ANNIVERSARY ADDRESS.

By Christopher Rolleston, Esq., Vice-President.

[Delivered to the Royal Society of N.S.W., 1 May, 1878.]

Gentlemen,

The absence of our highly esteemed Senior Vice-President must be a subject of great regret to all of you, more particularly when it is known that his absence is not a matter of choice, but of necessity, forced upon him by failing health, and it is especially so to myself, upon whom devolves the duty of opening this year's Session. I may venture to say that nothing has contributed more to the success of the Royal Society, and rendered its meetings at the same time both instructive and popular, than meeting under the presidency of a gentleman of such varied scientific attainments and general mental accomplishments as are concentrated in the person of the Rev. W. B. Clarke.

Whilst the Institution affords ample scope for every class of workers amongst us—for the man of reading as well as the geologist or naturalist—the laborious collector of facts must always hold the first rank amongst us; and foremost in this rank stands the name of our venerable Vice-President, whose researches into the geological formation of this country would fill volumes, and whose contributions to this Society have done so much to illustrate the Natural History of Australia.

In a new country like this, whilst we may not, perhaps, look for great original thinkers or investigators of the calibre of Darwin, Tyndall, or Huxley, we may be well satisfied to have amongst us so accomplished a geologist as Mr. Clarke; and although it may be true that his unobtrusive labours in the field of science have not met with that public recognition to
which, in the opinion of his friends and admirers, their importance entitles them, I venture to suggest that this arises rather from the lack of scientific knowledge amongst us than from any lack of generous sympathy or appreciation of the services which he has rendered to the country. But however this may be, it must be as gratifying to our venerable friend as to ourselves to know that his labours have met with flattering commendation from the most eminent men of science in Europe—that his name has been enrolled in the list of Members of some of the chief Scientific Societies of the Mother Country, and occupies a high place amongst the leading geologists of the day. I should particularly mention the honor conferred upon Mr. Clarke in the year 1876, by the Royal Society of England, in his election to a Fellowship—first, for valuable geological work in classifying the rocks of New South Wales; secondly, for services rendered in the discovery and development of gold-fields; thirdly, for his contributions to knowledge, amounting to upwards of fifty, published since 1826, in the Journals of the Geological and Meteorological Societies, and elsewhere; and, fourthly, for the important part taken by him in the re-founding of the Royal Society of New South Wales, and in the promotion of scientific knowledge in the Colony. Here we have an epitome of Mr. Clarke's valuable labours in the cause of science, as set forth in the "Journal of the Royal Society of England," which stamps him as a man of whom the Colony has reason to be proud.

The spread of a taste for scientific inquiry is one of the leading objects of our Society. With this view the different Sections hold their meetings, and with what degree of success may be gathered from the records of their proceedings published in the Society's Journal for the past year. Doubtless we are all of us, each in his own sphere, anxious to promote this object, and to direct our efforts to make the Institution the vehicle of practical rather than theoretical science. Those who can collect facts will communicate them to the Society, so as to give value and interest to its proceedings; and those who, like myself, have no special scientific knowledge will endeavour to combine those general
scientific facts which may come within the range of their observation, or which can be collected from scientific literature in a form to enliven our meetings, and to make them at the same time both attractive and instructive.

In order, then, to keep alive an interest in all the higher branches of science, we must not allow to pass unheeded the great discoveries and expansions of thought which characterize the age in which we live, and which in Europe as well as in America are traversing the realms of nature at greater depths than have hitherto been sounded, and continually stirring up to greater efforts the inquiring intellects of the master-minds of the present generation. In pursuance of this view, I propose to lay before you to-night a slight sketch of the progress of science during the past year, in those phases of it which will interest not scientific men only, but all who regard with general interest the investigations and discoveries which mark the stirring times in which our lot is cast.

Foremost, I think, in point of interest is the Telephone of Professor Graham Bell, which may be claimed as a British invention. Mr. Bell, a native of Edinburgh, originated the idea whilst engaged in the work of teaching the deaf and dumb to speak, in Boston, United States. His researches began with the production of musical sounds by means of electrical telephony. It is generally supposed that the dumb are mute because they are deaf, and that when they know how to regulate the action of their vocal organs they can articulate with comparative facility. In his attempts to perfect his system of teaching it occurred to Mr. Bell that if, instead of presenting to the eye of his pupils a system of symbols, he could make visible the vibrations of the air, a great step would be gained in teaching them to articulate. To this end Mr. Bell directed all his energies. Employing apparatus by which he had been producing undulatory currents of electricity for the purpose of multiple telegraphy, Mr. Bell attached a rod loosely by one extremity to the uncovered pole of a magnet, and fastened the other extremity to the centre of a
stretched membrane of gold-beater's skin. He supposed that upon speaking in the neighbourhood of the membrane it would be thrown into vibration, and cause the steel rod to make a corresponding motion, thereby occasioning undulations in the electrical current that would correspond to the vibrations in the density of the air during the production of sound; and further, that the change in the intensity of the current at the receiving end would cause the magnet there to attract its rod so as to copy the motion imparted to that at the sending end.

Mr. Bell's first experiments were not altogether successful, but, persevering in his efforts, he at last produced a model which consisted of a permanent magnet with a coil of wire round it, and an iron plate in front, which produced audible results. The vibration of the voice caused the vibration of the iron plate, that vibration produced a current of electricity, the current of electricity caused a variation of power in the magnet in the distant instrument; the variation of power in the distant magnet caused the iron plate in front of the magnet to vibrate, and that vibration produced a sound. Thus the voice was converted into electricity at one end, and electricity became voice at the other end.

Such was the instrument that Mr. Bell sent to the Centennial Exhibition at Philadelphia, and the following is the official report of Sir William Thomson upon it:—"Mr. Alexander Graham Bell exhibits apparatus by which he has achieved a result of transcendent scientific interest—the transmission of spoken words by electric currents through a telegraph wire. To obtain this result, Mr. Bell perceived that he must produce a variation of strength of current in the telegraph wire as nearly as may be in exact proportion to the velocity of a particle of air moved by the sound, and he invented a method of doing so—a piece of iron attached to a membrane, and thus moved to and fro in the neighbourhood of an electric-magnet—which has proved perfectly successful. The battery and wire of this electro-magnet are in circuit with the telegraph wire and the wire of another electro-magnet at the receiving-station. This second electro-magnet has
a solid bar of iron for core, which is connected at one end by a thick disc of iron to an iron tube surrounding the coil and bar. The free circular end of the tube constitutes one pole of the electro-magnet, and the adjacent free end of the bar core the other. A thin circular iron disc, held pressed against the end of the tube by the electric-magnetic attraction, and free to vibrate through a very small space without touching the central pole, constitutes the sounder by which the electric effect is reconverted into sound. With my ear pressed against this disc I heard it speak distinctly several sentences. * * * I need scarcely say I was astonished and delighted; so were others, including some judges of our group who witnessed the experiments and verified with their own ears the electric transmission of speech. This, perhaps, the greatest marvel hitherto achieved by the electric telegraph, has been obtained by appliances of quite a homespun and rudimentary character. With somewhat more advanced plans and more powerful apparatus, we may confidently expect that Mr. Bell will give us the means of making voice and spoken words audible through the electric wire to an ear hundreds of miles distant."

Inspired by so flattering a verdict, Mr. Bell returned to his experiments with renewed enthusiasm, and in 1877 he subjected his instrument to a series of experiments in America, of which, if not greatly exaggerated, the accounts we have received are perfectly astounding. We read of concerts being heard at places forty-three miles distant, and telephonic communication being carried on between Boston and New York, a distance of 250 miles. The first practical application of the telephone is stated to have been made in May, 1877, by the Water Board of Cambridge, in the State of Massachusetts, who established telephonic communication with the waterworks at Freshpond, in order to facilitate the sending of messages. Now more than 500 houses in New England hold telephonic communication, and more than 3,000 telephones are said to be in operation in the United States.
The invention was introduced into England last year, where it has received marked attention. Telephonic communication has been established between the mainland and Jersey. Several business houses have been connected with the private residences of their principals, whilst at the Prescott Colliery, near Liverpool, remarkable success has attended some experiments made under the superintendence of Sir W. Thomson. In these experiments 600 yards of ordinary electric wire were used, the end in one instance being at the bottom of the pit, while the other end, to which the tubes or trumpet-like orifices, which resemble ordinary stethoscopes, were attached, were brought into the office of the Company, some distance from the pit’s mouth. While one of the Government Colliery Inspectors and others went to the bottom of the pit, the majority of the audience remained in the office. Complete success crowned the experiment—which was merely to test the telephone as a means of communication. Questions asked in the office were answered instantaneously from the pit—even the cheering of the colliers at a distance from the instrument was distinctly heard. The telephone was afterwards applied to test the ventilation of the mine, and so adjusted in connection with the air-measurer in the mine, that the overseer above ground could ascertain at once at what rate of current the air was running in the mine. It is hardly possible to conceive a greater benefit to colliers than this discovery entails. Sir William Thomson expressed his own amazement at the great improvement which the instrument had undergone since he tested it at Philadelphia, and stated that if such admirable results had been accomplished by the telephone while still in embryo, what may not be hoped from the future?

At the meeting of the British Association in Plymouth, in August last, Professor Graham Bell himself explained the processes by which the telephone had been brought to its present state. He stated that it had been evolved from a study of the mechanism of the human ear. What ultimate form it might yet assume he did not know; it was as yet only in its embryo state; experiments and investigations were still being carried on by
himself and other scientific friends. Mr. Preece conducted some experiments on the same occasion by placing the meeting in connection with the Guild Hall, and in a very short time a verse of "God save the Queen," as played on a harmonium, was distinctly heard. A song, with chords, was afterwards played, which was clearly heard by numbers of the audience seated near this instrument. But Mr. Bell stated in reply to a question that the report that a concert had been heard in America by means of the telephone was not correct. We may not unreasonably hope that our able Superintendent of Electric Telegraphs will favour this Society with some experiments in connection with this remarkable instrument during the course of the present session.

In the month of December Professor Tyndall communicated to the Royal Society the results of certain experiments made by him in relation to "spontaneous generation," which had been confirmed by further experiments during a summer residence in the Alps. This question has for years been one of interest and experiment by men of science; but it appears now to be determined that the theory of spontaneous generation of infusoria—the lowest forms of which, called bacteria, are the known agents of putrefaction—must be abandoned. The method by which boiling has been employed to destroy germs in the infusion used has been thoroughly tested. The difficulty of killing germs in the infusions, and the difficulty of being sure that the infusions were opened in air free from germs, appear to have led to the belief in spontaneous generation and to the early mistakes in connection with the subject. In a lecture before the Royal Institution, in June last, Professor Tyndall showed that oxygen was necessary to the life of these low organisms. Hence the idea of sterilizing the infusions by depriving them of air. This was done with perfect success. Subjecting an infusion for four or five hours to the action of the Sprengel pump, and afterwards to one minute's boiling, with a view to extinguish its already expiring life, germs were completely destroyed. A minute thus accomplished what three hundred minutes in the
presence of air had failed to accomplish. Nor is the effect here mentioned to be ascribed to a mere suspension of the life of the germs. They are deprived of life when they are deprived of air; for when after a sufficient time germless air is restored to the infusions it fails to revive them. There is a singular similarity between the vital actions of these lowest organisms and those of the highest. Privation of oxygen stifles both high and low, and excess of oxygen poisons both. Professor Tyndall concludes by saying that he is led inexorably to the conclusion that no evidence of "spontaneous generation" exists, and that in the lowest as in the highest of organized creatures the method of nature is that life shall be the issue of antecedent life. A perusal of Professor Tyndall's paper on the subject, contributed to the Nineteenth Century Review, in January last, will well repay any one who will take the trouble to look it up. Professor Sanderson, who at one time favoured the belief in the possibility of spontaneous generation, has since announced himself as entirely in accord with Professor Tyndall on the general question.

The important researches of Mr. Dallinger and Mr. Drysdale on the origin and development of minute and low forms of life, which were communicated by Mr. Dallinger to the Royal Institution in May last, being closely allied to the question of spontaneous generation, call for passing notice. After years of special training for the work, these gentlemen watched in turns through a powerful microscope the whole life and reproduction of a monad. The largest specimens examined by them were the one-thousandth of an inch when young, and four-thousandths of an inch when adult. The spores were so small that it required a magnifying power of 5,000 diameters to see them as they began to grow. Among other points of interest, they observed that while it was possible for monads to live with a gradual change of temperature from 45° to 125°, any sudden increase of heat was fatal; and that, whilst adults could stand 140°, the spores could live for ten minutes in a temperature of 300°.

In December last, Professor Stokes communicated to the Royal Society some of the latest investigations of the radiometer, and set
forth in his paper the many difficulties which surround the problem — a problem which, involving the consideration of so many apparent anomalies, seems to suggest the need for re-examination of some of the accepted theories in physics. Most of us are familiar with the small glass vacuum bulbs enclosing the rotating discs, which are shown in the windows of philosophical instrument makers, and no doubt many have noticed the greater rapidity of rotation when much light is thrown upon them than when there is little light. When the instrument was first invented it was thought to be conclusively shown that the rotation resulted from a hitherto unknown mode of action of light. The fact that the light of a candle would cause a radiometer to rotate, even when the light was passed through a solution of alum, which is believed to stop all radiant heat, was put forward as a triumphant proof that an important discovery with regard to light had been made. A multitude of experiments were, however, soon brought to demonstrate that heat unaccompanied by light would produce the same results. The theory of the mechanical action of light had therefore to be given up, and many and various experiments were made to solve the question of "repulsion resulting from radiation." Mr. Stoney gave the results of his experiments to the Royal Society in connection with the question; and subsequently Mr. Crookes, in April, 1877, exhibited to the same Society a form of radiometer differing so far from the ordinary instrument that he proposed to give to it the name of "otheoscope." In the radiometer the alternate sides of the discs of the fly are bright and dark; in the otheoscope the heater is stationary, and the cooler rotates. In the radiometer the glass bulb is an essential part of the machinery, for without it the fly would not move. In the otheoscope Mr. Crookes believes it is only useful to preserve the requisite amount of rarefaction. The unsolved mysteries which still enshroud it give to the radiometer an interest second to none amongst the scientific problems of the present day.

I dare say most of you may remember the visit of H.M.S. "Challenger" to this port, and some of you may
have had the pleasure of becoming acquainted with Mr. Moseley, the naturalist, on board that ship. In the early part of the past year that gentleman published a very interesting paper on the colouring matter of various animals, especially of deep sea forms, in which are mentioned some interesting facts referring to light in ocean depths. At a depth of 60 fathoms it has been proved that light has no effect on sensitized paper, and it is considered probable that at a depth of from 1,000 to 2,000 fathoms solar light has no effect. At a depth of 450 and 490 fathoms respectively, two blind decapod crustaceans were dredged up in the "Challenger" expedition; and other forms without the eyes possessed by their shallow water congeners were found at various depths. Other animals, however, living in very deep water, were found to have very large eyes; hence it seems to Mr. Moseley fair to infer that some kind of light must exist. He mentions that all the deep-sea aleuronarians dredged up were highly phosphorescent, and suggests that there are probably large areas peopled by these; so that there may probably be illuminated patches in the ocean with dark tracts between. He further threw out this interesting idea,—that it is quite conceivable that animals may exist to which obscure heat rays may be visible, and to such even men and animals generally would appear constantly luminous.

The periodicity of Indian famines has been another subject of importance which has engaged the attention of the learned in investigations of this nature. The question between these and the sun spot period has been discussed, but the theory has yet to be worked out to a practical conclusion. The theory is that the rainfall rises and falls as the sun spots increase or decrease, and that the minimum of the solar spots is the period of the maximum sun heat, which prevents the atmospheric water supply condensing into rain clouds. A trained observer has been sent out to India to arrange for the taking of daily photographs of the sun, and we may know more by and by as to the merits of this problem. This is a question so full of interest to ourselves that I dare say our own able and indefatigable
Astronomer may have had his attention directed to the subject; and if so we may hope to be favoured with the results of his observations before the present session of our Society closes.

The Astronomer Royal has during the past year issued a report on the Transit of Venus Expeditions, and intimated that when the photographs of this transit have been measured and worked out another report may be required. The observations of our own Astronomer were, it is well known, amongst the most valuable of the contributions offered towards the solution of the problem of the earth's distance from the sun, and the result of the working-out of the calculations gives the mean distance as equal to 93,300,000 miles.

Mr. Romane's observations on the nerves of jelly-fish, communicated to the Royal Institution in May last, were a valuable contribution in the direction of our knowledge on the evolution of nerve and nerve systems, possessing additional significance when considered in connection with Mr. Herbert Spencer's "Principles of Psychology"; whilst the studies of Mr. Osborne Reynolds, on vortex motions in fluids, which were communicated to the Physical Society, and which may be illustrated by puffing rings of smoke into the air, will, it is believed, when further carried out, afford many valuable data in shipbuilding, as well as in other ways. His communication to the British Association "On the difference of the steering of steamers with the screw reversed when under full way and when moving slowly," is specially valuable to such a maritime country as Great Britain.

But I must not attempt to pursue this interesting inquiry further to-night. It would be impossible within the limits of an address of this kind to follow out and bring under notice the progress that has been made in all the departments of science in the Mother Country, and I must now return to matters of local concern calling for notice at my hands. In the first place, I should call attention to the work that has been done by our own Sections towards the promotion of the
scientific objects of the Society. It is both interesting and important, covering as it does the fields of—1. Astronomy and Physics; 2. Chemistry and Mineralogy; 3. Geology and Palæontology; 4. Botany; 5. Microscopical Science; 6. Geography and Ethnology; 7. Literature and Fine Arts; 8. Medical Science; 9. Social and Sanitary Science. Good work has been done in nearly all of these Sections, for particulars of which I must refer you to the Journal of the Society.

In addition to the interesting address delivered by your late Vice-President (Mr. H. C. Russell) at the opening of the session of 1877, seventeen papers were communicated to the Society, which will be found at length in the Journal of the Society’s proceedings. Of these papers perhaps the most noteworthy are those of Mr. Tenison Woods:—1st. On “the Tertiary Deposits of Australia.” 2nd. On “the palæontological evidence of Australian Tertiary formation”; and 3rd. On “some Australian Tertiary Corals.” And next to these, the two papers by the Rev. W. B. Clarke, on “Dromornis australis, a new fossil gigantic Bird of Australia,” and “Thynurus minor, a new fossil extinct species of Kangaroo”—as illustrative of the geological history of animal forms long since passed away—are full of interest to the palæontologist. Professor Huxley, in a lecture delivered at the Royal Institution last year on “the History of Birds,” says that there is not one of the distinctive characteristics of birds as they now exist but has to be given up as a characteristic in looking at fossil forms. How true this may be of the fossil remains discovered in Australia further researches may be necessary to determine. He further says that the discoveries to which he alluded, if they did not indicate the actual gradation between birds and reptiles, did show the intermediate forms that had existed.

The report of the Council which has been read to you by the Honorary Secretary, dealing, as it does most fully, with all the details of the Society’s position and progress during the past year, relieves me of the duty of laying
these matters before you; but I cannot help noticing
the munificent gift of Mr. Thomas Walker towards the
Building Fund of our contemplated new Home. This instance of
liberality on the part of a gentleman not bound to us by member-
ship ought to animate us with greater zeal in the cause we have
in hand, and instigate us to greater efforts to secure for the
Society a permanent habitation.

In his last address the Rev. W. B. Clarke laid great stress
upon the obtaining of a Charter for the Society, and I may
venture to say that the announcement that has been made
to-night will afford to him in his sick room the pleasing prospect
of a speedy accomplishment of his aspirations in that behalf.
Whether the Home should precede the Charter or the Charter
should precede the Home has been a moot point amongst us.
We now see an early prospect of obtaining the one, and can have
no difficulty, I apprehend, whenever we see fit to apply for it, in
obtaining the other. But whilst the one and the other will give
stability to the Society, we must never forget that, upon the
individual efforts of its members to collect facts and to supply
information in a manner to attract attention and to stimulate
thought and discussion, rest the popularity, the usefulness, and
the success of the Institution.

And now gentlemen, before closing this address, I will ask you
to favour me with your further attention for a few minutes,
whilst I submit to your notice a very remarkable and interesting
piece of information contributed by Mr. Henry Bessemer to the
Times newspaper, in the month of January last. It is headed
'A Billion dissected.' Few, if any of us, are I dare say aware
of the vastness of the quantity expressed in that little word, and,
as I have not seen the information reproduced in this Colony, I
make no apology for appending it to my address, being assured
that you will not grudge the time occupied in listening to its
very remarkable revelations.

He says: 'It would be curious to know how many of your
readers have brought fully home to their inner consciousness the
real significance of that little word 'billion' which we have seen of late so glibly used in your columns. There are, indeed, few intellects that can fairly grasp it and digest it as a whole; and there are, doubtless, many thousands who cannot appreciate its true worth even when reduced to fragments for more easy assimilation. Its arithmetical symbol is simple and without much pretension; there are no large figures—just a modest 1 followed by a dozen ciphers, and that is all. Let us briefly take a glance at it as a measure of time, distance, and weight.

"As a measure of time, I would take one second as the unit, and carry myself in thought through the lapse of ages back to the first day of the year 1 of our era, remembering that in all those years we have 365 days, and in every day just 86,400 seconds of time. Hence, in returning in thought back again to this year of grace 1878, one might have supposed that a billion of seconds had long since elapsed; but this is not so. We have not even passed one-sixteenth of that number in all these long eventful years, for it takes just 31,687 years 17 days 22 hours 45 minutes and 5 seconds to constitute a billion of seconds of time.

"It is no easy matter to bring under the cognizance of the human eye a billion objects of any kind. Let us try in imagination to arrange this number for inspection, and for this purpose I will select a sovereign as a familiar object. Let us put one on the ground and pile upon it as many as will reach 20 feet in height; then let us place numbers of similar columns in close contact, forming a straight line, and making a sort of wall 20 feet high, showing only the thin edges of the coin. Imagine two such walls running parallel to each other and forming, as it were, a long street. We must then keep on extending these walls for miles—nay, hundreds of miles, and still we shall be far short of the required number. And it is not until we have extended our imaginary street to the distance of 2,386½ miles that we shall have presented for inspection our one billion of coins."
“Or in lieu of this arrangement we may place them flat upon the ground, forming one continuous line like a long golden chain, with every link in close contact. But to do this we must pass over land and sea, mountain and valley, desert and plain, crossing the Equator, and returning around the southern hemisphere through the trackless ocean, retrace our way again across the Equator, then still on and on, until we again arrive at our starting point; and when we have thus passed a golden chain around the huge bulk of the earth we shall be but at the beginning of our task. We must drag this imaginary chain no less than 763 times round the globe. If we can further imagine all these rows of links laid closely side by side and every one in contact with its neighbour, we shall have formed a golden band around the globe just 52 feet 6 inches wide; and this will represent our one billion of coins. Such a chain, if laid in a straight line, would reach a fraction over 18,328,445 miles, the weight of which, if estimated at $\frac{3}{4}$ oz. each sovereign, would be 6,975,447 tons, and would require for their transport no less than 2,325 ships, each with a full cargo of 3,000 tons. Even then there would be a residue of 447 tons representing 64,081,920 sovereigns.

“For a measure of height let us take a much smaller unit as our measuring rod. The thin sheets of paper on which these lines are printed, if laid flat and firmly pressed together in a well-bound book, would represent a measure of about 1,333rd of an inch in thickness. Let us see how high a dense pile formed by a billion of these thin paper leaves would reach. We must, in imagination, pile them vertically upward, by degrees reaching to the height of our tallest spires; and passing these, the pile must grow higher, topping the Alps and Andes and the highest peaks of the Himalayas, and shooting up from thence through the fleecy clouds, pass beyond the confines of our attenuated atmosphere, and leap up into the blue ether with which the universe is filled, standing proudly up far beyond the reach of all terrestrial things; still pile on your thousands and millions of thin leaves, for we are only beginning to rear the mighty mass. Add millions on
millions of sheets, and thousands of miles on these, and still the number will lack its due amount. Let us pause to look at the neat ploughed edges of the book before us. See how closely lie those thin flakes of paper, how many there are in the mere width of a span, and then turn our eyes in imagination upwards to our mighty column of accumulated sheets. It now contains its appointed number, and our one billion of sheets of the Times superimposed upon each other and pressed into a compact mass has reached an altitude of 47,348 miles.

"Those who have taken the trouble to follow me thus far will, I think, agree with me that a billion is a fearful thing, and that few can appreciate its real value. As for trillions and quadrillions, they are simply words, mere words, wholly incapable of impressing themselves on the human intellect."

I think you will all agree with me that the moral conveyed in this communication is not the least interesting nor yet the least instructive feature in it.