorial and an Instrument for Facilitating the Observation of Mars.*

By T. Harrison, Esq.

[Read 6th September, 1875.]

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## Art. XIX.—*The Arithmometer.*

By W. C. Kernot, Esq., M.A.

[Read 6th September, 1875.]

The machine to which I propose to invite your attention this evening is the invention of M. Thomas de Colmar, and is termed by him the Arithmometer, or number measurer. It was first patented in 1820. In 1822 the inventor exhibited it to the Société d'Encouragement pour l'Industrie Nationale. In 1851 the gold medal of that society was awarded to the inventor, and one of the instruments was exhibited at the Great Exhibition at London of that year; but, as far as I can judge from the published records of that exhibition, does not appear to have been so complete as those of more recent construction. The first machine that reached this colony, as far as I am aware, was imported by J. M. Templeton, Esq., F.I.A., about three years ago. On inspecting Mr. Templeton's machine I became convinced of its utility, and immediately ordered one, which you now see before you. This instrument I have had in constant use for more than two years, with the most satisfactory results.

The diagram accompanying this paper represents the upper surface or "face" of the instrument, which consists of two plates of brass, *AA* and *B B*. The plate *A*, which is permanently fixed, is pierced by a series of slots, in each of which is placed a metal button capable of motion from one end of the slot to the other. At the side of each slot the numbers 1 to 9 are engraved on the plate. Immediately beneath each slot there is a square horizontal steel axis, upon which a pinion of ten teeth is capable of sliding longitudinally. This pinion is connected with the button, so that its position on its axis will vary when the button is moved. Below the pinion there is a drum or cylinder, having nine teeth of successively diminishing length, so arranged that when the button is placed at any given number, the pinion will be opposite a part of the drum presenting that particular number of teeth. This whole combination of mechanism is repeated as many times as there are slots, and all the drums are connected by bevel wheels of equal size to a horizontal shaft, which is actuated by the handle *b*. The plate *B B*, which is usually termed the "slide," is movable upon an elongated bar hinge at the back, which permits longitudinal sliding as well as the ordinary hinge action. In this plate there are a series of openings *c*, having revolving discs beneath, each bearing the numbers from 0 to 9. To each disc is attached a bevel wheel, which gears with an equal bevel wheel on one of the square steel axes previously mentioned. Hence each of the result discs, as they are termed, will be moved through as many tenths of a revolution at each revolution of the handle as is expressed by the number opposite which the corresponding button is placed, and by means of a simple reversing arrangement, actuated by the "regulator" *E*, this motion may be caused to increase or reduce the numbers exhibited by the "result" discs. Thus, at each turn of the handle the number "set on" the buttons is added to or deducted from that previously exhibited by the result discs. But in order that this operation may be continued indefinitely, it is requisite to provide for "carrying," and this is done by means of an exceedingly elegant system of levers and cams, which come into action whenever the number 0 passes beneath any of the result openings. Thus, with the instrument set as in the diagram, if the handle were turned once the right hand or unit result disc would move through five-tenths of a revolution, and would then present the number 0. The carrying mechanism would thus be brought into action, and would cause the tens result disc to move through one-tenth of a revolution more than it otherwise would, so as in the present case to exhibit the number 4, instead of 3, to which the tens button is set.

The discs *d*, are known as the "quotient," from their use when dividing, and simply record the number of revolutions of the handle, one of the quotient discs only, viz. that nearest to the unit button, being in action at one time. Thus, in the diagram, it is evident that the handle has been turned three times with the slide in the position shown, eight times with the slide moved one figure to the right, and so on.

The large knobs *C* and *D*, are known respectively as the "result effacer," and the "quotient effacer," and operate upon a very simple and ingenious arrangement of wheels and racks, whereby all the result and quotient discs can be brought to zero, preparatory to undertaking a new calculation.

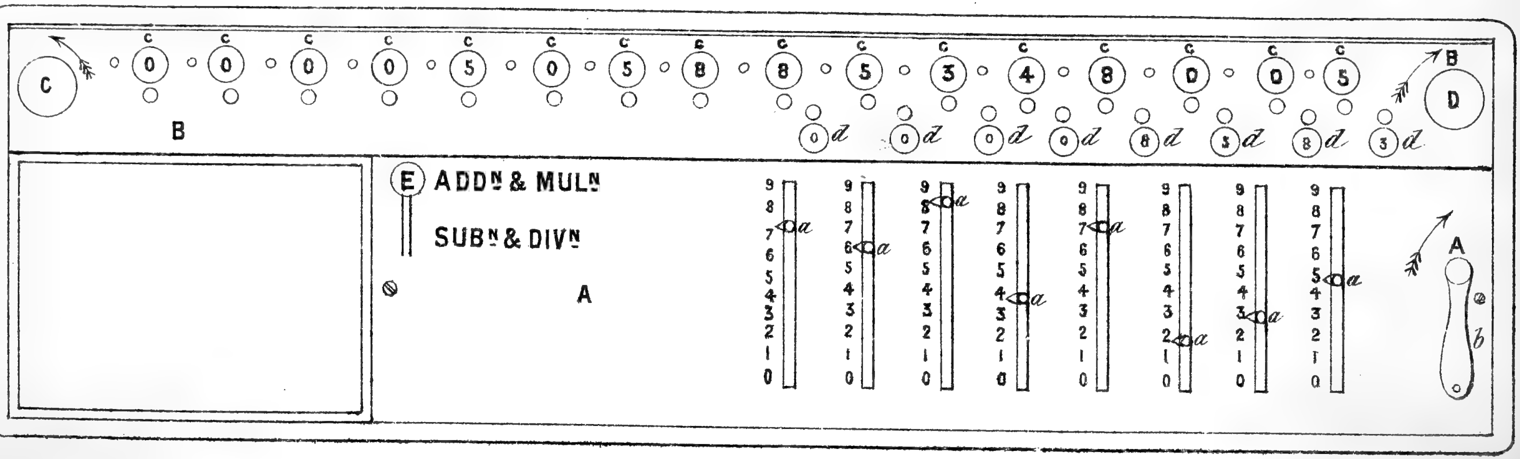
It is impossible to convey by a mere verbal description, unaided by detailed diagrams, an adequate idea of the numerous and ingenious mechanical contrivances with which this instrument abounds. To give an idea of the intricacy of the mechanism, I may state that in the smaller of the two arithmometers exhibited on the present occasion, and which has but twelve result discs, there are no less than 120 separate cogged wheels, and 44 different springs, all essential to its proper working. In spite of this apparent complexity, the machine has never yet got out of order, has never made a mistake; while of the springs, which are regarded by the makers as the weak point of the whole affair, not one has given way.

The machine, as will be seen from what has preceded, essentially a difference engine, adding to or subtracting from the number in the result, an equal difference at every revolution of the handle. Hence, it is capable of computing tables having a constant difference with great rapidity, exhibiting successive results, at the rate of one for each revolution.

Tables of this kind are very common, and although their computation requires but very little arithmetical skill, yet the operation is fatiguing and disagreeable, and an error in any one item will vitiate all that follows; hence a mechanical aid is by no means to be despised.

In many tables the difference, though not absolutely constant, varies so slowly that it may safely be taken as constant for a considerable number of successive items. In such cases also the arithmometer can be used with advantage.

Another large class of tables has for its fundamental formula $y = a x^2$. Here it can be shown that the difference of the difference, or second difference, is constant, and by altering the buttons by the amount of the second difference with one hand, and turning the handle with the other, results twelve figures long can be obtained very much more rapidly than the most expert writer can copy them



ADDN & MULN
SUBN & DIVN
E
A
B
C
D
a
b
c
d

down. To this class belong tables of squares, weights of square and cylindrical rods of various materials, strength of ditto, &c. &c.

In order to understand the operation of the machine when multiplying, it will be neccessary to observe that multiplication is but a form of addition, *e.g.*, if we wish to multiply 63 by 4, we may proceed thus—

63
63
63
63
———
252

and the method, though tedious, will be admitted to be perfectly accurate. The corresponding operation will be performed by the instrument, by setting the units button to 3, and the tens button to 6, and turning the handle four times, when the result discs will exhibit the number 252, and the multiplier 4 will be presented by the unit quotient disc. If the multiplier were 24, we should need to shift the slide one notch to the right, and turn the handle twice, the result discs would then give 1512, while the quotient discs would show the multiplier 24. The operation being similar to the subjoined addition:

```
  63
  63
  63
  63
 63
 63
----
1512
```

In this way long multiplication can be performed expeditiously and accurately, a result 20 figures long being obtained by actual trial in 45 seconds, with a machine having 20 result discs.

By means of a simple algebraical artifice results containing many more figures than the machine has result discs may be obtained, *e. g.*, a result 24 figures long, expressing the product of two factors, each 12 figures long, was obtained from an arithmometer having only 12 result discs, in about 2 minutes.

One notable feature is this, that should a mistake be made in the number of revolutions of the handle, it may be detected by a glance at the quotient discs on the completion of the operation, and at once remedied by a single motion of the handle, the slide, and if necessary the regulator.

Should a number of products having a common factor be needed, they can be similarly obtained without involving the necessity of effacing and recommencing. We simply modify the multiplier as it is exhibited in the quotient discs, and the result is correspondingly modified by the action of the mechanism. In this way, the following set of results was obtained, the time occupied being less than 2 minutes :

| | | | | |
|---|---|---|---|---|
| 323,457 | × | 317 | = | 102,535,869 |
| ,, | × | 429 | = | 138,763,053 |
| ,, | × | 1,749 | = | 565,726,293 |
| ,, | × | 2,438 | = | 788,588,166 |
| ,, | × | 196 | = | 63,397,572 |
| ,, | × | 12,198 | = | 3,945,528,486 |
| ,, | × | 144 | = | 46,577,808 |

In the corresponding case of a series of quotients having a common divisor, the reciprocal of the divisor is set on, and we proceed as in multiplication.

One of the most important properties of the arithmometer, is its power of accumulating results. If the result figures instead of being at zero at the commencement of a multiplication, be set at any particular number, at the close of that multiplication they will exhibit the sum of that number and the product obtained. Thus the summation of a series of products is rapidly effected. Nay more, should any of the products be preceded by the negative sign, that circumstance can be provided for by setting the regulator *E* at division, while obtaining those products. Thus, the algebraical sum of a series of products is obtained at one continuous operation.

As an example of this accumulation of results, I may refer to the subjoined calculations, which actually occurred in determining the capacity of one of our large reservoirs. The figures in the right hand column represent the capacity of the reservoir, for various depths of water. The first result was obtained by multiplying the first number in the left hand column ·12, by the common multiplier 653,400, the second by multiplying ·52 by 653,400, and adding the product to the first result, and so on. The time required to obtain the fifteen results, consisting in the aggregate of 120 figures, with comfort was $5\frac{1}{2}$ minutes :

| | | | |
|---|---|---|---|
| ·12 | .. | .. | 78,408 |
| ·52 | .. | .. | 418,176 |
| 2·65 | .. | .. | 2,149,686 |
| 8·55 | .. | .. | 7,736,256 |
| 17·44 | .. | .. | 19,131,552 |
| 27·88 | .. | .. | 37,348,344 |
| 38·79 | .. | .. | 62,693,730 |
| 49·81 | .. | .. | 95,239,584 |
| 61·65 | .. | .. | 135,521,694 |
| 75·55 | .. | .. | 184,886,064 |
| 91·30 | .. | .. | 244,541,484 |
| 109·27 | .. | .. | 315,938,502 |
| 129·30 | .. | .. | 400,423,122 |
| 149·99 | .. | .. | 498,426,588 |
| 173·19 | .. | .. | 611,588,934 |

In order to divide, the dividend must be placed in the result holes, if it be not there already, which is frequently the case, if multiplications or additions have preceded, and the divisor being set on the buttons, and the regulator at division, the slide is placed as far to the right as is possible, consistently with the condition that it shall be possible to subtract the divisor without reducing that portion of the dividend immediately above it, below zero. The handle being turned, the divisor is deducted successively until the figures in the result holes directly above the divisor form a number less than the divisor. The slide is then shifted one step to the left, and the process repeated, and so on until it is not possible to proceed further. The quotient will be found in the quotient holes, and the remainder in the result holes. If we wish to obtain a more extended quotient, we must record and efface the portion already obtained, and transferring the remainder to the left hand end of the slide, proceed as before. We shall thus obtain several additional figures of the quotient, recording and effacing which we may proceed to obtain another batch of numerals, and so on *ad infinitum.* In this manner the subjoined operation was effected with a machine having six buttons and twelve result discs, in about four minutes :

$$\frac{987{,}647 \times 129{,}343}{318{,}644} = 4{\cdot}00902656007958725097601$$

In conclusion, I would state that, like most other things, the arithmometer acts far more efficiently under some circumstances than others, and a very great deal depends upon the shape in which the computation is presented to it. It frequently needs special formulæ and peculiar methods, such as do not at once suggest themselves to the minds of persons inexperienced in its use, and there is scope for the exercise of no small amount of ingenuity, in so arranging the work as to gain the utmost benefit. Some formula are peculiarly suitable for logarithmic work, and rather unsuitable for the arithmometer; others are of precisely the reverse character; hence, while I believe the arithmometer to possess great advantages, I do not for one moment anticipate that it will altogether supplant tables of logarithms and reciprocals. Each will be found to have its own sphere of usefulness, within which it has no rival, Moreover, different persons will form different estimates of the value of the machine. Some who through years of incessant practice have obtained a special facility in arithmetical operations will be inclined to regard it as unnecessary; others, who find arithmetical work to constitute a severe tax upon mental energy which could be profitably employed in other directions, will value it highly.

My own experience is, that I perform my work in less than half the time that I previously required, and with not a tithe of the fatigue. Indeed, I calculate that the saving of time and labour, consequent upon its use during the past two years, has repaid its original cost several times over.

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## Art. XX.—*On the Meteor of April 15th.*

By J. Perry, Esq.

[Read 6th September, 1875.]

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## ART. XXI.—*On "Surcharge" of the Bullion Assay.*

By ROBERT BARTON, ESQ.

[Read 6th September, 1875.]

It is generally understood by assayers that the surcharge of the gold cornet does not exactly represent the residue of silver which the parting has failed to boil out, and that it is on the contrary a resultant error, in fact the difference between this silver residue and the loss which the gold suffers by volatilization in the muffle and absorption by the cupel.

As these two opposite sources of error vary according to circumstances of temperature of the muffle, porosity of the cupel, thickness of the ribbon forming the cornet, quantity of lead and proportion of silver employed, strength of acid, time of the operations, &c., it becomes necessary to control the work by the use of "proof" assays of gold of known fineness, which, passed with the work under exactly the same conditions throughout, show what correction for "surcharge" is to be made in each case.

The more closely a routine is adhered to—the same from time to time in all its minor details of temperature, &c., using cupels of the same make, acid from the same bulk—the more uniform will the surcharge remain, from day to day. But even when this approximate uniformity is secured, there still remains an influencing cause, the neglect of which will lead to reports of a comparatively inaccurate character; *the loss on the cupel depends upon the quantity of gold in the assay,* so that the surcharge will be greater in samples of gold of high fineness, than in those of low gold, passed in the same fire and parted in the same acids.

The loss of gold may be so great as exactly to neutralize the excess weight due to silver left in the cornet, when a surcharge of 0 will result; or the volatility may exceed what is required for compensating the excess weight due to remanent silver, when the surcharge will be represented by a negative sign. Something must in such instances be added to the weight of the cornet, in order to represent the exact fineness of the sample assayed.

In practice, the variation of surcharge in agreement with the varying fineness of the samples may be compensated by passing in the same fire proofs of fine gold of weights approximately corresponding to the presumed fineness of the several assay pieces under trial, correcting each of the latter by its corresponding proof; gold of ·9 by the 9 grains proof, gold of ·7 by the 7 grains proof, and so on (supposing the assay pound in these instances to be 10 grains). But with rough gold especially, of which often a large range of finenesses is passed in one fire, it would be exceedingly operose to provide proofs for each variation and for commercial, as distinguished from purely experimental work, some kind of general rule or compromise has to be made.

The following experimental trials illustrate the case:

Silver employed 2½ times the weight of the gold.
Lead ,, 84 grains.
All other conditions the same throughout.

According to the above results, when with full pound of fine gold, the surcharge equals + ·00085. Then,

With 8 grains under same influences the surcharge is reduced to one-half.
With 7 ,, ,, ,, ,, to one-quarter.
At 6 ,, ,, ,, ,, to zero.
At 2·5 the "minusage" is nearly equal in amount to the "plusage" at 10.

Of course by altering the weight of lead or in any other manner modifying the ruling conditions, other figures would be obtained, but special experiment under any given routine would show the interrelation existing between the surcharge quantities for the several finenesses of gold.

The attached graphic illustration shows the results of these experiments. The vertical column represents surcharge; the horizontal series of figures shows fineness or quantity of gold contained in the assay; the line *A* (———) connects the results of actual experiments; the line *B* (---------) averages the results; and the straight line *C* (...........) connects the extreme results.

When samples of gold of different finenesses are passed with proofs of the full pound of fine gold, with proportions of silver and lead, &c., as already stated; from the surcharge indicated by these proofs, that for any low gold may be approximately estimated by reference to the subjoined table deduced from lines ruled parallel to *C*.

Half these experiments were performed by Mr. Foord, and half by myself, so that personal error may be considered to be eliminated by the combination of results.

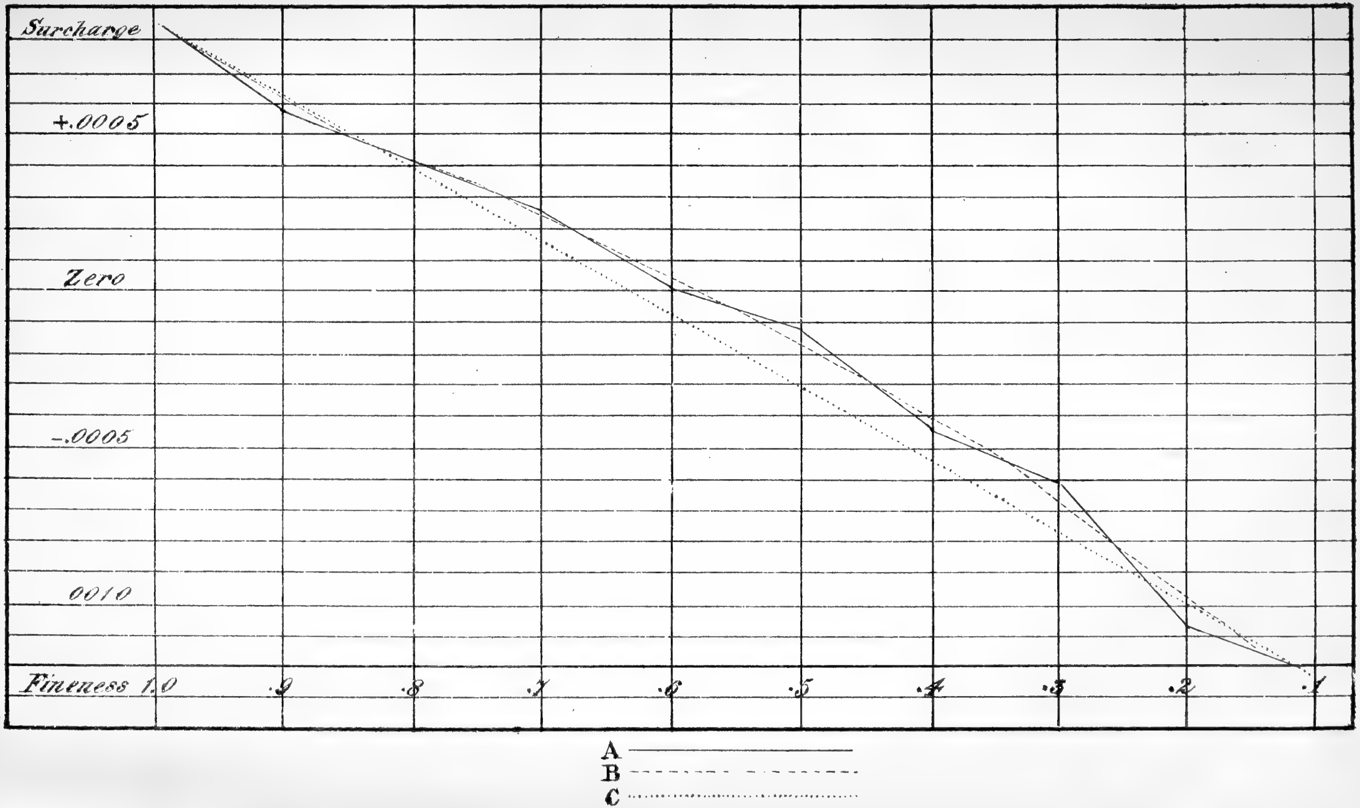
FOUND BY EXPERIMENT.

| Fine Gold. | Surcharge. | | | | |
|---|---|---|---|---|---|
| Grains. | I. | II. | III. | IV. | Mean. |
| With 10 | + ·0008 | + ·0009 25 | + ·0008 661 | + ·0008 161 | + ·0008 518 |
| ,, 9 | + 5 571 | + 5 819 | | | + 5 695 |
| ,, 8 | + 4 25 | + 5 | + 3 229 | + 3 979 | + 4 114 |
| ,, 7 | + 7 5 | + 0 25 | + 1 637 | + 1 138 | + 2 631 |
| ,, 6 | + 0 5 | + 0 5 | + 0 047 | − 0 703 | + 0 114 |
| ,, 5 | − 2 5 | + 0 5 | − 0 045 | − 3 339 | − 1 346 |
| ,, 4 | − 4 25 | − 1 5 | − 6 135 | − 5 635 | − 4 38 |
| ,, 3 | − 7 25 | − 5 | − 5 976 | − 5 976 | − 6 05 |
| ,, 2 | − 12 5 | − 9 5 | − 10 317 | − 10 067 | − 10 596 |
| ,, 1 | − 14 | − 11 25 | − 10 658 | − 13 408 | − 12 329 |

## APPROXIMATE SURCHARGE TABLE.

| 1·0 | ·9 | ·8 | ·7 | ·6 | ·5 | ·4 | ·3 | ·2 | ·1 |
|---|---|---|---|---|---|---|---|---|---|
| + 14 | + 11½ | + 9½ | + 7 | + 5 | + 2½ | + 0 | — 2 | — 4½ | — 7 |
| + 13 | + 10½ | + 8½ | + 6 | + 4 | + 1½ | — 1 | — 3 | — 5½ | — 8 |
| + 12 | + 9½ | + 7½ | + 5 | + 3 | + ½ | — 2 | — 4 | — 6½ | — 9 |
| + 11 | + 8½ | + 6½ | + 4 | + 2 | — ½ | — 3 | — 5 | — 7½ | — 10 |
| + 10 | + 7½ | + 5½ | + 3 | + 1 | — 1½ | — 4 | — 6 | — 8½ | — 11 |
| + 9 | + 6½ | + 4½ | + 2 | + 0 | — 2½ | — 5 | — 7 | — 9½ | — 12 |
| + 8 | + 5½ | + 3½ | + 1 | — 1 | — 3½ | — 6 | — 8 | — 10½ | — 13 |
| + 7 | + 4½ | + 2½ | + 0 | — 2 | — 4½ | — 7 | — 9 | — 11½ | — 14 |
| + 6 | + 3½ | + 1½ | — 1 | — 3 | — 5½ | — 8 | — 10 | — 12½ | — 15 |
| + 5 | + 2½ | + ½ | — 2 | — 4 | — 6½ | — 9 | — 11 | — 13½ | — 16 |
| + 4 | + 1½ | — ½ | — 3 | — 5 | — 7½ | — 10 | — 12 | — 14½ | — 17 |
| + 3 | + ½ | — 1½ | — 4 | — 6 | — 8½ | — 11 | — 13 | — 15½ | — 18 |
| + 2 | — ½ | — 2½ | — 5 | — 7 | — 9½ | — 12 | — 14 | — 16½ | — 19 |
| + 1 | — 1½ | — 3½ | — 6 | — 8 | — 10½ | — 13 | — 15 | — 17½ | — 20 |
| + 0 | — 2½ | — 4½ | — 7 | — 9 | — 11½ | — 14 | — 16 | — 18½ | — 21 |
| — 1 | — 3½ | — 5½ | — 8 | — 10 | — 12½ | — 15 | — 17 | — 19½ | — 22 |
| — 2 | — 4½ | — 6½ | — 9 | — 11 | — 13½ | — 16 | — 18 | — 20½ | — 23 |
| — 3 | — 5½ | — 7½ | — 10 | — 12 | — 14½ | — 17 | — 19 | — 21½ | — 24 |
| — 4 | — 6½ | — 8½ | — 11 | — 13 | — 15½ | — 18 | — 20 | — 22½ | — 25 |
| — 5 | — 7½ | — 9½ | — 12 | — 14 | — 16½ | — 19 | — 21 | — 23½ | — 26 |
| 1·0 | ·9 | ·8 | ·7 | ·6 | ·5 | ·4 | ·3 | ·2 | ·1 |

The figures in the columns denote ten-thousandths of unity.


Surcharge
+.0005
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0010
Fineness 1.0
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A
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C

## Art. XXII.—*On a Proposed New Method of Weighing, applicable to the Gold Bullion Assay.*

By George Foord, Esq.

[Read 8th November, 1875.]

It is well known that the modern practice of the gold assay includes many refinements upon the routine formerly practised; that it commands chemicals of greater purity, balances of greater sensitiveness and accuracy, and certain accessory tools which facilitate and expedite the work. But it is also well understood, especially by those immediately interested in the work, that although the method has been thus refined, it still falls short of absolute certainty and exactitude, and that further progressive improvement is still possible. One of the chief sources of minor errors which may yet be in part removed is that which belongs to the operation of weighing, and it is the object of this paper to propose modifications, which promise some advantage over the method of weighing hitherto practised.

It will assist my explanation if in the first place I offer a few practical observations concerning the construction and adjustment of the assay beam.

For weighing, in the ordinary routine of the gold assay, there are required :—

1st.—A sensitive and accurate balance.

2nd.—A series of accurate weights.

The balance-beam should be as light as possible, the requisite stiffness being at the same time secured. The arms of the balance should be of exactly equal length, measuring from the centre to each end knife edge. The knife edges must be sharp. The centre of gravity should be a little below the plane of the three knife-edges, and immediately under the centre knife-edge. Each arm of the beam should be accurately and distinctly divided by lines into fifty parts, each fifth mark from the centre, however, being distinguished by a dot instead of a line; these dots will therefore indicate tenths of the space between the centre and end knife-edge. The pans, of whatever pattern, should be small and light. The scale, measuring the sweep of the index or needle, should be accurately divided, so that each division of this scale represents uniformly a subdivision of the smallest weight: for example, when the real weight of the rider is $\frac{1}{10}$ of a grain the subdivisions of the index scale should represent $\frac{1}{100}$th part of the rider weight, or ·001 of a grain.

The beam should be constructed as simply and of as few pieces of metal as possible; the *fixed* constituent members of the beam should be fastened together as firmly as possible; the movable pieces, the ball and tongue, should be fitted to move neither too stiffly nor too loosely, but so as to retain whatever position they are placed in during the adjustment and after-use of the beam.

When the skilled workman has exerted the utmost care and ability in making such a balance-beam, the instrument will require adjustment of the tongue and ball, that is to say, of the centre of gravity of the beam, so as to suit it for the special work for which it is to be used, whether for quantity of work or for extreme accuracy regardless of the quantity of work performed in a given time. When this adjustment has been effected, it is probable that the index readings on the scale will be found to deviate more or less from the required decimal subdivisions of the rider weight.

A few sentences will elucidate the details of this final adjustment of the beam. By screwing up the ball, over the centre of the beam, we bring about two results:—

1. We raise the centre of gravity of the beam; and 2. As the ball is at best only an approximation to a true and uniformly dense sphere revolving on a vertical axis, by its revolution we displace, in some degree, the centre of gravity, in a direction other than the vertical. After screwing up or lowering the ball, the balance of the arms of the beam is found to be disturbed, and it becomes necessary to restore equilibrium by adjustment of the tongue. The tongue should be movable in azimuth on a plain cylindrical pin, without rising or falling on a screw-thread.

We may raise the ball until the balance becomes unstable, or we may lower the ball and consequently lower the centre of gravity of the beam until stability (disturbed by raising the ball) is fully restored. But when we require the greatest sensibility consistent with stability, we must, by a series of trials, bring the centre of gravity to a position a very little below the point upon which the beam oscillates (the centre knife-edge).

In the practice of this latter adjustment it will greatly assist operations to paint a small neat black dot on the equator of the ball, so as to be able by means of this mark to heighten or lower the ball with certainty a known number of threads of the screw, or, if necessary, any subdivision, as one half or a quarter of a turn.

These preliminary adjustments effected, the balance is to be loaded with the full load employed in the actual work, for example, with ten grains in each pan; and by means of the rider-weight, the two sides are to be brought into exact equilibrium. Ascertain critically the justness of the equipoise, then move the rider so as to make one side of the beam ·005 of a grain heavier than the other side, and now observe, by aid of the seconds hand of a watch, the time required for the oscillations of the loaded beam; observe, also, how many divisions of the index are equivalent to the extra load of ·005 of a grain. I will suppose that in this trial repeated experiments show that with the loaded pans for this weight of ·005 of a grain the needle sweeps from zero across two divisions of the scale, returning again to zero, and that the vibration is more than sufficiently rapid for our work. We now make a second trial: the ball is raised by two revolutions on the screw, the equilibrium of the loaded beam is adjusted by altering the position of the rider until the needle sweeps over an equal space on each side of the zero mark of the scale, and now, by moving the rider so as to be equal to an added weight of ·005 of a grain, we again try the time of oscillation and sensitiveness of the balance: the oscillations have become less rapid in consequence of the raising the centre of gravity of the beam, and the beam has at the same time become more sensitive, the ·005 of a grain being now represented by a larger sweep of the needle.

But after two or more trials of this kind we not only arrive at a nicer and still nicer adjustment of the sensitiveness and time of oscillation, but the comparison of our results affords a valuation of the thread of the screw upon which the ball is raised and depressed, as a means of adjusting with certainty the performance of the beam; each revolution of the ball, raising it by the width of one thread, is found to retard the oscillation by a certain fraction of a second, and to increase its sensitiveness by a certain fraction of a division of the index-scale per ·001 of a grain added.

Patient and careful trials of the kind will enable us to adjust the balance so as to ensure the greatest sensitiveness compatible with its weight and workmanship, or we may compound between sensitiveness and rapidity, sacrificing the former in some degree, so as to secure a speed suitable to the quantity of work which is demanded in a given time.

Chemical balances of the best construction are known to indicate the millionth part of the load, that is to say, with 1000 grains in each pan the index will move over one division of the scale for ·001 of a grain added. With the assay balance, with 10 grains in each pan, if ·001 of a grain added is represented by one division of the scale, the sensitiveness falls far short of that of the larger chemical balance; instead of one-millionth, the quantity indicated is one ten-thousandth of the load; it is one hundred times less sensitive than the former, although in each case ·001 of a grain is indicated by one division of the scale. The oscillations, however, are quicker in the case of the assay balance.

Each individual assay balance will have its own degree of sensitiveness when adjusted for the slowest speed, or its own lesser degree of sensitiveness when adjusted for a given rapid working speed; and by lowering and heightening its centre of gravity, we may attain any combination of speed and sensitiveness, gaining in the one while we lose in the other, between these limits; but we are with each particular assay balance, bound within these limits of performance of the special instrument. Thus, if we have two assay beams, without radical defects, but of different make and weight, it will be found that their performances will differ; one will prove inferior to the other. If the inferior beam be adjusted to the same degree of sensitiveness as the better constructed beam, it will take a longer time for its oscillations; or if it be adjusted to oscillate in the same time as the superior beam, it will then fall short in sensitiveness.

But the knife-edges of the best balances, whether made of steel or agate, wear and become blunted during use, and the performance is, from this particular cause, gradually deteriorated. A large part of the keeping the balances in repair consists in the reparation, from time to time, of the knife-edges, and the readjustment of them in position in the beam. But between the time when the knife-edges are sensibly perfect and when they require the instrument maker's attention there is of course a small progressive wear and alteration of them, with consequent deterioration of the performance of the beam; the value of each degree of the index scale becoming from time to time a larger weight. These small progressive differences, within certain limits, may be obviated by adjustment of the ball; but when we have thus restored the sensitiveness of the beam we have thereby added to the time required for each weighing: the beam will oscillate more slowly. A better arrangement is that in which a series of scales, any one of which may be easily and quickly slipped into position under the index, is employed. The ordinary scale divides the full sweep of the index into twenty equal divisions, ten on each side of the zero point. If, now, we provide a series of five other scales in which smaller arcs are divided into twenty divisions, ten on each side of the zero point, we can from time to time substitute one or other of these scales for that originally in use, which latter, for distinction, I will call the ordinary scale. When the ordinary scale is replaced by one of these scales, we can weigh with the same speed, and virtually the same sensitiveness of the beam, and with no other disadvantage than such as may belong to a scale of somewhat closer divisions.

In these proposed supplementary scales ten divisions on each side of the zero mark are respectively equal to the following proportions of the ordinary scale.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| In scale No. | 2, 10 | divisions | = | an arc of | 9 | divisions | on No. 1, the | ordinary scale |
| „ | 3, 10 | „ | = | „ | 8 | „ | „ | „ |
| „ | 4, 10 | „ | = | „ | 7 | „ | „ | „ |
| „ | 5, 10 | „ | = | „ | 6 | „ | „ | „ |
| „ | 6, 10 | „ | = | „ | 5 | „ | „ | „ |

and with this series we can preserve the decimal value of the index readings until the sensitiveness of the beam has diminished by one half. The following example will illustrate the way in which these scales are brought into use:—For some time after the new beam is employed, no measureable diminution of sensitiveness can be observed; but eventually the knife-edges become a little impaired, and when critically tried it is found that for ·005 of a grain the index sweeps only $4\frac{1}{2}$ divisions of scale No. 1; this is equivalent to sweeping 9 divisions for ·01 of a grain, and we can now readily compensate this diminished sensitiveness by replacing scale No. 1 by scale No. 2, in which the arc equal to nine divisions of scale 1 is divided into ten divisions. We may from time to time thus change the scales until the instrument has deteriorated in sensibility by one-half, when scale 6 will be used. A little consideration will make obvious that the series of six scales will cover all possible cases of wear between these wide limits. They provide ample and ready means of adjusting the value of the index readings, without modifying the speed of the weighing, and the instrument maker can be resorted to for keeping up the absolute sensitiveness of the balance as often as the quality of the work demands, just as under ordinary circumstances when these shifting scales are not employed. The method of using these shifting scales, indeed, is intended for obtaining more accurate readings of the index in decimal subdivisions of the weight employed as the assay pound, and not in any manner to supersede the necessary renovation and adjustment of the knife-edges by the instrument maker. It may be stated that the proposition of movable scales is one which has already been put into practice with complete and satisfactory results.*

Another form of these shifting scales has been conceived, but has not hitherto been put into actual use; it seems to promise special facilities for adjusting the index readings to even a greater nicety than that belonging to the series of flat scales above described. Instead of a series of interchangeable flat scales, a small ivory reel, revolving on a horizontal axis, and retained in any position by a small spring, is fixed between the pillars of the balance support, immediately under the point of the index. The curve of the sides of this reel corresponds to the arc described by the point of the index, and around this curved surface, 72° apart, are inscribed the scales corresponding to Nos. 1 to 5 of the above described series of flat scales. The scale agreeing with No. 6 of that series is engraved in contact with scale No. 1, or that which divides the full arc swept by the index into 10 degrees on each side of the zero point; the ten divisions of No. 6 exactly corresponding with five divisions of No. 1. A series of diverging or scroll lines connects these several scales, and in adjusting this revolving index scale it will be merely necessary to turn it round until that part, of which five divisions are found to be exactly equal to ·005 of a grain, is immediately under the index point.

But there are other points concerning the performance of the balance beam which are of great practical significance. If a beam, after careful adjustment, is exposed to change of temperature, its metallic constituent parts become altered in dimensions by expansion or contraction, and, as change of

* These shifting scales were made for the writer many years since, by Mr. L. Oertling, of London, who contrived them as a substitute for the proposed reel, as it is described in the following paragraph.

temperature in our apartments is the rule rather than the exception, the balance-beam is to be regarded in the light of a body constantly undergoing fluctuations in its size. We take the best precautions practicable under the circumstances, and we find that we are still unable wholly to counteract the influence of this cause upon the equilibrium of the beam; the effect of heated walls, stoves, &c., are among the causes which bring about unequal heating, and therefore unequal expansion of the arms of the balance; and it is only in a chamber sunk in the earth to the depth of approximate constant temperature that we can hope to escape from them, and it need hardly be added that such subterranean arrangements are incompatible with the conditions under which the ordinary assay of bullion is conducted.

But if a balance-beam adjusted at 60° Fahr. were slowly and equally raised in temperature to 90° Fahr., would all its parts remain so far just in their proportions as to retain accurately for the instrument, at this higher temperature, its original equilibrium and sensitiveness? It cannot be said that this would follow. The following extract from Professor W. H. Miller's elaborate memoir on the construction of the new imperial pound, in the Transactions of the Royal Society of London, 1856, is conclusive on this point:—

"In the course of making the preliminary observations some peculiarities of the instrument were discovered, which, though they probably exist in other balances, do not appear to have been hitherto noticed. One of these is that the expansion of one arm by heat, the left in the present case, is a little greater than that of the other arm. Hence, when the weights in the two pans are nearly equal and of equal volume, the reading of the scale in the position of equilibrium diminishes as the temperature of the beam increases. Another is, that the sensibility of the balance, as measured by the number of parts of the scale, equivalent to a given weight, was found to diminish with an increase of temperature. The cause of this is obvious. The beam being of bronze and the knife edges of steel, the balance-beam becomes an over-compensated pendulum, and an increase of temperature increases the distance between the middle knife-edge and the centre of gravity of the beam and weights, supposing the latter concentrated in the extreme knife-edges. Possibly, also, the flexure of the beam may increase with the temperature, or the mean expansion of the upper bar of the beam may be greater than that of the under bar. The variation of the sensibility of the balance is so large that it is necessary to determine the weight equivalent to a given number of parts of the scale for each set of observations, except in cases when the temperature is very nearly the same."

Between 60° and 87° Fahr. the expansion of each arm of a 10 in. balance is 14 ten-thousandths of an inch; if, for example, one arm of a balance were thus expanded, the opposite arm remaining of its original length; in that case, as the load multiplied into the length of arm is equal to the opposite load multiplied into the length of its arm, it follows that ten grains on the elongated arm would balance ten grains and ·003 of a grain on the opposite shorter arm. But although ·003 of a grain is a minute quantity regarded in the individual sense of so much gold, it is far from insignificant regarded in relation to the ten grains representing the mass assayed. Three ten-thousandths of a million sterling is no less than £300, and although it is not pretended that any inequality of the length of the arms at all approaching this proportion could occur through inequality of temperature or inequality of the coefficients of expansion in the mass of metal of which the beam consists, it at least shows that very small differences, due either to molecular constitution of the material of which the beam is made, or to inaccurate workmanship, can sensibly affect the results, and Dr. Miller's observations teach us that differences due to such causes actually exist in a measurable amount.

The adjustment of the centre and exterior knife-edges, even when the greatest care and skill are observed, is, at best, no more than a very close approximation to accuracy; with this closest approach properly ensured for one temperature, we are not to expect that it will obtain with certainty at another. If our desire is that of obtaining, under the limiting conditions of rapid execution of the work, &c. (which always belong to the bullion assay), the utmost accuracy of result, in this case it would appear that our attention should be devoted especially to the accuracy of the weights, and to such a system of work as will adopt all the reliable efficiency of the balance, at the same time counteracting the mixed and variable defects of the kind already mentioned. The modes of "double weighing," those of Borda and Gauss, are examples of methods by which a comparison of two ponderable bodies is effected in such a manner as to eliminate the errors proper to the balance itself.

In Borda's method :—The weights to be compared may be distinguished as Nos. 1 and 2. We counterpoise the heavier of the two weights by shot in the opposite pan; we now substitute for weight No. 1 that marked No. 2, and add to the latter small fractional weights until an equipoise is established. The weights added show how much No. 1 is heavier than No. 2, and the result thus obtained is quite independent of inequality of the arms of the beam.

In Gauss' method :—The weights are placed in the opposite pans and the difference noted; the pans with weights are now reversed on the beam, and the difference again noted; the mean of these differences is the real difference of the weights in air, independent of any inequality of the arms of the balance.

These examples of methods actually employed whenever rigid determinations of weight are the object, show, beyond question, that with balances rendered sensitive by lightness and judicious distribution of metal, and by sharpness and true position of the knife-edges, the accuracy of our work will depend less on the accuracy of construction of the beam itself than on the accuracy of the weights, and that a method involving the principle of double weighing and depending especially on the accuracy of the weights is the one at present to be sought for as likely to lead to a nearer and more uniform approach to accuracy of results.

In proposing a mode of assay which involves the principles of double weighing, I wish to explain that although the method has been the subject of actual experiment, it is yet quite new in my hands; I venture to describe it in the sense of a proposition, the adoption of which into daily practice must depend upon its ultimate proved merits as compared with the routine of weighing at present in use.

I will now make a short explanation concerning the assayer's weights, those employed at the present time. Let us take the case in which the assay is made on 10 grains of each sample, the weight representing this amount taken for trial, is what is commonly called the "assay pound." Whatever proportion of pure gold this assay pound of the sample is found to contain, such a proportion will the original bar, from which the assay piece has been cut, contain: all results being expressed according to a decimal notation.

Then, for this method the assay weights consist of:—

10 grains and its subdivisions in grains.
1 ,, ,, ,, in tenths of a grain.
·1 ,, ,, ,, in hundredths of a grain.

and a rider of platinum or gilt silver wire carried by a lever which slides parallel to the upper edge of the beam, permitting the rider to be placed on any point of the divided beam, or to be lifted off the beam altogether. This rider, according to its position on the beam, represents thousandths of a grain from ·001 to ·100, or its full weight when placed in the pan, as will be obvious when we consider that the beam is divided into 100 parts on each arm, and that the rider weighs one-tenth of a grain. But because the ten-grain weight, the assayer's pound, is regarded as unity, and all the smaller weights are regarded as decimal fractions of unity, they are marked, conformably to this view, as follows :—

The 10 grain weight or pound is marked 1·
The grain subdivisions are marked respectively ·6 ·3 ·2 and ·1
The subdivisions of the grain ,, ,, ·06 ·03 ·02 and ·01

The rider, weighing one-tenth of a grain, and used on the principle of the steelyard, by placing it on one or other of the divisions of the beam, furnishes all subdivisions of unity from ·01 to ·0001.

In assay balances, as they are now made, a few subdivisions of the beam, namely, those nearest the outer knife-edges, are wanting, a deficiency resulting from the particular pattern of the beam ends. This incompleteness of the divided beam is certainly not of an insurmountable character, should complete subdivision of the beam be required ; and that this complete subdivision is wanted for the routine about to be proposed will presently become apparent.

But besides the weights just described, a second series is commonly used. Taking the unit (or pound) weight, representing each bulk or bar of gold, and submitting this quantity to the operations of the assay, and thus obtaining, for each sample, the pure gold obtained in it ; the weight of this pure gold product as ascertained with the above-described weights, expresses decimally the fineness of the particular sample, and enables us to value the bar or parcel of gold which it represents, as far as gold contents are concerned.

For expedition and accuracy it is found best to have, in addition to the above-described series of weights, a second set, such as will enable us to weigh these fine gold educts, or cornets as they are called, with always a single weight in the pan, and with the rider on the beam. Twenty weights are required, they range according to the decimal notation already described from ·80 to ·99 (from eight grains to nine and nine-tenth grains actual weight). If the cornet weighs ·9843 with the weight ·98 in the pan, and the rider on the 42nd division of the beam, we seek the additional ·0001 by the sweep of the index, and thus arrive at the weight of the cornet; *the accuracy of the weighment, however, depending more or less on those points which concern the accuracy of the beam,* to which reference has already been made.

One final explanation will prepare the way for what I have to propose in amendment of the above-described method. First, it is to be understood that for economy of time, and for other obvious reasons, the proper weight of each sample to be assayed is first prepared with tolerably close approximation, by an assistant, and the assay pieces thus prepared are finally weighed and adjusted by the assayer. Secondly, it should be remembered that the cost or care required for the preparation of weights of extreme accuracy, even though the weights be multiplied in number, is a matter of quite minor importance as long as the utmost accuracy of the work is thereby maintained.

I will now proceed to a concise description of the proposed method. First, as to the balance suitable for this modified procedure: it is essential that it be light in the beam, simple in construction, rigid, with sharp and hard knife-edges, which must be truly set at right angles to the length of the arms. These qualifications are essential; they are commonly to be found in the best description of assay balances, but certain others commonly attempted in the best assay balances are non-essentials for the particular method about to be described. It is not necessary that there shall be absolute or even approximate equality of the two arms, but prime importance is attached to those requisites which determine rapidity of oscillation and sensitiveness. Only one minor alteration of the pattern of the common assay beam is proposed, that, namely, which concerns the range of the rider. It is suggested that an offshoot from the beam for supporting the latter, as shown in the illustration, be formed, so as to become rigidly a part of the beam and allow the rider to rest over the outer knife-edge, or on any position intermediate between that and the centre knife-edge of the beam. The range of the rider thus includes the whole extent of one arm of the balance.

In adapting this piece to the assay beam of the usual pattern it will be found necessary to set the divided upper edge of it a little out of the vertical plane, which equally divides the beam from end to end, and to incline it towards the back of the lantern, so as to accommodate its position to the sweep of the lever by which the rider is lifted (this is shown in the sketch attached to the present paper). The same lever will then serve for placing the rider on any part of the beam itself, or on this auxiliary piece.

Besides the weights already enumerated, I propose an additional series of twenty small weights, of gold or platinum, weighing actually one-tenth of a grain, two-tenths of a grain, and so by regular progression of one-tenth of a grain, up to one and nine-tenths grains; and at the outset we must convince ourselves that these weights are as accurate as care and skill can make them, and then I think it can be shown that with them we shall be able to perform all the work of the assay independently of the relative lengths of the arms of the balance, and that fortified by the series of weights ·99 to ·8 (as above described) in the position of weights of reference, they will enable us to eliminate one of the chief sources of error in the assay, that, namely, which results from the wearing of the weights.

But the use of this series of weights which I now propose, involves this principle, namely, that the load of the balance is in all cases constant (the pound of ten grains), a condition which is also highly favourable to uniform and accurate results. We adopt the conjoint advantages of double weighing and a constant load.

We adjust our balance so as to effect an equipoise with the pound in the right-hand pan, and removing this pound we weigh in its place and adjust to equality with it each of our samples to be assayed. The assay is conducted through its several processes in the usual manner, and the resulting gold cornets are each in succession placed in the pan of the balance. What the trial piece has lost is base metal; what is retained of its ponderable substance, subject however to the usual variable correction for surcharge,* is pure gold.

* For the general reader, it is explained that the technical term "surcharge," used in its broadest sense, is understood to mean the correction which it is necessary to make in order to reduce the weight of the cornet to that of the pure gold which it represents; there is loss of gold on the cupel

The weight which it is necessary to add to the cornet in the pan of the balance so as to restore equilibrium, represents what it has lost and what was alloy, and *we may mark the weight thus added not with its own real weight, but with what is more convenient, namely, its difference from the weight of the pound or unity.* If ten grains or unity has lost during the assay one grain, because it originally contained that amount of silver, copper, or other foreign metals, the cornet, when placed in the pan of the balance, will require the addition to it of one grain weight to effect an equipoise, and this one grain weight, by establishing an equipoise, will signify that the cornet weighs nine grains, and that the sample assayed has a fineness of ·9.

This routine would possess the anticipated advantages in all cases of gold bullion of finenesses between ·8 and 1·0, excepting that the fractional parts, as determined by the use of the rider, have as yet no solution by its means; the use of the rider, so valuable in all appeals to the balance, need not be excluded from this method, as I hope now to explain by a more detailed description of the proposed method.

First, I will describe the new set of weights: they consist of a progressive series from ·1 grain to 1·9 grains, gradually rising through the series by tenth of a grain differences, and, for reasons to be presently explained, they are each marked as shown in the following table:—

TABLE OF NEW SERIES OF COMPENSATING WEIGHTS.

| | | | | | |
|---|---|---|---|---|---|
| Real amount of weight | ·1 gr. | ·2 gr. | ·3 gr. | ·4 gr. | ·5 gr. |
| Mark - - | ·98 | ·97 | ·96 | ·95 | ·94 |
| Real amount of weight | ·6 gr. | ·7 gr. | ·8 gr. | ·9 gr. | 1·0 gr. |
| Mark - - | ·93 | ·92 | ·91 | ·9 | ·89 |
| Real amount of weight | 1·1 gr. | 1·2 gr. | 1·3 gr. | 1·4 gr. | 1·5 gr. |
| Mark - - | ·88 | ·87 | ·86 | ·85 | ·84 |
| Real amount of weight | 1·6 gr. | 1·7 gr. | 1·8 gr. | 1·9 gr. | |
| Mark - - | ·83 | ·82 | ·81 | ·8 | |

There is also to be provided a rider of the real weight of ·1 grain, as usual.

All these weights, in addition to the pound of 10 grains, are to be arranged on the right hand side of the balance,

by volatilization and absorption, and there is increase of weight of the cornet by a small residue of silver which the parting operation has left in it, and the difference of these two opposite errors constitutes the surcharge.

and the rider is to be placed on the slider of the same side ready for use. Before commencing work, we place the pound weight in the pan, and adjust, if necessary, the tongue of the beam so as to effect an equipoise. We remove the 10-grain weight and substitute, in order, our trial pieces; as we now effect an equipoise with each of these, we are sure we obtain a weight of each exactly the same as that of the 10-grain weight, and quite irrespective of the relative length of the two arms of the balance, and when we have cupelled and parted these, and obtained their gold in the form of cornets, we place these in succession in the pan of the balance and add weights until an equipoise is effected. We add weights and we also use the rider, *placing the latter always first over the end knife-edge and moving it progressively towards the centre of the beam.* We read the divisions of the beam in an order inverse to that employed in the common mode of weighing. When the rider is placed on the mark immediately over the end knife-edge, it is read ·0000 of unity; if placed over the centre knife-edge, or what is the same thing, lifted off the beam altogether, it is read ·0100 of unity, and for intermediate positions, on the first of the nine major divisions between the centre and end knife-edges (dividing the arm into ten equal parts), it is read on that nearest the end knife-edge .0010, and on the others as we progress ·0020, ·0030, to ·0090, the major division nearest the centre of the beam; for in sliding the rider-weight towards the centre of the beam we are in reality taking off weight, which act implies a corresponding amount of gold in the cornet. Whether in the pan or on the beam, our weights placed so as to effect an equipoise, make up with the weight of the cornet exactly ten grains; they are in this sense the complement to the weight of the cornet, and the mode of marking the weights and reading the position of the rider, is that which instead of regarding the real value of the weight itself, indicates always the amount of which it is the complement. Thus, to suppose a case, with cornets of the following weights, an equipoise will in each case be obtained by the addition of a single weight as marked, and by shifting the rider to the position indicated in the table.

| FINENESS INDICATED. | | | | | | | LOAD. | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Real Weight of Cornet. | Mark of Weight added. | | Position of Rider indicates | | Fineness therefore indicated. | | Real Weight of Cornet. | | Real value of Weight added. | | Virtual Weight of Rider. | | Total Load. Cornet, Weight, and Rider. |
| | | | | | | | Grains. | | Grain. | | grain. | | Grs. |
| ·9433 | ·94 | + | ·0033 | = | ·9433 | | 9·433 | + | ·500 | + | ·067 | = | 10 |
| ·9999 | nil. | + | ·0099 | = | ·9999 | | 9·999 | + | nil. | + | ·001 | = | 10 |
| ·9172 | ·91 | + | ·0072 | = | ·9172 | | 9·172 | + | ·800 | + | ·028 | = | 10 |
| ·8426 | ·84 | + | ·0026 | = | ·8426 | | 8·426 | + | 1·500 | + | ·074 | = | 10 |
| ·8016 | ·80 | + | ·0016 | = | ·8016 | | 8·016 | + | 1·900 | + | ·084 | = | 10 |
| ·9652 | ·96 | + | ·0052 | = | ·9652 | | 9·652 | + | ·300 | + | ·048 | = | 10 |
| ·9789 | ·97 | + | ·0089 | = | ·9789 | | 9·789 | + | ·200 | + | ·011 | = | 10 |

The notation involved in this method is as easy as that of the old practice, the index readings are also as facile. Thus, suppose a cornet weighing ·9958, and placing it in the pan without any other weight, we now put the rider on the division marked 60, this would read ·9960; but as the beam carries now a real weight of only 9·958 + ·040 = 9·998, it will show two divisions of the scale light on the right hand pan or cornet side; we may therefore either move the rider back to the ·0058, when the beam will have its full load of ·9958 + ·0042 = 10 grains, making an equipoise, or we may compute this ·9960 — ·0002 = ·9958; for with any given reading of the weights what falls short of an equipoise is so much deficiency of the cornet below the fineness indicated, and must be deducted from the reading to arrive at the real weight of the cornet. Conversely with any given reading of the weights, what is shown by the index to be in excess of an equipoise, is so much excess weight of the cornet beyond the fineness indicated by the weights, and must be added to the reading of the weights for arriving at the real weight of the cornet.

The greater part of Mint gold assay work, in Victoria at least, concerns gold varying in fineness between ·8 and 1·0, or pure gold, for which the series of weights above recommended is suitable. For the comparatively rare occasions presenting gold of a fineness lower than ·8 the ordinary grain weights could be used as by the old method, but in the sense of complements to the weight of the cornet; say that with the cornet in the pan we are obliged to place three grains, and one grain and ·4 of a grain, and the rider on the ·0043 to form an equipoise less two divisions of the index scale: then we have 4·4 grains which, deducted from 9·9 grains = 5·5 grains, and ·0043 — ·0002 = ·0041 indicated by the rider. The fineness thus indicated is obviously ·5541: or a small card of reference might be used for showing at a glance the complementary value of any combination of grain weights and tenths of a grain in these extreme cases.

I will now endeavour to enumerate the special advantages of this method, premising that weights as much in use as those of the bullion assayer, even when lifted with ivory or horn forceps, are liable to wear, and that wear of the weights is a dangerous source of error.

1. The proposed method is in all respects equivalent to double weighing; it is independent of the relative lengths of the arms of the beam, whether arising from original imperfect workmanship or from permanent molecular alteration, or from daily vicissitude.

2. The weighments are all made with an uniform load, which satisfies another condition of accuracy more exactly than the common method, the sensitiveness of the beam varying with the load.

3. Substituting the proposed new series of weights for the old (for those described on page 103) we devote the latter henceforth to the purposes of reference, upon which aplication a few sentences may now be bestowed:—

With the rider over end knife-edge, each weight of the new series added to that bearing the same mark in the old series should effect an equipoise, thus:—

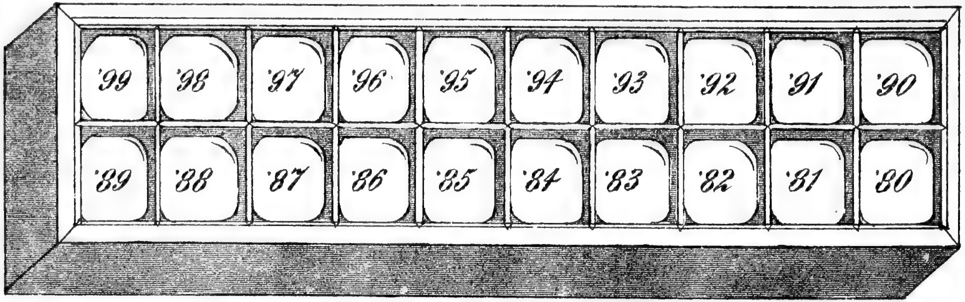
| | Old Series | + | New Series | + | Rider | = | 10 grains. |
|---|---|---|---|---|---|---|---|
| Mark. | Real weight. | | Real weight. | | | | |
| ·99 | 9·9 grains | + | 0 | + | ·1 grain | = | 10 grains. |
| ·98 | 9·8 ,, | + | ·1 | + | ·1 ,, | = | 10 ,, |
| ·97 | 9·7 ,, | + | ·2 | + | ·1 ,, | = | 10 ,, |

and so on. And for further verification of the new weights, interchanges, too obvious to require explanation, can be employed. Now, supposing a weight of the new series to have worn in use, say, for example, that the weight marked ·97 has become a thousandth of a grain short of its real weight (·2 of a grain) when just; this becomes evident on placing it in the pan with the ·97 reference weight, the rider also in the pan or over the end knife-edge; this combination of weights will fall short of an exact equipoise by ·001 of a grain. To make a fresh weight in place of the defective one, we have only to fashion and reduce a piece of platinum or gold until with the old ·97 weight and the rider it effects an equipoise.

# Serial Weights

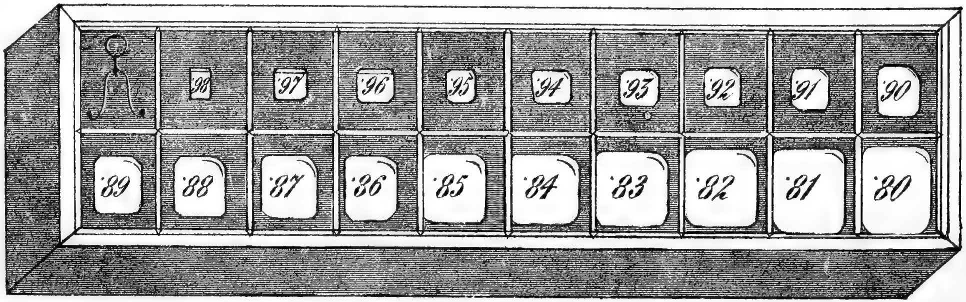
*Old Series, ·8 to ·99* (·8 = 8 grains. ·99 = $9\frac{2}{10}$ grs.)

1.




*Proposed Series, ·8 to ·98.* (·8 = $1\frac{8}{10}$ grains. ·98 = $\frac{1}{10}$ grain.)

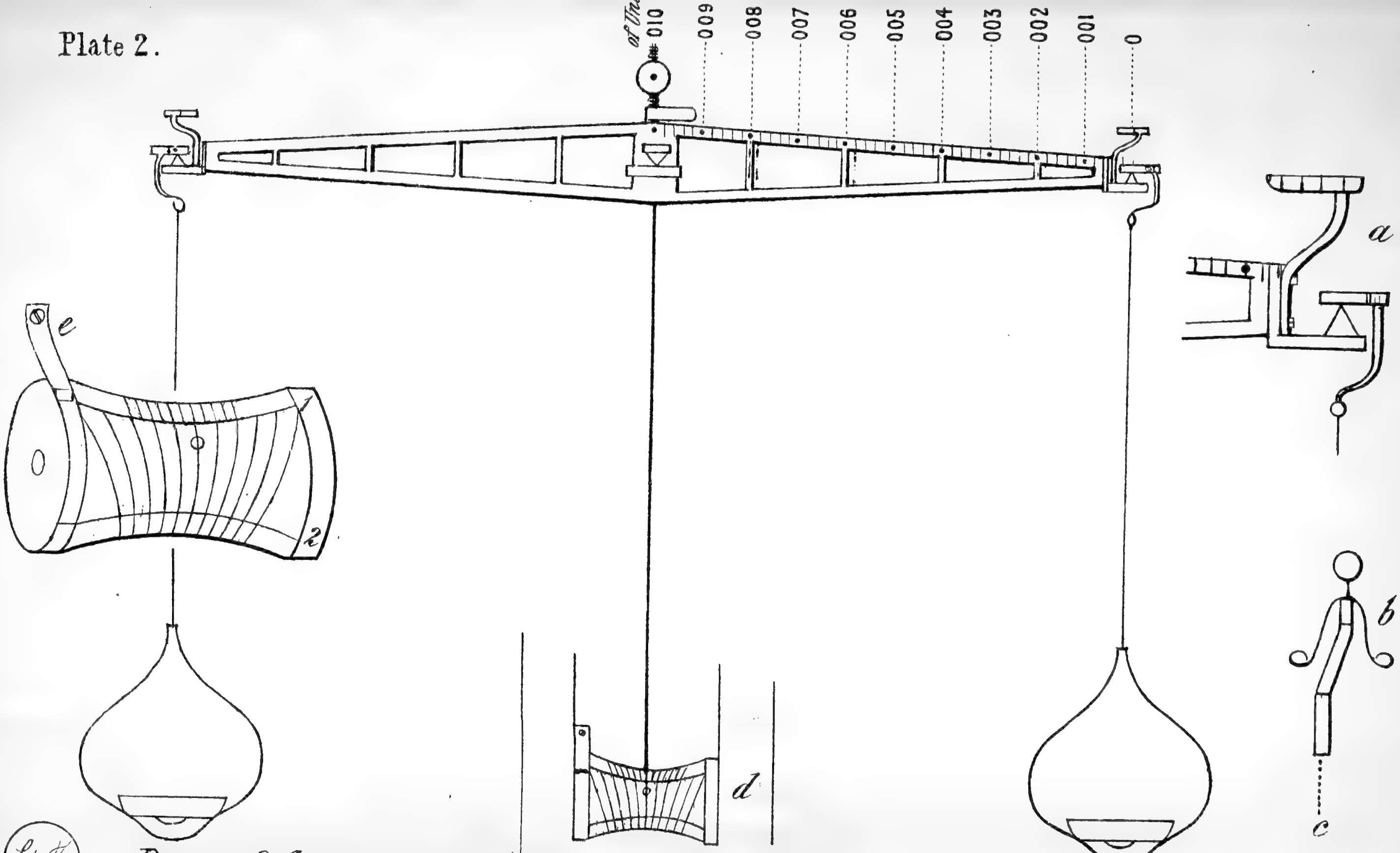
2.




G.F.

*Real Size.*

Plate 2.




*Beam of Assay Balance (Half real Size Linear)*

*(a, b, e, real size.)*

One point may be added respecting the wear of weights, in special reference to those of platinum, namely, that when worn they may be easily restored to accuracy, by taking a small piece of fine gold enough to make the particular weight slightly heavy; if the gold be placed on the weight and heated before the blowpipe the gold on fusing will attach itself firmly to the surface of the platinum, and the weight may now be tried and reduced alternately, reducing it first if necessary on a very fine file, and finally rubbing it on a hone or touch-stone until the precise weight is arrived at.

Of course there should be a standard weight, and copies of it with which the ten-grain weight can from time to time be compared. A ten-grain standard weight of rock-crystal offers the advantages of great hardness and inalterability; but as the displacement of air by equal weights of bodies differing so much in specific gravity as quartz and platinum is considerable, and may cause under extreme variations of atmospheric temperature, pressure, &c., a difference of apparent weight amounting to nearly two-thirds of a ten-thousandth of unity, equal to sixty-six pounds in a million sterling, this influence must either be allowed for by correction in such comparisons of quartz and platinum weights, or the comparisons must be always made under the same atmospheric conditions. For the preparatory weighing of the samples for assay, conducted usually by an assistant, and for which the wear of the weight is likely to be comparatively great, a quartz weight will be found peculiarly suitable. This quartz pound is counterpoised by a weight in the opposite pan, adjusting the two by the tongue of the beam until equilibrium is obtained; the quartz weight is then removed, and the gold samples to be weighed substituted, one after the other, for it; this method gives the advantages of double weighing, and if the beam be sufficiently sensitive, very uniform weighments will be effected, even though the arms of the balance be of irregular length.

## DESCRIPTION OF THE PLATES.

Plate 1 shows:—

1. The series of platinum weights in common use by bullion assayers, ranging from ·80 to ·99 inclusive; arranged in partitioned tray.
2. Proposed series of "compensating" weights, ranging from ·80 to ·98, the rider representing ·99; arranged as the foregoing.

Plate 2:—Shows the assay beam, with the notation of its major divisions according to the compensating method. The additional end piece, as described in the paper, is shown at (*a*), and a side view of it at (*b*), in which its inclination from the plane of the beam itself (*c*) is represented.

The index reel (*d*) is shown full size at (*e*).

For clearness the supporting columns of the balance and other accessories are omitted in the drawing.

## Art. XXIII.—*On the Past and Present of the Port of Melbourne, and Proposed Works for its Improvement.*

By T. E. Rawlinson, Esq.

[Read 13th December, 1875.]

In resuming the question of harbour accommodation for Victoria, after a lapse of twenty years, it is with advantages which did not exist then.

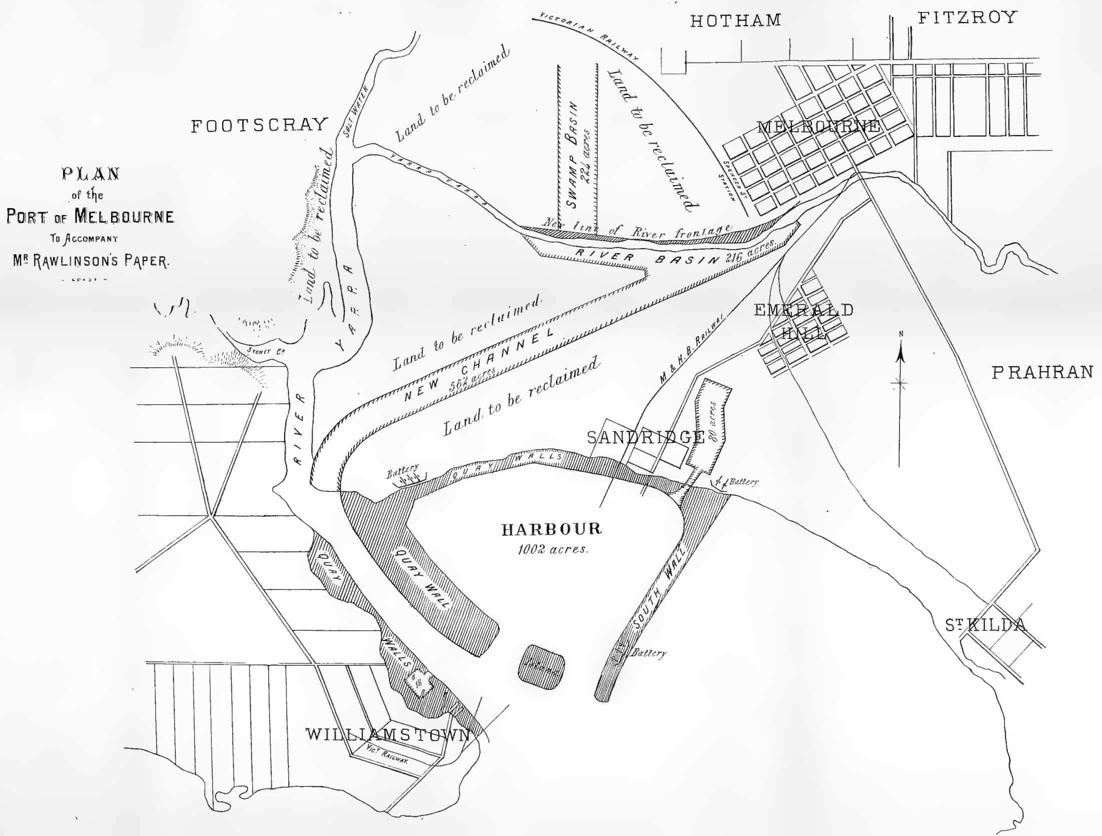
It was pointed out that Hobson's Bay and Port Phillip Gulf, if left to natural agencies, would in time become things of the past; but it was little anticipated that such would be so far facilitated by future harbour improvements.

Whilst left to itself Port Phillip Gulf was slowly but surely silting up, in accordance with natural laws, as other gulfs and inland seas have filled before; and evidence of this fact exists in the made lands now lying between Sandridge and Flemington, whilst the lines of soundings in the bay indicate the same continuous action of shoaling and filling, partly caused by the littoral drift created by prevailing winds from the south and south west, and partly by the deposit brought down by the rivers and creeks being precipitated in the bay.

The increase of land, owing to drift from the south east, is shown by the make of foreshore at Sandridge; but the shoaling from river silt was not so perceptible, owing to the river being permitted to sweep past the Williamstown shore and precipitate in the waste of waters southwards towards Point Cook, and possibly with certain winds towards Brighton; whereas now, the recently constructed stone dykes at the river mouth has diverted the Yarra waters direct into Hobson's Bay, where the current is rapidly lost, and precipitation takes place there.

To better understand the question, it will be well to take a retrospect of Hobson's Bay in 1853, and compare it with the bay as existent in 1875.

In 1853, with the exception of one or two small boat piers at Williamstown, which lay almost out of the stream, the waters of the River Yarra had a clean sweep along the land, with a sharp set of current around Point Gellibrand, leaving a comparatively clean foreshore; whilst on the Sandridge side there existed the Government and the Railway Piers, and a


PLAN
of the
PORT OF MELBOURNE
TO ACCOMPANY
MR RAWLINSON'S PAPER.
HOTHAM
FITZROY
VICTORIAN RAILWAY
FOOTSCRAY
SALT WATER
Land to be reclaimed
SWAMP BASIN
224 acres
MELBOURNE
SPENCER ST
STATION
YARRA YARRA
New line of River frontage
RIVER BASIN 216 acres
Land to be reclaimed
YARRA
Stoney Ck
NEW CHANNEL
562 acres
EMERALD HILL
M & H. B. RAILWAY
PRAHRAN
N
RIVER
SANDRIDGE
80 acres
Battery
QUAY WALLS
HARBOUR
1002 acres.
QUAY WALL
QUAY
WALLS
SOUTH WALL
Battery
Island
ST KILDA
WILLIAMSTOWN
VICT RAILWAY.

narrow strip of beach opposite Liardet's hotel, while a line of sounding extended south-west and south into and down the bay, indicating the edge of the littoral drift from the east, south, and south-west.

In 1875 there is a serious change of all this; for at the river entrance we have a stone dyke, which, as constructed diverts the river waters direct into the centre of Hobson's Bay, and the foreshore of Williamstown literally bristles with piers, extending well into deep water, which effectually diverts any feeble remnant which may be left of the river current from its original course in 1853. On the Sandridge side the piers have been extended further into the bay, but this, as will be afterwards shown, is in such locality as great a benefit as on the Williamstown side similar structures have been and are mischievous. The increase of foreshore in front of Liardet's and the creep westwards of the line of shoal water, are the natural and unavoidable consequence of causes which are beyond man's control.

Such was the position of things as existent in 1853-4, and we have now this lamentable difference, that in 1875 there is several feet less of depth of water in Hobson's Bay, and the foreshore of Williamstown is silted up with mud.

Under the circumstances it should surprise no one that such injurious changes have taken place, because theory points out that we ought to realise them under the conditions given, namely, checking of the river current and its diversion into the still waters of the bay.

A consideration of the causes which have been, and are still in operation forming and moulding the shores of Hobson's Bay and of the River Yarra, and afterwards a brief allusion to the laws governing the precipitation of matters held in mechanical suspension in water, will aid in showing the origin of much of the mischief done within the past twenty years.

I premise that no geologist will question that the site now occupied by the low lands between Sandridge and Flemington, within a comparatively recent period, formed a portion of the Port Phillip Gulf, Emerald Hill existing as an island, the River Yarra entering the bay at where Prince's Bridge now stands, the Saltwater entering at the racecourse, and the Moonee Ponds at North Melbourne.

That in the course of time, owing partly to solid matter brought down these several streams, deposits formed at the mouth of each as they lost their current in the still waters, whilst the prevailing winds from the south and south-west brought up the littoral drifts along the shore, continuously edging the waters of the River Yarra along the side of the rising land on the north, and forcing it to form the curved bend to the north, known as Humbug Reach, until joining with the Saltwater, they kept the edge of the high and rocky foreshores of Footscray and Williamstown; sweeping past Point Gellibrand, the current became dissipated in the still waters of the gulf southwards.

Such is a brief theoretic history of the formation of Hobson's Bay and the channel of the River Yarra, as inferred from the teachings of geology in the operations of nature elsewhere, to which causes may probably be added the slow upheaval of our coasts, as evidenced in the old raised estuary beds between Corio Bay and Bass's Straits.

Assuming the above theory to be granted as highly probable, if not absolutely true, it follows that if Port Phillip be left to itself, it can only be a question of time for the complete filling up, not only of Hobson's Bay, but the gulf itself (the same agencies remaining in operation), being a natural sequence of cause and effect.

It is a fact established beyond all doubt, that all land degrades, and all waters shoal, following the natural law of change; but that areas of water receiving running streams shoal more rapidly than waters remote from such action, because running streams carry more or less of solid matter in mechanical suspension of a fineness proportioned to the velocity of the current, which solid matter is precipitated on losing its velocity, and from fresh water more rapidly on entering brackish or saline waters.

Now in the case of the River Yarra prior to 1853, it debouched nominally at what is called the river entrance, but practically, from the pressure of littoral currents along the coast from the south and east past Sandridge, and along the north side of the bay, it was facilitated in its flow along the Williamstown shore, owing to all such littoral currents turning to flow with the river stream until past Point Gellibrand, from whence, having no controlling line, it enters into the broader waters and becomes lost; and this view of the case is justified, because when the river is most surcharged with mud, and discharging the heaviest freshets, the winds usually blowing are strong from the south and south-west against the Brighton and St. Kilda shores, causing a littoral drift northerly and westerly past Sandridge towards the river's mouth.

Such being the state of things prior to 1853, I propose to examine what has been done since, and show the consequences which theory leads us to expect, and what practice has actually realised.

The construction of the stone pier and timber jetty at Point Gellibrand and other timber jetties for the railway in the vicinity, should, in accordance with theory, obstruct and divert the current previously existing along the shore at these points, and cause deposit, whilst the stone walls at the mouth of the river must absolutely turn the stream into the bay in the direction of Sandridge, and in doing so destroy its current, and cause precipitation of all solid matters held in suspension, and this precipitation will take place much more rapidly on entering saline than in fresh waters. Such are the teachings of theory, and they may be illustrated by examples from practice.

The rivers entering the sea on our south coast have all bars, and the rivers Latrobe and Mitchell are excellent examples of bars in slightly brackish water, formed under precisely similar conditions to those existent in Hobson's Bay, whether natural or artificial, but more especially the latter.

Of the influence of open timber piling in checking currents and causing deposit, I beg to instance two or three which have fallen more immediately within the range of my own experience and observation. At Caernarvon, in North Wales, the River Sieont enters the Menai Straits, and at its mouth a stone pier was built out to accommodate the shipping ; but this being at right angles to the tidal current, became silted up, and was extended further out with open timber piling; but this also silted up, and about 1846 and '47, a further extension of timber pier was run out also at right angles to the stream, finishing with an L end parallel to the current, but before I left the district in 1850, the direct extension had silted up, whilst the L end being exposed to the direct scour remained clear, showing how very influential open timber work is in checking and diverting current, and causing deposit.

The next instance is an extension of the Beaumaris Pier, also in the Menai Straits, which being at right angles to the current, diverted it, and also caused deposit.

The next instance is the old pier at Leith, in the Firth of

Forth, which was of open timber work, and was sufficient obstruction to the passage of waves, that I have seen the outside surface a mass of white water, whilst inside it was comparatively smooth, and this at a time when, owing to the fury of the gale blowing, the spray was breaking nearly over the Bass Rock. This last case is an illustration of the influence of open piling in checking wave action, and if wave action, also currents.

The above are given only as examples of cases which exist in abundance, proving that currents are checked by open timber piers, as well as by stone walls, and that both theory and practice show that when such check takes place, matter held in mechanical suspension must precipitate.

Now if we examine what has taken place on the Williamstown shore and in Hobson's Bay since 1853, we find precisely the results which theory and practice point to as a probable consequence of what has been done there, namely, a rapid filling up in Hobson's Bay and heavy deposits of mud on the Williamstown shore, owing to the stone walls and timber piers having diverted the river currents, whereas the shore used to have a clean surface of rock and kelp before the construction of the works named.

It is no unusual thing now, for one of our Colonial steamers in passing Williamstown, to leave behind her a trail of putrid mud, and it is only a few days ago a paragraph appeared in the daily journals to the effect that mud had deposited so thick at the steamboat jetty as to render it inconvenient for use by the boats of light draft plying at the pier, which is a state of things I imagine few will regard as an improvement on the waters of 1853.

In time of freshets, the river bringing down waters heavily surcharged with mud, the brown water can be seen as diverted by the stone walls right across the bay to Sandridge, whilst the waters south of Point Gellibrand are comparatively translucent. After heavy westerly weather, when the waters of the bay rise above the stone dykes, the brown water may be seen driven over into the Williamstown recesses, but with little or no current, and it is indicative of the extensive character of the mischief being done. The actual extent of the evil is only realised by reference to the soundings by Captain Cox, and more recently by Commander Stanley.

It has been suggested to me that the shoaling of the bay waters may be accounted for by upheaval; but I do not believe we have the slightest evidence of such within the period elapsed since the first settlement of Port Phillip, although there is evidence of it in times past, such as the raised estuary bed of Connewarre and Point Henry; but this evidence, although geologically recent, is historically remote, and has no bearing on the facts now discussed. Whereas we have direct evidence of deposits taking place where none existed before, and we can trace cause and effect in the construction of the works enumerated, and the consequent silting up on the foreshore and in the bay.

A quotation given by Commander Stanley, from one of the late Chief Harbour Master's (Captain Ferguson's) reports in 1866, alludes to the silting up of the bay as an established fact, and traces much of the mischief to the construction of piers in the bay, although he erroneously attributes the injury to their shutting out the tidal waters, instead of their direct effect in diverting the current of the river; being right in fact, but wrong in theory.

Captain Cox notes on his chart that from 1864 to 1866 two feet of deposit was made in Hobson's Bay, whilst Commander Stanley is most absolute and positive in his evidence as to the rapid filling in of the bay between the period of Captain Cox's survey and the date of his own, and in attributing very much of the mischief to the form and position of the stone walls at the river mouth having diverted the muddy waters into the bay; and in recommending the early removal of the cause of such a large amount of injury.

One valuable result of the late surveys is, the absolute proof given of the rapid silting up and its general direction. Commander Stanley informs us that the six feet water line has advanced towards St. Kilda at the rate of 1,100 ft. in eleven years, and at a similar rate of progression, it will take only eighty years to reach St. Kilda; but, as a matter of course, long before that period, Hobson's Bay will have ceased to have an existence. Such a statement from so competent an authority is a very serious one indeed, and gives point to warnings written twenty years ago, when treating on the question of a harbour for Melbourne, the following expressions were used: "Having satisfied ourselves that the process of silting up is going on slowly although surely in the bay, we are prepared to meet this difficulty in the usual way when necessary to do so by dredging, but in this we apprehend none; and as to the expense, it is only a question that must arise sooner or later to any dock pier or harbour constructed in Hobson's Bay, it being only a question of time when Hobson's Bay and Port Phillip Gulf itself will no longer exist, so surely is the process going on by which this inland sea will be converted into dry land, as former seas and lakes have been before, from the date of creation up to the present day." Such was the language of myself and the gentleman acting with me in these matters at that time, but we never for a moment supposed that natural agencies would receive such an impetus by the construction of the stone walls at the river mouth, and timber piers in front of Williamstown.

Whilst availing myself of the very valuable series of results of the recent survey of the bay, as given by Commander Stanley, I must demur entirely to the prudence of the remedial measures as set forth in his direct canal scheme, and in a more modified form to his proposed extension of the Sandridge Lagoon into a blind canal or long dock. To cut a direct canal from the Queen's basin to the bay, anywhere near to the Railway Pier or Baths, would be most disastrous in its results in every way, whilst its alleged advantages are wholly mythical. A diversion of the river through the short canal would of necessity weaken the scouring power, as it exists at the present entrance, where the waters of the Moonee Ponds and Saltwater Rivers, with those of Stony Creek, are all concentrated with those of the River Yarra, and are available, in so far as such a power under the especial circumstances of a low rise and fall of tide are useful; and in the next place an entrance at such point would ensure the very worst results of precipitation in forming a bar, and hastening the silting up of the bay. There is no scheme which could be more disastrous, and I am happy to find that Mr. Gordon has arrived independently at the same opinion on this point

The difference in length between the direct canal and the longer one by way of the present embouchure is an advantage in favour of the longer line, because every yard of quay room on the longer line is valuable for trade purposes, and every cubic yard of material excavated is valuable for raising and reclaiming land which is now liable to flood, whilst the trifling difference in time of transit is an unimportant item to shipping. The blind canal or long dock would, in my opinion, be found seriously to inconvenience trade in another way, and be excessive in providing for the requirements of the locality, whilst the material available for embanking being so far from the place required, would be costly in removal. I do not concur in Commander Stanley's opinion as to the alleged evil result of ships lying alongside the piers, for supposing any current to exist transverse to the line of pier, the tendency would be to create an under draught below the ship, and whilst such existed it would be beneficial rather than otherwise.

The evidence afforded by Commander Stanley of the make of foreshore at Sandridge, and the shoaling of water between that place and St. Kilda, is valuable in pointing out the existence of another source of danger to the bay, in the alleged existence of a littoral drift past Sandridge in the direction of the Yarra mouth, as before alluded to in this paper. The make of the foreshore in front of Liardet's, from a few feet to several chains between the house and high water mark, and the contour of the soundings between Sandridge, St. Kilda, and Brighton, have all told the same story of increase, and from the quarter which Commander Stanley's recent report and survey confirms; but I shall have occasion to speak of this drift when submitting my suggestions for improvements in the harbour.

Mr. Gordon's report on the navigation of the Yarra evinces his usual careful summary of facts bearing on the case, and as before remarked, it is most important to have the benefit of his opinion so decidedly expressed in favour of the retention of the embouchure of the river in its present position near Williamstown; and I attach greater importance to his opinion in this matter because of the persistent advocacy by many of the "direct canal," in the face of a series of adverse facts, and in direct opposition to the teachings of theory and of practice, but more especially the lessons taught by results in Hobson's Bay.

The principal objection I have to Mr. Gordon's proposals is that they do not go far enough, and are only adapted to meet a part of the difficulties which exist; and being in the nature of expedients are more likely to embarrass future operations. Under the circumstances I beg to enter a protest against any works being undertaken which are not part of a comprehensive general scheme adapted to the difficulties of our position and suited to the several requirements of the case, and from this stand-point protest against all expenditure in the river whilst the question is left untouched as to the silting up of the bay, because if we cease to have a harbour, a large expenditure in the Yarra will be money thrown away. The Queen's Wharf basin is far from being a credit to us, and it is impossible that merely shortening the river bends can be of much avail whilst we retain the narrow channel of the river, bound in as it is with buildings and wharves, to the obstruction of trade and shipping; and I submit that it is useless to incur the expense of further deepening the river, unless we are prepared to widen it to allow room for working the vessels in the river basin.

The great evil of the past has been that marine works in and about the river have been carried on apparently as matters of temporary expediency, and on no definite or comprehensive plan, by which each portion however small should be part of a complete whole; and it is with a hope of showing the necessity for the adoption of some systematic plan of works which shall be capable of affording immediate relief for the present, and yet be part of a general system capable of future extension and completion, that I have undertaken this paper. As a physician first makes a diagnosis of his patient's ailment before attempting to cure, so I now endeavour to point out the physical defects under which we have been and are suffering, before suggesting remedial measures; and it is for this reason I have given an epitome of what our river and harbour was twenty years ago, and what it is, pointing out the consequences of what has been accomplished, and by inference showing what ought to be done now.

The ports on the western coasts of England are notable examples of the evils experienced by silting up, and perhaps the most remarkable of them is the old Port of Chester, which, owing to the silting up of the estuary of the River Dee, is now but an inland city, its whole sea trade being such as can be carried along an artificial canal.

Liverpool, with its magnificent estuary of the River Mersey and its noble line of docks, would in a few years become impracticable for large vessels, and be silted up with mud, if it were not for the systematic skill of the engineers in charge in dredging, sluicing, and other means for keeping the port clear of accumulation.

Under present conditions, Hobson's Bay is rapidly filling up, and of late years the so-called improvements have rapidly accelerated the process, so that if allowed to go on without interruption it cannot be a very remote period before the River Yarra will have to wind a sluggish course through marsh lands to the Heads, as the River Thames passes from London in its course to the German Ocean; with this disadvantage, we have here no corresponding lift of tide to give us the scouring power which exists in the River Thames.

In reference to the condition of the river and the low lying lands between Emerald Hill and Melbourne, Mr. Gordon has very justly remarked, that in the case of heavy floods we are in a worse position now than on the occasion of the disastrous 14th December, 1863.

The remedy I propose for the above evils is, the removal of Raleigh and Cole's, and the Australian wharves, and widening the river basin to 1000 feet to below the Gasworks, and cutting an entirely new channel 1000 feet wide from the Queen's Wharf basin in the direction of Stoney Creek, entering the bay at the old embouchure at Williamstown, and removing the whole of the stone dykes constructed at the lower end of the Yarra, and deepening the river, to give not less than 20 feet at lowest tide. Such a width of channel would give ample space for the outflow of flood waters, and the drawback of deposit must be met by dredging. Many have objected to the length of the new channel, and no doubt such objections will be strengthened by the extreme width and depth proposed; but when it is borne in mind that every yard of material excavated is highly valuable as a means of reclaiming land, which at present is worse than useless, such objections ought to be allowed to fall to the ground.

On the western side of the Gasworks, a water float excavated as shown would not only accommodate a large trade, but afford materials for reclamation of land which at present is but a noxious swamp; and in lieu of a pestilential marsh, give us land worth from five to six thousand pounds per acre.

By extending the eastern wall of the river at the entrance as shown, the current would be confined to its proper channel, and check deposit in the bay from that source; whilst on the east, from a point a little below the present lagoon at Sandridge, a wall carried out over the rocky shoal into five-fathom water would check the littoral drift from the south and east. The lagoon at Sandridge should be converted into a dock, as shown, with an entrance from the harbour, the materials from which dock would reclaim land equal in value to the cost of construction.

On the Williamstown shore the river current should be regulated by a sea wall having a dock formed in the deep bend as shown, and indented with basins for the patent slip, graving dock, and timber piers where required, by which means the current of water both entering and flowing out of the river would be restrained to certain limits, within which no obstruction would exist to divert it from its proper course.

With such a system of retaining walls and channels, Hobson's Bay when once dredged out to the proposed depth of 30 feet, would have little or no deposit, for the sources from whence it is now derived would be cut off, owing to the river waters being kept out and the littoral drift from the south stopped.

In the Queen's basin the river and new channel, the deposit would after freshets be continuous, but it would be under conditions easily dealt with by the dredge, and being thus dealt with at the upper part of the river, the great evil of deposit in the bay would be materially lessened.

One of the results to be anticipated in the bay outside of the harbour would be the rapid make of foreshore south eastward of the east wall, but I should not deem this an evil, owing to the fact that as we must have shoaling and making of foreshore somewhere in the gulf, it is just as well to let it occur where in place of doing harm it will do good, by reclaiming land which at some future day will be valuable.

It may be urged that such a scheme of works as above suggested is much beyond our present requirements, but to this I say most decidedly no, because in executing them it is not sinking capital, but creating it by giving value to lands that are now worthless, and which are even now wanted for the extension of business, and this creation of capital will be a certain result if the work is carried out with economy and prudence.

In the general estimate of cost which I annex, provision has been made for facing the walls with concrete, coped with wrought bluestone, and faced with the usual fender piling.

The estimated cost for a completed scheme of works as above suggested, and shown on plan, would be wholly recuperated by the value of the reclaimed lands, and the whole cost of after working and superintendence, defrayed from the leasing of wharf sites and frontages, so as to give a free port and harbour, save and except light and pilot dues.

ESTIMATE OF COST.

| | £ | s. | d. |
|---|---|---|---|
| Excavation, 66,035,185 cubic yards, at 1s. 6d. | £4,952,638 | 17 | 6 |
| Material used for embanking, 27,348,148 cubic yards; balance, 38,687,037 cubic yards. | | | |
| Quay wall, 34,666 lineal yards, at £121 .. | £4,200,586 | 0 | 0 |
| | £9,153,224 | 17 | 6 |
| Fender piling .. .. .. .. .. | 207,996 | 0 | 0 |
| Miscellaneous .. .. .. .. .. | 638,779 | 2 | 6 |
| Gross total .. .. .. .. | £10,000,000 | 0 | 0 |
| Land reclaimed in— | | | |
| Swamp .. 333 acres. | | | |
| Quay walls .. 588 ,, | | | |
| From material available 2,398 ,, | | | |
| 3,319 ,, | | | |
| Deduct for quays .. 1,000 ,, | | | |
| Net .. 2,319 ,, at £5,000 .. | £11,595,000 | 0 | 0 |
| Surplus .. .. .. .. | £1,595,000 | 0 | 0 |

The gain to the port would be—

| | | |
|---|---|---|
| Water space—Harbour .. .. .. | 1,002 | acres. |
| New channel .. .. | 562 | ,, |
| River basin .. .. | 218 | ,, |
| Swamp do. .. .. | 224 | ,, |
| Sandridge .. .. | 80 | ,, |
| Williamstown .. .. | 18 | ,, |
| Gross area of water surface .. | 2,104 | ,, |
| Length of quay wall .. .. | 34,666 | lineal yards. |
| Area quay space .. .. .. | 1,000 | acres. |

In the above estimate there is a nominal cost of ten millions for the outlay, but it is shown that at a moderate estimate of value for the reclaimed lands, there is an actual surplus of value of over one and a half millions, besides giving a free port for trade for ever.

In submitting the foregoing, I feel perfectly confident of the cost being highly estimated and the beneficial results under-estimated, and it must be further borne in mind that many things of large cost are included in the above which in practice may be largely reduced or omitted for the present, whilst the advantages and extent of gain has been in every instance largely understated, my first object being to show the vast means of benefit to trade which lies at our disposal, if we do but take the necessary means to realise them, and how lamentably we shall destroy our own prestige and opportunity if we continue to temporise, as we have hitherto done, in half-hearted attempts to provide for our need, and continuous neglect of the great dangers with which we are surrounded in reference to the maintenance of our present port and harbour, and of which we have been warned from time to time.

I cannot conclude without the expression of a hope that my hearers will consider I have established the position assumed at the beginning of this paper, of showing the past of the port, its condition in the present, and of what it is capable in the future.

*Letter from* R. C. GUNN, ESQ., F.R.S. F.L.S. &c., *respecting the Discovery of Keys in the Shore Formation of Corio Bay, and the Paper relating to them read by Mr. Rawlinson, C.E., on the 16th November,* 1874.

"Launceston, 29th May, 1875.

"DEAR SIR,—Ever since the receipt of your letter of 16th December last, I have been too ill to attend to business of any kind, or to make the necessary references to enable me satisfactorily to answer your inquiry as to the (alleged) 'discovery of some iron keys under 15 feet of diluvium near Corio Bay, by Mr. C. J. La Trobe.' I now annex all the information I can supply on the subject, and which I think will be deemed sufficient.

"I remember the circumstances of the alleged discovery of the keys in the position named by you perfectly well.

"I saw the two keys (three were, I believe, found) in the possession of my friend Mr. La Trobe, in Melbourne, in the end of September or beginning of October, 1849 (*not in* 1845 *or* 1846), immediately after they were picked up. He promised to accompany me to Geelong on 4th October, but early on the morning of that day I received a note from him, in which he says, 'I find it impossible to get away from my office with a good conscience this week, and am sorry that it is so. I have written the enclosed to Mr. Addis to ask him to show you where the keys were found. Let me know when you return.'

"I proceeded to Geelong on the above day, and next morning, accompanied by Mr. Addis, visited the spot where the keys were discovered. On questioning the lime-burner, I ascertained that he did *not* pick the keys out of the stratum of shells at the depth alleged, but found them at the bottom of the hole, mixed with some shells, and *assumed* that they had dropped along with them. I was perfectly satisfied that the keys never had been embedded in the stratum of shells, as supposed by the lime-burner and by Mr. La Trobe, consequently all the theories based on that assumption fall to the ground. The keys were small, about the size ordinarily used for chests of drawers, *of very modern make,* not encrusted with lime, and very slightly corroded with rust.

"I have little doubt but that they had been dropped by some inhabitant of Geelong, lay in the grass for some—not very long—time, and fell to the bottom of the hole from the surface *after the excavation was made,* the margin being formed of a rather light, crumbling soil.

"I expressed my views and opinions to Mr. La Trobe on my return to Melbourne, and thought the whole question had been considered as settled, until I saw a letter from Mr. La Trobe in *The Australasian* of June 3rd, 1871, under the heading, 'Port Phillip a Lake.'

"Yours very faithfully,

"R. C. GUNN, F.R.S. F.L.S. &c.

"F. J. PIRANI, Esq.

"*Secretary to the*
*Royal Society of Victoria.*"

# 1874.

# PROCEEDINGS.

## ROYAL SOCIETY OF VICTORIA.

*9th March*, 1874.

The President, Mr. R. L. J. Ellery, in the chair.

The election of office-bearers and members of Council was held, with the following results:—

President, R. L. J. Ellery, Esq.; Vice-Presidents, George Foord, Esq., and Professor Wilson; Treasurer, Percy de Jersey Grut, Esq.; Secretary, Frederick J. Pirani, Esq.; Librarian, James Edward Neild, Esq., M.D.; Members of Council, J. Bosisto, Esq., Rev. H. P. Kane, J. Cosmo Newbery, Esq., T. E. Rawlinson, Esq., H. K. Rusden, Esq., and A. K. Smith, Esq.

The secretary then read the Report of the Council, as follows:—

### Report of the Council of the Royal Society of Victoria for the year 1873, to the Members of the Society.

In laying before you Volume X. of the Transactions of your Society, containing the papers and proceedings for the years 1869 to 1872 inclusive, your Council has to congratulate you on the resumption of printing after an interval of five years, and hopes that the Transactions will be issued at short intervals in future. The liberality of the present Government has placed it in the power of your Council to bring up the arrears of publishing to the present date.

The papers read since the last annual meeting are as follow: On the 14th May Mr. A. K. Smith read a paper on "The Storm Waters of Swanston and Elizabeth-streets, Melbourne, and how to prevent them." A conversazione was held in the Hall on the 8th of August, when, after the conclusion of the presidential address, an illustration was given by Professor Wilson of the meaning of "Electric Potential;" and a short paper was read by Mr. George Foord, upon some of the characteristics of the metal "Palladium." On the 13th of September a social or conversational character was given to the proceedings, with a view of making them more popular. Your President submitted some observations on lightning and lightning conductors, and the general features of atmospheric electricity. On the 13th of October Mr. Sydney W. Gibbons read a paper on "A contaminated Water Supply;" and your President described an instrument called Eckhold's Omnimeter. A paper by Mr. W. Etheridge, jun. (Edin.), on a new species of Retepora, found in the tertiary deposits at Schnapper Point, was presented and read by the President. On the 10th of November Mr. E. J. White read some remarks on a method of finding Greenwich time and the longitude, suggested by Mr. E. K. Horne, of Adelaide. On the 18th November Mr. A. K. Smith read a paper on the New Embankment near Princes Bridge, on the south bank of the Yarra, which he considered likely to occasion much damage in flood time. The same subject was revived at a meeting on the 8th of December, when also Dr. Neild read a paper on "The Advantages of Burning the Dead."

Your Council has accepted a tender for the thorough repair of the fencing around the Hall, with new gates, and has under consideration the propriety of cementing the exterior of the building at no very distant date.

The Society has been honoured in the course of the year by the consent of his Excellency Sir G. F. Bowen to become the patron of the Society, and by his presence at the annual conversazione.

Seven new members have joined the ranks of the Society during the year.

Measures have been taken to distribute, with as little delay as possible, the new volume of the Transactions to all those learned societies with whom your Society exchanges publications, and to all the members of the Society.

# THE BALANCE-SHEET.

*The Royal Society of Victoria in Account with the Treasurer.*

**Dr.** | **Cr.**

| Date | Dr. | £ | s. | d. | Date | Cr. | £ | s. | d. |
|---|---|---|---|---|---|---|---|---|---|
| 1874. Feb. 27. | To Printing and Publishing Vol. IX. | £87 | 0 | 4 | 1874. Feb. 27. | To Balance from last Balance-Sheet | £207 | 5 | 3 |
| | ,, Library Catalogue | 14 | 1 | 0 | | ,, Eclectic Society, rent paid | 23 | 7 | 8 |
| | ,, Collector's Commission | 15 | 10 | 9 | | ,, Medical ,, ,, | 21 | 3 | 4 |
| | ,, Wages | 11 | 2 | 6 | | ,, Pharmaceutical Society, rent paid | 3 | 14 | 0 |
| | ,, Conversazione and Extra Meetings | 17 | 7 | 6 | | ,, Six Entrances, 1873 | 12 | 12 | 0 |
| | ,, Customs' Charges | 1 | 1 | 0 | | ,, Subscriptions, 1871, 1 town | 2 | 2 | 0 |
| | ,, Rates, &c. | 8 | 3 | 6 | | ,, ,, 1872, 13 town, 2 country | 29 | 8 | 0 |
| | ,, Insurance | 2 | 6 | 0 | | ,, ,, 1873, 56 town, 6 country | 130 | 4 | 0 |
| | ,, Petty Cash | 20 | 0 | 0 | | ,, Exchange on Cheque not charged by Bank | 0 | 0 | 6 |
| | ,, Sundries | 3 | 5 | 2 | | | | | |
| | ,, Interest on Debt paid | 40 | 14 | 8 | | | | | |
| | ,, Balance in Bank | 209 | 4 | 4 | | | | | |
| | | £429 | 16 | 9 | | | £429 | 16 | 9 |

Examined and found correct, (Signed) J. BOSISTO, P. DE J. GRUT, } Auditors.

**Dr.** — **Cr.**

### ASSETS. (1874.)

| Date | Item | | £ | s. | d. |
|---|---|---|---|---|---|
| Feb. 27. | Balance in Bank | | £209 | 4 | 4 |
| | Subscriptions due— | | | | |
| | 23 for 1873 | | 48 | 6 | 0 |
| | 12 for 1872 | | 25 | 4 | 0 |
| | Entrance Fees, 1 for 1873 | | 2 | 2 | 0 |
| | ,, 1 for 1872 | | 2 | 2 | 0 |
| | State Grant | | 200 | 0 | 0 |
| | Agreements to let Hall | | 21 | 0 | 0 |
| | Hall, Furniture, Books, &c., insured for | | 2000 | 0 | 0 |
| | | | £2,507 | 18 | 4 |

### LIABILITIES. (1874.)

| | | | | | |
|---|---|---|---|---|---|
| Feb. 27. | Debentures, 113, for 1879 | | 565 | 0 | 0 |
| | Interest on Debentures | | 28 | 11 | 4 |
| | Printing Vol. X. | £115 17 0 | | | |
| | ,, Sundry | 12 5 0 | | | |
| | | | 168 | 2 | 0 |
| | Fencing Repairs | | 65 | 0 | 0 |
| | Petty Cash | | 3 | 10 | 0 |
| | Rates, Insurance, &c. | | 7 | 0 | 0 |
| | Holroyd, hanging windows | | 8 | 0 | 6 |
| | Williams and Norgate, agents | | 6 | 15 | 0 |
| | Collector's Commission | | 2 | 8 | 6 |
| | Balance | | 1,653 | 11 | 0 |
| | | | £2,507 | 18 | 4 |

### WAYS AND MEANS. (1874.)

| | | | |
|---|---|---|---|
| Balance in Bank | £209 | 4 | 4 |
| Subscriptions—Previous years | 31 | 10 | 0 |
| ,, 1874 (82) | 172 | 4 | 0 |
| ,, New (say 7) | 14 | 14 | 0 |
| Entrance Fees, New (say 7) | 14 | 14 | 0 |
| Letting Hall, say | 21 | 0 | 0 |
| State grant | 200 | 0 | 0 |
| | £663 | 6 | 4 |

### ESTIMATED EXPENDITURE. (1874.)

| | | | |
|---|---|---|---|
| Debentures (20 paid already) | £100 | 0 | 0 |
| Holroyd, hanging windows (paid) | 8 | 0 | 6 |
| Williams and Norgate (paid) | 6 | 15 | 0 |
| Collector's Commission (£2 8s. 6d. paid) | 31 | 1 | 7 |
| Printing Vols. X. and XI. and Sundries | 220 | 0 | 0 |
| Fencing Repairs | 65 | 0 | 0 |
| Petty Cash (£5 paid) | 25 | 0 | 0 |
| Rates, Insurance, &c. | 7 | 0 | 0 |
| Conversazione | 12 | 0 | 0 |
| Interest on Debentures, 465 | 39 | 1 | 6 |
| ,, Arrears unclaimed | 28 | 11 | 4 |
| Wages | 6 | 0 | 0 |
| Debentures (prepared to pay) | 50 | 0 | 0 |
| Balance to Cr. | 64 | 16 | 5 |
| | £663 | 6 | 4 |

The report and balance-sheet were adopted on the motion of Mr. A. K. Smith, seconded by Mr. P. Hunt.

The President briefly returned thanks for his re-election, and expressed his hope of a busy session.

(Signed) R. L. J. Ellery.

## ORDINARY MEETINGS.

13*th April*, 1874.

The President, Mr. R. L. J. Ellery, in the chair.

The Secretary stated that at a meeting of the Council, held on April 10th, it had been resolved by an absolute majority of the Council that Professor Wyville Thompson be recommended for election as an honorary member of the Society.

Professor W. Thompson was nominated for election as an honorary member by Mr. A. K. Smith, seconded by Mr. R. Willan.

Messrs. H. M. Andrew and J. J. Phelps were elected members of the Society.

The Hon. Librarian reported the publications received since last announcement.

Mr. Sydney Gibbons read a paper on "The disposal and utilization of Excreta."

Discussion ensued.

(Signed) R. L. J. Ellery.

11*th May*, 1874.

The President, Mr. R. L. J. Ellery, in the chair.

Professor Wyville Thompson was unanimously elected an honorary member of the Society.

The President having vacated the chair, which was taken by Professor Wilson, read a paper on "The forthcoming Transit of Venus."

Discussion ensued.

A paper by Mr. D. Kennedy was postponed till next meeting.

The President stated that the Council had resolved that it was desirable that persons cultivating particular branches of science should bring before the Society occasional reports of the progress of those branches, and requested all members who were willing to assist in the matter to forward their names to the Secretary.

The President stated that the Council had resolved that copies of those volumes of the *Transactions* of which more than 100 were in stock, should be obtainable by members for 2s. 6d. each.

(Signed) George Foord.

*8th June,* 1874.

Mr. G. Foord, Vice-President, in the chair.

Mr. E. S. Parkes was elected a member of the Society.

The Secretary read a paper by Mr. D. Kennedy, on "A late extraordinary Escape of a Miner from Drowning." (See *Transactions*, Art. No. iii.)

Discussion ensued.

The Secretary read a paper by Mr. R. Etheridge on "The Sand-dunes of the Coast of Victoria." (See *Transactions*, Art. No. iv.)

In the discussion which ensued, Mr. Rawlinson gave an account of some Sand-dunes near Warrnambool.

(Signed) R. L. J. Ellery.

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*13th July,* 1874.

The President, Mr. R. L. J. Ellery, in the chair.

Mr. A. M. Smith was nominated for election as an ordinary member.

The President read a communication received from Mr. F. Corbett, of Belfast, "On Abyssinian Tube Wells." (See *Transactions*, Art. No. v.)

The thanks of the Society were accorded to Mr. Corbett for his paper, and to Mr. Danks, who exhibited a Tube Well of the kind described by Mr. Corbett.

Mr. Sydney Gibbons read a paper on "Cremation."

Discussion ensued.

(Signed) R. L. J. Ellery.

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*10th August,* 1874.

The President, Mr. R. L. J. Ellery, in the Chair.

Mr. Alfred Mica Smith was elected a member of the Society.

Messrs. Parnell, Willimot, and Trail were nominated for election at next ordinary meeting.

The President stated that the Annual Conversazione would be held on the 27th August.

Mr. Bosisto read a paper entitled, "Is the Eucalyptus a Fever-destroying Tree?" (See *Transactions*, Art. No. vii.)

Discussion ensued.

(Signed) R. L. J. Ellery.

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*12th October,* 1874.

The President, Mr. R. L. J. Ellery, in the chair.

Messrs. Parnell, Willimot, and Trail were elected ordinary members of the Society, and Mr. E. Dobson was nominated for election at next meeting.

The President announced that Volume XI. of the *Transactions* had been published, and that members could procure copies from the Secretary; also that three of the papers read during the session had been printed in pamphlet form, that members could obtain a copy of each, and could purchase additional copies at half the published price. The President also stated that the Microscopical Society intended holding a Conversazione on the 29th inst., to which the Royal Society had been invited.

Mr. Pirani read a paper on "Some Processes of Scientific Reasoning." (See *Transactions*, Art. No. viii.)

The President described the photographic means by which the forthcoming Transit of Venus would be observed, and also exhibited Janssen's apparatus for obtaining a number of photographs of the phenomena in rapid succession.

A conversational discussion ensued.

(Signed) R. L. J. Ellery.

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16*th November*, 1874.

The President, Mr. R. L. J. Ellery, in the chair.

Mr. E. Dobson, was elected a member of the Society; Mr. Stuart Murray was nominated for election at next meeting.

Mr. Rawlinson read a paper on "The Discovery of some Iron Keys under fifteen feet of diluvium in 1845 or 1846." (See *Transactions*, Art. No. x.)

Discussion ensued.

(Signed) R. L. J. Ellery.

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21*st December*, 1874.

The President, Mr. R. L. J. Ellery, in the chair.

Mr. Stuart Murray was elected a member of the Society.

The Secretary read the names of the retiring Office-bearers and of the retiring members of the Council, as follow:—President, Mr. R. L. J. Ellery; Vice-President, Mr. G. Foord; Treasurer, Mr. P. de J. Grut; Librarian, Dr. J. E. Neild; Secretary, Mr. F. J. Pirani. Members of Council—Mr. E. Howitt, Mr. S. W. McGowan, Mr. J. Marshall, Mr. F. Poolman, Mr. J. T. Rudall, Mr. E. J. White.

Mr. Rusden read a paper on "The Week." (See *Transactions*, Art. No. xi.)

Discussion ensued.

The President, after vacating the chair, which was taken by Mr. G. Foord, Vice-President, read a paper on "The Physical Appearances observed during the recent Transit of Venus." (See *Transactions*, Art. No. xii.)

Mr. Kane referred to the great loss which the Society and the colony had suffered by the death of Professor Wilson, and the President stated that the observations of the Transit taken by him (Professor Wilson) were of the utmost value.

(Signed) R. L. J. Ellery.

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*8th March,* 1875.

The President, Mr. R. L. J. Ellery, in the chair.

The election of office-bearers and members of the Council was then held, with the following results:—President, Mr. R. L. J. Ellery; Vice-Presidents, Mr. G. Foord and Professor McCoy; Treasurer, Mr. P. de J. Grut; Librarian, Dr. J. E. Neild; Secretary, Mr. F. J. Pirani; Members of Council, Mr. A. C. Allan, Mr. E. Howitt, Mr. S. W. McGowan, Mr. F. Poolman, Mr. J. T. Rudall, Mr. E. J. White.

Twelve months' leave of absence were, by unanimous resolve, granted to the President.

The Annual Report of the Council was then read and adopted.

The Balance-sheet and Statement of Assets and Liabilities were then read, and their adoption moved by Mr. G. Foord, seconded by Mr. E. J. White.

An amendment, moved by Mr. A. K. Smith and seconded by Mr. T. Rawlinson, that the Treasurer be instructed to insert in the Statement of Assets and Liabilities a debt of £217 due to the Publishing Fund was, after considerable discussion, abandoned, on the understanding that the subject of the Publishing Fund would be immediately dealt with by the Council. The Balance-sheet and Statement of Assets and Liabilities were then adopted.

The Report, Balance-sheet, &c., were as follows:—

Annual Report.

Your Council has the honor to report that since last Annual Meeting Vol. XI. of the Transactions has been printed and issued. Since the issue of that volume it has been determined to print each paper in pamphlet form, as soon as possible after it has been read before the Society, a course which it is considered will prove convenient both to members reading papers and to the Society generally. As soon as a sufficient number of the papers have been printed, they will be published collectively to form Vol. XII.

The papers read since last Annual Meeting are as follows:—On the 10th April, Mr. Sydney Gibbons read a paper "On the disposal and utilization of Excreta." On the 11th May, Mr. R. L. J. Ellery read a paper "On the forthcoming Transit of Venus." On the 8th June, the Secretary read a paper by Mr. D. Kennedy "On a late Extraordinary Escape of a Miner from Drowning;" and one by Mr. R. Etheridge "On the Sand Dunes of the Coast of Victoria."

On the 13th July, the President read a paper by Mr. Corbett "On Abyssinian Tube Wells;" and Mr. Sydney Gibbons read a paper "On Cremation." On the 10th August, Mr. Bosisto read a paper entitled "Is the Eucalyptus a Fever-destroying Tree?" On the 27th August the Annual Conversazione was held. On the 12th October, Mr. F. J. Pirani read a paper "On some Processes of Scientific Reasoning;" and Mr. R. L. J. Ellery read a paper "On the Photographic Processes to be adopted in observing the forthcoming Transit of Venus." On the 16th November, Mr. Rawlinson read a paper "On the Discovery of some Iron Keys under 15 ft. of diluvium in 1845 or 1846." On the 21st December, Mr. Rusden read a paper "On the Week;" and Mr. R. L. J. Ellery read a paper "On some of the Physical Appearances observed during the late Transit of Venus."

The papers which have been published in pamphlet form are:—Mr. R. Etheridge "On the Sand Dunes of the Coast of Victoria." Mr. Bosisto "Is the Eucalyptus a Fever-destroying Tree?" Mr. Corbett "On Abyssinian Tube Wells." Mr. Pirani "On some Processes of Scientific Reasoning."

The following are in the press:—Mr. Rawlinson "On the Discovery of some Iron Keys under 15 ft. of Diluvium in 1845 or 1846." Mr. Rusden "On the Week." Mr. Ellery "On the late Transit of Venus."

A Catalogue of the Library is also in course of publication.

Your Council has to deplore the recent loss of one of your Vice-Presidents, Professor W. P. Wilson. Professor Wilson was one of the earliest members of the Royal Society, and always manifested a great and active interest in its welfare. His death is a calamity which will be severely felt both by the Society and the Colony generally.

We have much satisfaction in stating that the Government has again granted the subsidy in aid of the printing funds, and we have every reason to believe that this course will be continued.

In presenting the Balance-sheet, your Council has much pleasure in stating that the fencing account has been paid, the printing account has been reduced by £100, and debentures have been paid off to the amount of £200; a considerable reduction in the liabilities of the Society has thus been effected. For the permanent preservation of the building, a considerable outlay for cementing must, however, soon be required.

The President stated that at last meeting the appointment of Auditors had been omitted, and that the Council had consequently appointed Messrs. Bosisto and Rusden, subject to the approval of this meeting.

The action of the Council was confirmed.

(Signed) GEORGE FOORD.

## *The Hon. Treasurer in Account with the Royal Society of Victoria.*

**Dr.**

| | | | | £ | s. | d. |
|---|---|---|---|---|---|---|
| To Balance from last Balance-sheet | | | | 209 | 4 | 4 |
| ,, Government Grant for 1873 | | | | 200 | 0 | 0 |
| ,, Do. do. 1874 | | | | 200 | 0 | 0 |
| ,, Eclectic Society, rent for 1874 | | | | 15 | 3 | 0 |
| ,, Sale of Transactions | | | | 2 | 0 | 0 |
| ,, 7 Entrance Fees | | | | 14 | 14 | 0 |
| ,, Subscriptions:— | | | | | | |
| 1872. 1 ordinary | 2 | 2 | 0 | | | |
| 1873. 3 do. | 6 | 6 | 0 | | | |
| 1874. 54 do. | 113 | 8 | 0 | | | |
| ,, 4½ do. | 4 | 4 | 0 | | | |
| ,, 6 country | 6 | 6 | 0 | | | |
| 1875. 1 do. | 1 | 1 | 0 | | | |
| | | | | 133 | 7 | 0 |
| | | | | £774 | 8 | 4 |

**Cr.**

| | £ | s. | d. |
|---|---|---|---|
| By Printing | 168 | 2 | 0 |
| ,, Transmission of Transactions | 11 | 1 | 0 |
| ,, Compiling Catalogue and Clerical Assistance | 14 | 2 | 0 |
| ,, Conversazione | 11 | 0 | 6 |
| ,, Debentures paid off | 200 | 0 | 0 |
| ,, Interest on Debentures | 37 | 3 | 3 |
| ,, Fencing | 68 | 8 | 0 |
| ,, Furniture and Improvements | 17 | 2 | 5 |
| ,, Repairs | 8 | 0 | 6 |
| ,, Gas, Rates, and Insurance | 14 | 10 | 11 |
| ,, Hall Keeper | 6 | 0 | 0 |
| ,, Collector's Commission | 17 | 8 | 0 |
| ,, Petty Cash | 20 | 0 | 0 |
| ,, Balance in Bank | 181 | 9 | 9 |
| | £774 | 8 | 4 |

Compared with the Vouchers, Bank Pass Book, Cash Book, and Member's List, and found correct.

H. K. RUSDEN, } Auditors.
J. BOSISTO, }

*26th February*, 1875.

## STATEMENT OF ASSETS AND LIABILITIES.

### ASSETS.

| | £ | s. | d. |
|---|---|---|---|
| Balance | 181 | 9 | 9 |
| Estimated value of outstanding Subscriptions | 25 | 0 | 0 |
| Hall, Furniture, &c., insured for | 2300 | 0 | 0 |
| | £2506 | 9 | 9 |

### LIABILITIES.

| | £ | s. | d. |
|---|---|---|---|
| 73 Debentures | 365 | 0 | 0 |
| Interest unclaimed | 27 | 6 | 2 |
| Printing Account | 60 | 0 | 0 |
| Stationery | 1 | 6 | 6 |
| Balance | 2052 | 17 | 1 |
| | £2506 | 9 | 9 |

*12th April*, 1875.

Mr. G. Foord, Vice-President, in the chair.

Messrs. Morris, Alcock, Howitt, and Gould were elected members of the Society, and Messrs. Daniels and Sutherland nominated for election at next meeting.

The Secretary read a paper by Mr. Etheridge on "Some Upper Palæozoic Polyzoa from Queensland." (See *Transactions*, Art. No. xiii.)

A vote of thanks was accorded Mr. Etheridge for his paper.

Mr. Foord, after vacating the chair, which was taken by Dr. Neild, read a paper on "The Importance of a more close and systematic Observation of the Oceanic and Atmospheric Phenomena of our Coasts," by Mr. T. Rawlinson.

Discussion ensued.

It was resolved that consideration of the subject of the paper be referred to the Council.

(Signed) George Foord.

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*17th May*, 1875.

Mr. G. Foord, Vice-President, in the chair.

Messrs. Daniels and Sutherland were elected members of the Society.

Mr. Foord, after vacating the chair, which was taken by Mr. Rusden, read an account of some of the results of the *Challenger* Expedition.

A conversational discussion ensued.

Mr. W. M. Cooke then described and exhibited a new form of Magic Lantern, called the Sciopticon.

(Signed) George Foord.

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*14th June*, 1875.

Mr. G. Foord, Vice-President, in the chair.

Mr. A. R. Wallis was nominated for election at next meeting.

The Secretary read a letter from Mr. R. C. Gunn, of Launceston, in reference to the alleged discovery of some iron keys in 1845 or 1846, concerning which a paper had been read by Mr. Rawlinson on November 16th, 1874, and stated that the Council had ordered the letter to be printed in the *Transactions* of the Society, and that copies of it be distributed at next ordinary meeting. (See p. 122.)

Mr. A. M. Smith read a paper "On the Phenomena of Approach and Recession exhibited by Bodies under the Influence of Radiant Energy." (See *Transactions*, Art. No. xvii.)

Discussion ensued.

Mr. T. Harrison then exhibited and described a Universal Equatorial, and an instrument for the Observation of Mars.

Discussion ensued.

(Signed) GEORGE FOORD.

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*1st September*, 1875.

Mr. G. Foord, Vice-President, in the chair.

Mr. A. R. Wallis was elected an ordinary member of the Society, and Professor Nanson and Mr. C. W. Foster were nominated for election at next meeting.

The Chairman stated that he had received a letter from the President, Mr. Ellery, in which he (Mr. Ellery) desired to be remembered to the members of the Society.

Mr. W. C. Kernot read a paper on "The Arithmometer." (See *Transactions*, Art. No. xix.)

The Secretary read a paper contributed by Mr. J. Perry, "On the Meteor of April 15th."

Mr. R. Barton read a paper on "Surcharge in the Bullion Assay." (See *Transactions*, Art. No. xxi.)

(Signed) GEORGE FOORD.

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*8th November*, 1875.

Mr. G. Foord, Vice-President, in the chair.

Professor Nanson and Mr. C. W. Forster were elected members of the Society, and Messrs. J. C. Ogier and Martin Gardiner were nominated for election at next meeting.

The Chairman, having vacated the chair, which was taken by Mr. Rawlinson, read a paper "On a Proposed New Method of Weighing." (See *Transactions*, Art. No. xxii.)

Discussion ensued.

(Signed) GEORGE FOORD.

---

*13th December*, 1875.

Mr. G. Foord, Vice-President, in the chair.

Messrs. J. C. Ogier and Martin Gardiner were elected members of the Society.

The Secretary read a communication from the Colonial Institute, 15 Strand, London, in which it was stated that "Any member of any Colonial Club or Society, with which the Institute may enter into such an arrangement, may, on producing a letter from the Chairman and Secretary of such Club or Society, be admitted to the Rooms, without payment, for one month."

The Secretary read the list of the retiring office-bearers and members of Council, as follows:—President, Mr. R. L. J. Ellery; Vice-Presidents, Mr. G. Foord and Professor McCoy; Treasurer, Mr. P. de J. Grut; Librarian, Dr. J. E. Neild; Secretary, Mr. F. J. Pirani. Members of Council, Mr. J. Bosisto, Rev. H. P. Kane, Mr. J. C. Newbery, Mr. H. K. Rusden, Mr. T. E. Rawlinson, Mr. A. K. Smith.

Messrs. Bosisto and Rusden were elected Auditors.

Mr. T. E. Rawlinson read a paper "On the Past and Present Condition of the Port of Melbourne, with suggestions for its Permanent Improvement." (See *Transactions*, Art. No. xxiii.)

Discussion ensued.

(Signed) GEORGE FOORD.

# LAWS.

Name. I. The Society shall be called "The Royal Society of Victoria."

Objects. II. The Royal Society of Victoria is founded for the advancement of science, literature, and art, with especial reference to the development of the resources of the country.

Members and Honorary Members. III. The Royal Society of Victoria shall consist of Members and Honorary Members, all of whom shall be elected by ballot.

Patron. IV. His Excellency the Governor of Victoria, for the time being, shall be requested to be the Patron of the Society.

Officers. V. There shall be a President, and two Vice-Presidents, who, with twelve other Members, and the following Honorary Officers, viz.: Treasurer, Librarian, and Secretary of the Society, shall constitute the Council.

Management. VI. The Council shall have the management of the affairs of the Society.

Ordinary Meetings. VII. The ordinary meetings of the Society shall be held on the second Thursday of each month during the Session, from March to December inclusive, subject to alteration by the Council with due notice.

General and Anniversary Meetings. VIII. In the second week in March there shall be a General Meeting, to receive the report of the Council and elect the Officers of the Society for the ensuing year.

Retirement of Officers. IX. All Office Bearers and Members of Council, except the six junior or last elected ordinary Members, shall retire from office annually at the General Meeting in March. The names of such Retiring Officers are to be announced at the ordinary meetings in November and December. The officers and members of Council so retiring shall be eligible for the same or any other office then vacant.

X. The President, Vice-Presidents, Treasurer, Secretary, and Librarian, shall be separately elected by ballot (should such be demanded), in the above-named order, and the six vacancies in the Council shall then be filled up together by ballot at the General Meeting in March. Those members only shall be eligible for any office who have been proposed and seconded at the Ordinary Meeting in December, or by letter addressed to the Secretary, and received by him before the 1st March, to be laid before the Council Meeting next before the Annual Meeting in March. The nomination to any one office shall be held a nomination to any office the election to which is to be subsequently held. And such ballot shall take place prior to the ordinary business of the meeting. Election of Officers.

XI. No Member whose subscription is in arrear shall take part in the election of Officers or other business of the meeting. Members in arrear.

XII. An Address shall be delivered by the President of the Society at either a Dinner, Conversazione, or extra meeting of the Society, as the Council for the time being may determine, not later than the ordinary meeting in June in each year. Inaugural Address by the President.

XIII. If any vacancy occur among the Officers, notice thereof shall be inserted in the summons for the next Meeting of the Society, and the vacancy shall be then filled up by ballot. Vacancies.

XIV. The President shall take the chair at all meetings of the Society, and of the Council, and shall regulate and keep order in all their proceedings; he shall state questions and propositions to the meeting, and report the result of ballots, and carry into effect the regulations of the Society. In the absence of the President the chair shall be taken by one of the Vice-Presidents, Treasurer, or ordinary member of Council, in order of seniority. Duties of President.

XV. The Treasurer may, immediately after his election, appoint a Collector (to act during pleasure), subject to the approval of the Council at its next meeting. The duty of the Collector shall be to issue the Treasurer's notices and collect subscriptions. The Duties Treasurer.

Treasurer shall receive all moneys paid to the Society, and shall deposit the same before the end of each month in the Bank approved by the Council, to the credit of an account opened in the name of the Royal Society of Victoria. The Treasurer shall make all payments ordered by the Council, on receiving a written authority from the chairman of the meeting. All cheques shall be signed by himself, and countersigned by the Secretary. No payments shall be made except by cheque, and on the authority of the Council. He shall keep a detailed account of all receipts and expenditure, present a report of the same at each Council Meeting, and prepare a balance sheet to be laid before the Council, and included in their Annual Report. He shall also produce his books whenever called on by the Council.

**Duties of Secretary.** XVI. The Secretary shall conduct the correspondence of the Society and of the Council, attend all meetings of the Society and of the Council, take minutes of their proceedings, and enter them in the proper books. He shall inscribe the names and addresses of all members in a book to be kept for that purpose, from which no name shall be erased except by order of the Council. He shall issue notices of all meetings of the Society and of the Council, and shall have the custody of all papers of the Society, and under the direction of the Council, superintend the printing of the Transactions of the Society.

**Meetings of Council.** XVII. The Council shall meet on any day within one week before every ordinary meeting of the Society. Notice of such meeting shall be sent to every Member at least two days previously. No business shall be transacted at any meeting of the Council unless five Members be present. Any Member of Council absenting himself from three consecutive meetings of Council, without satisfactory explanation in writing, shall be considered to have vacated his office, and the election of a member to fill his place shall be proceeded with at the next ordinary meeting of members, in accordance with Rule XIII.

**Special Meetings of Council.** XVIII. The Secretary shall call a Special Meeting of Council on the authority of the President or of three Members of Council. The notice of such meeting shall specify the object for which it is called, and no other business shall be entertained.

**Special General Meetings.** XIX. The Council shall call a Special Meeting of the Society, on receiving a requisition in writing signed by twenty-four Members of the Society, specifying the purpose for which the meeting is required, or upon a resolution of its own. No other business shall be entertained at such meeting. Notice of such meeting, and the purpose for which it is summoned, shall be sent to every Member at least ten days before the meeting.

**Annual Report.** XX. The Council shall annually prepare a Report of the Proceedings of the Society during the past year, embodying the balance-sheet, duly audited by two Auditors to be appointed for the year at the Ordinary Meeting in December, exhibiting a statement of the present position of the Society. This Report shall be laid before the Society at the Annual Meeting in March. No paper shall be read at this meeting.

**Expulsion of Members.** XXI. If it shall come to the knowledge of the Council that the conduct of an officer or a member is injurious to the character of the Society, and if two-thirds of the Council present shall be satisfied, after opportunity of defence has been afforded to him that such is the case, it may call upon him to resign, and shall have the power to expel him from the Society, or remove him from any office therein at its discretion. In every case all proceedings shall be entered upon the minutes.

**Election of Members.** XXII. Every candidate for membership shall be proposed and seconded by Members of the Society. The name, the address, and the occupation of every candidate, with the names of his proposer and of his seconder, shall be communicated in writing to the Secretary, and shall be read at a Meeting of Council, and also at the following Meeting of the Society, and the ballot shall take place at the next following ordinary meeting of the Society. When the number of votes in favour of any candidate shall be five times the number of those against him, he shall be declared duly elected, and not otherwise.

Members shall sign Laws.

XXIII. Every newly-elected Member shall, at the first meeting of the Society at which he may be present, sign a declaration, in a book provided for that purpose, that he will observe the laws of the Society.

Honorary Members.

XXIV. Gentlemen not resident in Victoria, who are distinguished for their attainments in science, literature, or art, may be proposed for election as Honorary Members, on the recommendation of an absolute majority of the Council. The election shall be conducted in the same manner as that of ordinary Members, but nine-tenths of the votes must be in favour of the candidate.

Subscriptions.

XXV. Members of the Society, resident in Melbourne, or within ten miles thereof, shall pay two guineas annually, and Members residing beyond that distance shall pay one guinea annually. The subscriptions shall be due on the 1st of January in every year, and notice thereof shall be sent to every Member during the preceding December. At the commencement of each year there shall be hung up in the Hall of the Society a list of Members, upon which the payments of their subscriptions as made by Members shall be entered. On and after the 1st of July, fresh notice shall be sent to Members still in arrears. At the end of each year a list of names of such Members as have not then paid their subscriptions shall be prepared and submitted for the consideration of the Council, and hung in the Hall of the Society.

Entrance Fee, &c.

XXVI. Newly-elected Members shall pay an entrance-fee of two guineas, in addition to the subscription for the current year. Those elected after the 1st of July shall pay only half of the subscription for the current year. If the entrance-fee and subscription be not paid within one month of the notification of election, a second notice shall be sent, and if payment be not paid within one month from the second notice, the election shall be void. Members resident in Melbourne or within ten miles thereof, may compound for all Annual Subscriptions of the current and future years by paying £21 ; and members residing beyond that distance may compound in like manner by paying £10 10s.

XXVII. At the ordinary meetings of the Society the chair shall be taken punctually at eight o'clock, and shall be vacated not later than half-past ten o'clock. Duration of Meetings.

XXVIII. At the ordinary meetings business shall be transacted in the following order, unless it be specially decided otherwise by the Chairman: Order and mode of conducting the business.

Minutes of the preceding meeting to be read, amended if incorrect, and confirmed.

New Members to enrol their names, and be introduced.

Ballot for the election of new Members.

Vacancies among Officers, if any, to be filled up.

Business arising out of the minutes.

Cummunications from the Council.

Presents to be laid on the table, and acknowledged.

Motions, of which notice has been given, to be considered. Notices of motion for the next meeting to be given in, and read by the Secretary.

Papers to be read.

XXIX. No stranger shall speak at a meeting of the Society, unless specially invited to do so by the Chairman. Strangers.

XXX. No papers shall be read, or business entertained, at any meeting which has not been previously notified to the Council. What business may be transacted.

XXXI. The Council may call additional meetings whenever it may be deemed necessary. Additional Meetings.

XXXII. Every Member may introduce two visitors to the meetings of the Society by orders signed by himself. Visitors.

XXXIII. Members shall have the privilege of reading before the Society accounts of experiments, observations, and researches conducted by themselves, or original papers, on subjects within the scope of the Society, or descriptions of recent discoveries, or inventions of general scientific interest. No vote of thanks to any Member for his paper shall be proposed. Members may read papers.

Or depute other Members.

XXXIV. If a Member be unable to attend for the purpose of reading his paper, he may delegate to any Member of the Society the reading thereof, and his right of reply.

Members must give notice of their papers.

XXXV. Any Member desirous of reading a paper shall give in writing to the Secretary, ten days before the Meeting at which he desires it to be read, its title and the time its reading will occupy.

The Secretary shall lay this communication before the Council at its next meeting. Papers shall be read in the order in which such notices are received by the Secretary.

Papers by strangers.

XXXVI. The Council may permit a paper of a nature similar to the above, not written by a Member of the Society, to be read, if for any special reason it shall be deemed desirable.

Papers shall be the property of the Society.

XXXVII. Every paper read before the Society shall be the property thereof, and immediately after it has been read shall be delivered to the Secretary, and shall remain in his custody.

Papers must be original.

XXXVIII. No paper shall be published in the Transactions unless approved by the Council, and unless it consist mainly of original matter as regards the facts or the theories enunciated.

Council may refer papers to Members.

XXXIX. Should the Council feel a difficulty in deciding on the publication of a paper, the Council may refer it to any Member or Members of the Society, who shall report on the same.

Rejected papers to be returned.

XL. Should the Council decide not to publish a paper, it shall be at once returned to the author.

Members may have copies of their papers.

XLI. The author of any paper which the Council has decided to publish in the Transactions may have any number of copies of his paper, on giving notice of his wish in writing to the Secretary, with his paper, and on paying the extra cost of such copies.

Members to have copies of Transactions.

XLII. Every Member whose subscription is not in arrear, and every Honorary Member, is entitled to receive one copy of the Transactions of the Society as published. Newly-elected Members shall, on payment of their entrance-fee and subscription, receive a copy of the volume of the Transactions last published.

XLIII. Every book, pamphlet, model, plan, drawing, specimen, preparation, or collection presented to or purchased by the Society, shall be kept in the house of the Society. **Property.**

XLIV. The Library shall be open to members of the Society and the public at such times and under such regulations as the Council may deem fit. **Museum.**

XLV. The legal ownership of the property of the Society is vested in the President, the Vice-Presidents, and the Treasurer for the time being, in trust for the use of the Society; but the Council shall have full control over the expenditure of the funds and management of the property of the Society. **Legal ownership of property.**

XLVI. Every Committee appointed by the Society shall at its first meeting elect a Chairman, who shall subsequently convene the Committee and bring up its report. He shall also obtain from the Treasurer such grants as may have been voted for the purposes of the Committee. **Committees elect Chairman.**

XLVII. All Committees and individuals to whom any work has been assigned by the Society shall present to the Council, not later than the 1st November in each year, a report of the progress which has been made; and, in cases where grants of money for scientific purposes have been entrusted to them, a statement of the sums which have been expended, and the balance of each grant which remains unexpended. Every Committee shall cease to exist on the 1st November, unless re-appointed. **Report before November 1st.**

XLVIII. Grants of pecuniary aid for scientific purposes from the funds of the Society shall expire on the 1st November next following, unless it shall appear by a report that the recommendations on which they were granted have been acted on, or a continuation of them be ordered by the Council. **Grants expire.**

XLIX. In grants of money to Committees and individuals, the Society shall not pay any personal expenses which may be incurred by the members. **Personal expenses not to be paid.**

L. No new law, or alteration or repeal of an existing law, shall be made except at the General Meeting in **Alteration of Laws.**

March, or at a Special General Meeting summoned for the purpose, as provided in Law XIX., and in pursuance of notice given at the preceding ordinary meeting of the Society.

Cases not provided for.

LI. Should any circumstance arise not provided for in these laws, the Council is empowered to act as may seem to be best for the interests of the Society.

Sections.

LII. In order that the Members of the Society prosecuting particular departments of science may have opportunities of meeting and working together with fewer formal restraints than are necessary at the ordinary meetings of the Society, Sections may be established.

Names and number of Sections.

LIII. Sections may be established for the following departments, viz.:—

Section A. Physical, Astronomical, and Mechanical Science, including Engineering.

Section B. Chemistry, Mineralogy, and Metallurgy.

Section C. Natural History and Geology.

Section D. The Microscope and its applications.

Section E. Geography and Ethnology.

Section F. Social Science and Statistics.

Section G. Literature and the Fine Arts, including Architecture.

Section H. Medical Science, including Physiology and Pathology.

Meetings of Sections.

LIV. The meetings of the Sections shall be for scientific objects only.

Members of Sections.

LV. There shall be no membership of the Sections as distinguished from the membership of the Society.

Officers of Sections.

LVI. There shall be for each Section a Chairman to preside at the meetings, and Secretary to keep minutes of the proceedings, who shall jointly prepare and forward to the Secretary of the Society, prior to the 1st of November in each year, a report of the proceedings of the Section during that year, and such report shall be submitted to the Council.

LVII. The Chairman and the Secretary of each Section shall be appointed at the first meeting of the Council after its election in March, in the first instance from Members of the Society who shall have signified to the Secretary their willingness to undertake these offices, and subsequently from such as are recommended by the Section as fit and willing. Mode of appointment of officers of Sections.

LVIII. The first meeting of each Section in the year shall be fixed by the Council; subsequently the Section shall arrange its own days and hours of meeting, provided these be at fixed intervals. Times of meetings of Sections.

# MEMBERS

OF

# The Royal Society of Victoria.

*Names marked thus * are those of Life Members.*

Alcock, Peter C., Esq., 41 Swanston-street
Allan, Alex. C., Esq., Crown Lands Office
Andrew, Henry M., Esq., M.A., Wesley College

Barker, Edward, Esq., M.D., F.R.C.S., Latrobe-street East
*Barkly, His Excellency Sir Henry, K.C.B., Mauritius
Barnes, Benjamin, Esq., Rosslyn-street, West Melbourne
*Barry, His Honor Sir Redmond, M.A., Chancellor of the University, Supreme Court
Barton, Robert, Esq., F.C.S., Royal Mint
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*Bennison, R., Esq., Sale
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*Bosisto, Joseph, Esq., Bridge-road, Richmond
Brown, H. J., Esq., Park House, Wellington-parade, East Melbourne
Burrows, Thomas, Esq., Burwood-road, Hawthorn
*Butters, J. S., Esq., Queen-street, Melbourne

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Comber, P. F., Esq., Royal Mint
Cook, William M., Esq., Crown Lands Department

Danks, John, Esq., Bourke-street West
*Detmold, William, Esq., 44 Collins-street East, Melbourne
Dobson, E., Esq., A.I.C.E., Claremont House, Grey-street, East Melbourne
Duerdin, James, Esq., LL.B., Yorick Club
*Eaton, H. F., Esq., The Treasury, Melbourne

Ellery, Robert L. J., Esq., F.R.S., F.R.A.S., Observatory
*Elliott, S., Esq., 88 Collins-street West, or East Brighton
*Elliott, T. S., Esq., Railway Department, Spencer-street

Fitzpatrick, Rev. J., D.D., St. Patrick's College
*Flannagan, J., Esq., Collins-street East, Melbourne
Foord, Geo., Esq., F.C.S., Royal Mint
Foster, C. W., Esq., Collins-street

Gardiner, Martin, Esq., Crown Lands Department
*Gibbons, S. W., Esq., F.C.S., Collins-street East, Melbourne
Gilbert, J. E., Esq., Observatory
*Gillbee, William, Esq., M.R.C.S.E., Collins-street East, Melbourne
Gould, J. E., Esq., Collins-street East
Groves, J. W., Esq., Lands Department
Grut, P. de J., Esq., E. S. and A. C. Bank, Hotham

Harrison, Thomas, Esq., Registrar General's Office
Henderson, A. M., Esq., C.E., Reed and Barnes', Elizabeth-street
Henderson, J. B., Esq., Water Supply Department, Sandhurst
*Higinbotham, Hon. Geo., M.A., Chancery-lane, Melbourne
Higinbotham, Thos., Esq., M.I.C.E., Engineer-in-Chief, Railway Department
*Holt, John, Esq., Ledcourt, near Stawell
Howitt, E., Esq., Yorick Club
Hope, A., Esq., Greville-street, Prahran
Hopkins, D. M., Esq., Eaglehawk
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Hunt, Robert, Esq., Royal Mint

*Iffla, S., Esq., L.F.P.S.G., Emerald Hill
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Kelly, Rev. William, St. Patrick's College
Kennedy, Daniel, Esq., McKenzie-street, Sandhurst
Keogh, Lawrence F., Esq., Warrnambool
Kernot, W. C., Esq., M.A., C.E., University

Lewis, Geo., Esq., Collins-street East
Linacre, A., Esq., Lygon-street, Carlton
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McCoy, Professor F., F.G.S., University
McGillivray, P. H., Esq., M.A., M.R.C.S.E., Sandhurst
McGowan, S. W., Esq., General Post Office
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Muntz, T. B., Esq., C.E., Town Surveyor's Office, Prahran
Murray, Stuart, Esq., Kyneton

Nanson, Professor E. J., University
Neild, J. E., Esq., M.D, Collins-street East
Newbery, J. Cosmo, Esq., B. Sc., Technological Museum
Nicholas, W., Esq., Mining Department
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Noone, J., Esq., Lands Department

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*Reed, Thomas, Esq., Fiji
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Rusden, H. K., Esq., Tivoli Place, South Yarra

Sherrard, L. J., Esq., Flinders-lane East
Skene, A. J., Esq., M.A., Lands and Survey Department
*Smith, A. K., Esq., C.E., F.R.S.S.A., Leicester-street, Carlton
Smith, A. M., Esq., 5 Darling Terrace, Drummond-street, Carlton
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Thomson, W., Esq., F.R.C.S. Ed., South Yarra

Ulrich, G. H. F., Esq., F.G.S., Yorick Club

Ward, Colonel, R.E., Royal Mint
Waugh, Rev. J. S., Wesley College
*Were, J. B., Esq., Collins-street West, Melbourne
*White, E. J., Esq., F.R.A.S., The Observatory, Melbourne
Wigg, H. C., Esq., M.D., F.R.C.S., Grattan-street, Carlton

*Wilkie, D. E., Esq., M.D., Collins-street East, Melbourne.
Wilkins, A., Esq., 31 Market-street
Willan, Robt., Esq., 39 Queen-street
Willimot, W. C., Esq., Waltham Terrace, Richmond
Wyatt, A., Esq., P.M., Stawell

## Honorary Members.

Bowen, His Excellency Sir G. F., K.C.B., Governor of Victoria, *Patron*
Clarke, Sir Andw., Colonel, C.B., R.E., London
Goeppert, H. R., M.D., Ph. D., Breslaw
Haast, Julius, Esq., Ph. D., F.G.S., Canterbury, New Zealand
Neumayer, Geo., Professor, Ph. D., &c., Bavaria
Scott, W., Rev., M.A., F.C.P.S., Sydney
Smith, John, Esq., M.D., University, Sydney
Todd, C., Esq., C.M.G., F.R.A.S., Adelaide.

STILLWELL AND KNIGHT, PRINTERS, MELBOURNE.

# TRANSACTIONS

AND

# PROCEEDINGS

OF THE

# Royal Society of Victoria.

## VOL. XI.

*Edited under the Authority of the Council of the Society.*

THE AUTHORS OF THE SEVERAL PAPERS ARE SOLELY RESPONSIBLE FOR THE SOUNDNESS OF THE OPINIONS GIVEN AND FOR THE ACCURACY OF THE STATEMENTS MADE THEREIN.

MELBOURNE:
STILLWELL & KNIGHT, PRINTERS, 78 COLLINS STREET EAST.
*Issued August* 1874.

*AGENTS TO THE SOCIETY.*
WILLIAMS AND NORGATE, 14 HENRIETTA STREET, COVENT GARDEN, LONDON.
To whom communications for transmission to the Royal Society of Victoria from all parts of Europe should be sent.

# TRANSACTIONS

AND

# PROCEEDINGS

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# Royal Society of Victoria.

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15 Tafeln!