The completion of other work will prevent my return to this subject at present—perhaps altogether—but I have ventured to publish this incomplete account of an apparently promising method for the measurement of solar radiation, in the hope that it may be of use and interest to others.

University College, Liverpool. J. W. CLARK

P.S.—It may perhaps be found advantageous to use an apparatus like an inverted cryophorus, in which the absorbed radiant energy generates a vapour-pressure, and is made to lift a column of water in the tube—the height of the column and the time being registered photographically.

THE GROWTH OF CEREALS

PERHAPS nowhere is the influence of the different climatic factors on the rapidity of growth so well illustrated as on the plains of Russia. Therefore W. Kowalewski's careful researches into this subject, summarised in the *Memoirs* of the St. Petersburgh Society of Naturalists (xv. 1), are especially worthy of attention. The author has gathered all necessary information for showing the periods of growth of various cereals on the soil of Russia, from the far north of Arkhangelsk, to the southern province of Kherson, and he has arrived at most interesting results, of which the following is a summary. If the periods of growth of the same cereal be taken throughout Russia, it appears that, altogether, it is in the higher latitudes that it ripens fastest. Oats and spring wheat take 123 days and barley 110 days to ripen about Kherson, and only 98, 88, and 98 days at Arkhangelsk, the difference in favour of the north being respectively thus: 25, 35, and 12 days. The intermediate regions show also intermediate differences, while for each latitude the growth of cereals proceeds faster in the eastern parts of Russia than in the western. It is obvious that if the rapidity of growth were due to temperature, the phenomena would be the reverse of what they are. Moreover, the want of moisture in the southern steppes is also a condition in favour of the rapidity of growth: so that it is in the insolation that we must seek for the cause of the above-stated difference. In fact, oats being usually sown about May 17 at Arkhangelsk, and the harvest usually occurring about Sept. 1, the insolation continues there for 2000 hours in 98 days, not to speak of the 240 hours of bright nights; while at Kherson, during 123 days (from April 1 to Aug. 1) the insolation lasts only for 1850 hours. The difference in favour of Arkhangelsk is thus equal to 150 hours (to 400 hours, if the bright nights be added), and it compensates for the influence of temperature. It is useless to add, moreover, that the cereals cultivated in the north have already undergone a certain accommodation to their conditions. As to the intensity of light, Prof. Famintzin's work on the subject, corroborated by ulterior researches, shows that the great intensity of light in Southern Russia, combined with the great transparency of the atmosphere, is rather a condition against the rapidity of growth, the intensity of light exceeding the limits of the maximum of decomposition of carbonic acid. Winter rye shows the same differences as the spring cereals. It appears from M. Kowalewski's tables that in the Arkhangelsk district winter rye takes 375 days to arrive at ripeness, of which there are 202 days of winter rest, 68 days of autumn growth, and 105 days of spring and summer growth, making thus a total of 173 days of growth. At Kherson the total growth lasts for 290 days, of which only 101 days of winter rest and 189 days of productive growth (63 during the autumn and 126 during the summer). The difference reaches thus 16 days in favour of the north, and it would rise to 20 or 25 days if only spring and summer be taken into account. The graphical representation of all these data is most interesting. Thus the lines of simultaneous sowing of winter rye from north-west to south-east correspond to the isochimenes, while the lines of simultaneous ripening of the spring cereals—oats, barley, sarrazin, wheat—run from south-west to north-east, corresponding to the lines of equal summer temperatures. The retarding influence of rain comes out also pretty well.

THE ROYAL SOCIETY OF NEW SOUTH WALES

THE annual general meeting of the members of the Royal Society of New South Wales was held on May 7. The president, Mr. H. C. Russell, B.A., F.R.A.S., occupied the chair, and delivered an address, from which we give the following extracts:—

"There is a very general impression, borne out by the evidence which geology has furnished, that at least the east coast, if not all Australia, is rising in relation to the mean level of the sea. The late Rev. W. B. Clarke, in a report to the Port Jackson Harbour Commission, said 'that the coast has risen in former geological epochs, and that it has risen during the present epoch is capable of distinct proof.' 'Raised beaches of shells, which are not kitchen middens, may be seen about twenty-five feet above the sea, near Ryde, on the Paramatta estuary, and at Mossman's Bay, in Port Jackson, at a height of 132 feet above high-water.' Again, 'regarding the whole coast from Broken Bay to Botany Bay as mere peninsulatic fragments, united only by low isthmuses, bare or covered with sand, as they actually are, one may still see that there must have been oscillations of level, and finally elevation.' Speaking of other portions of the coast, Mr. Clarke says:—'At Adelaide in 1855 the railway between the city and the port was being constructed, and Mr. Babbage has since shown that in four years a difference of four inches of rise between the levels of those places has taken place.' And again, 'according to Mr. Ellery, the accomplished and accurate Williamstown observer, the self-registering tide-gauge at that place indicated a rise of the bottom of Hobson's Bay of four inches in twelve months, and a deposit of recent shells and imbedded bones of sheep and bullocks which had been thrown into the bay is now seen at a level above the reach of the sides.' Again, quoting from a letter by the late Mr. John Kent, of Brisbane:—'A survey was made of a shelf of rocks in Brisbane River in 1842 by Captain Gilmore, Mr. Petrie, and myself, and in making a re-survey in 1858 Mr. Roberts found the relative depths were singularly correct, but that the general depth of water over the shelf of rock had decreased eighteen inches in sixteen years since the first survey was made.' Sir Roderick Murchison, in the *Proceedings* of the Royal Geographical Society of London (vol. vii. p. 42) quotes from a letter he had received from the late Mr. Kent, of Brisbane:—'I have lately drawn the attention of the Rev. W. B. Clarke to the fact that the eastern coast of New Holland is rising at the rate of (say) one inch per annum, as ascertained by the height of rocks in the river Brisbane above tide levels, through a period of twenty years, and he assures me that to the south the same result has been inferred, though the observations have not extended over so long a period. At what rate the rise is now going on there are no data to establish. Till a series of mean tidal levels are marked on the rocks of the harbour, and the alteration made as distinct as that in Hobson's Bay, any deduction as to the rate of rise must be conjectural and unreliable.' I have but taken a few extracts from a great mass of evidence which Mr. Clarke brought forward in proof of the rapid elevation of the coast of Australia. I was deeply interested in this report when it was published in 1866, and as soon as I had opportunity determined to make such observations with a self-registering tide-gauge as would determine the rate of rise, if any, and in collecting information bearing upon this subject during the past thirteen years. I wrote to Mr. Ellery and asked him for further particulars of the rise going on in Victoria, and in reply he said that Mr. Clarke had in some way misunderstood his remarks, which had reference to the silting up of the harbour, not the elevation of the land; and he at the same time sent me a copy of his paper on 'The Tidal datum of Hobson's Bay,' read before the Royal Society of Victoria, August 14, 1879. After giving the history of the tide-gauge, which was started in 1858 under the Harbour Department, and was not under his control till 1874, Mr. Ellery says:—'It is to be regretted that no precise references to mean tide level in the earlier days can be found. Where measurements do exist in Hobson's Bay they are lacking in accurate information as to the state of the tides, and I find nothing trustworthy upon which to base any statements as to change of sea level since surveys have been made. I think it desirable that permanent bench marks on the natural faces of the rock *in situ* should be established around our bay, carefully connected by accurate levelling with one another and with the tide-gauge, for it is very doubtful if bench marks on buildings can be assumed to afford a permanent datum.' The first self-registering tide-gauge in Sydney was erected on Fort Denison by the late Mr. Smalley in 1867. Unfortunately the design was so faulty that all the records of the heights of tides made by it are of no value, although the times of high and low water are correct. The reason for this fault in its records was that an ordinary hempen cord was used to connect the float and the pencil, and this gradually got longer by use, and also varied with the weather. Finding it impossible to remedy this fault satisfactorily in view of the necessity for exact records of the heights of the tides, in 1872 I had a new gauge made, which, without losing the accuracy of the time record, which the old one possessed, insured the correct record of the height of the tides. This instrument is figured and described in the 'Sydney Meteorological volume for 1878,' and to that work I must refer you for particulars. The record by the new gauge was begun on June 27, 1872, and at that time the precaution was taken of measuring the length of the chain connecting the float and the wheel, so that should any change take place its exact amount could be ascertained. The wisdom of this has been evident on several occasions when the chain was broken by accident, and the exact length restored. The well made for the tide gauge is in part cut in the solid rock, and from the rock to the surface of the ground the sides of the well are built up (round) with solid masonry, so that the top ring of the well is practically part of the solid rock, and cannot move unless the rock does so. On this ring the frame of the tide gauge stands, and the instrument, therefore, has a permanent relation to the rock, and there can be no change in its parts which might be mistaken for a change in sea level. I have been particular in detailing the conditions under which the tide measurements have been made, to show you that sufficient precautions to ensure accuracy have been taken. In each year the mean of all the tides is taken as the mean sea level for that year, and when these results for the past twelve years are placed side by side, it is at first sight rather puzzling, for although the greatest departure from the mean of all is only one inch, yet within this small range the land seems to rise and fall in an erratic way. The cause of these variations, however, was found in the varying relative positions of sun, moon, and earth, and perhaps, to some extent, in the effects of heavy gales. Taken as a whole, these results seem to prove conclusively that no change whatever has taken place in the relation of land and sea during the past twelve years. Of course the question is not settled—a slow change that would be visible in centuries might be altogether hidden in the results before us; but so far as they go these results will be interesting to scientific men, for they are the first that have been taken with such accuracy as the investigation demands. Mean Sea Levels: 1873, 2 feet 5·9 inches; 1874, 2 feet 7 inches; 1875, 2 feet 6·3 inches; 1876, 2 feet 5·5 inches; 1877, 2 feet 6·7 inches; 1878, 2 feet 6 inches; 1879, 2 feet 5·5 inches; 1880, 2 feet 6·2 inches; 1881, 2 feet 5·2 inches; 1882, 2 feet 6·1 inches; 1883, 2 feet 6·8 inches; 1884, 2 feet 6·95 inches—2 feet 6·11 inches. In examining this question I looked for some mark of old surveys which might show what the evidence of a longer period would be, but I have failed to find any mark put in with such care as the investigation demands. There is, however, one mark on the north-east face of the round tower on Fort Denison which was put in by H.M.S. *Herald* during her survey of Sydney harbour. It is cut in the stone three feet above mean sea level, and is marked with the broad arrow under it. I have been at some trouble to find out on what observations this mark was based; but although I have learned that the survey was made in 1857, and that the *Herald* was in port from February 26 to December 21, 1857, I cannot learn how long the tide observations were continued, but I hope still to do so. The time and method of taking mean sea level might account for a difference from the true mean of four or five inches, as is shown by the different monthly means from the recording tide gauge, and until I can learn on what observations the *Herald's* mark depends, it cannot be used as evidence of change of level of the land. I have, however, connected it carefully with the zero of the tide gauge, and if it exactly represents mean sea level in 1857, it proved that the land has risen five inches in twenty-seven years; but, since the tide gauge shows no change whatever during twelve of these years, I think the evidence of the mark cannot be taken without full particulars of the observations on which it depends. In the course of conversation with the late Rev. W. B. Clarke on the question of the elevation of the coast, he pointed out to me evidence not only of the elevation of this coast, but also of its subsidence, and expressed his conviction that Port Jackson, Hawkesbury River, and other places on the coast had been cut out by the action of fresh water, when the coast was much higher than it is at present—in fact, that these inlets had been at one time gullies exactly similar in character to those which now exist in the Blue Mountains, and which have been so obviously cut out by fresh water. Since that time many bridges have been made along the coast, and the borings made for foundations for these bridges have special significance in connection with Mr. Clarke's opinion; and by the kindness of the Engineer-in-chief for Railways and the Engineer-in-chief for Roads and Bridges I am able to quote here some of these measures, which prove conclusively that the sea was at one time much lower than it is at present. The soundings taken for the Parramatta Railway bridge show 26 feet water, 32 feet mud and silt, 8 feet loose sand, 12 feet hard sand, 10 feet loose sand: total, 88 feet. George's River bridge—8 feet water, 87 feet mud and sand, 9 feet black clay, 16 feet sand, 4 feet hard sand: total, 121 feet. Hawkesbury River bridge—44 feet water, 31 feet light mud, 87 feet black mud, 8 feet very hard sand: total, 170 feet. In the road-bridge over the Parramatta River—41 feet water, 16 feet shells and mud, 15 feet sand, 9 feet blue clay, 6 feet clays and shells: total, 87 feet. Ironstone Cove road-bridge—26 feet water, 7 feet stiff blue clay, 36 feet very stiff blue clay, 15 feet yellow clay, 5 feet stiff black clay, 11 feet sand and clay, 2 feet clean sand, 3 feet gravel and wood: total, 105 feet. Shoalhaven River road-bridge—14 feet water, 103 feet mud and silt: total, 117 feet. The bottom of the Hawkesbury, therefore, where the railway-bridge is to be, is 170 feet below the level of the sea to-day; and when the rocks were washed away to form the river-bed to that depth, the sea must have been at least 170 feet below its present level, and the bearings in Sydney Harbour and George's River indicate a similar fact, if not to the same extent. Without going further into this question, which is foreign to my present purpose, I think I have said enough to show that the evidence for elevation and subsidence of the land are about equal, the question before us being, In which direction is the change going on now? In estimating the value of the evidence quoted as to the rate of rise in Queensland and South Australia, we must not forget that when engineers adopt the usual rule as to mean sea level—that is, as to the mean of high and low water at any time of the year—they assume that all such means are equal or represent a constant level, when in point of fact two such determinations of sea level may differ by 8 inches or even more, and in the absence of a self-registering tide-gauge, or constant observations extending over a year, no levelling referred to the sea in the usual way is of any value whatever in such an investigation as that required to determine whether the relative level of land and water varies. I have already shown that Mr. Ellery thinks there is no evidence of present rising in Hobson's Bay, and the fact that at the time the engineering levels referred to were taken in South Australia and Queensland there were no self-registering tide-gauges to determine accurately mean sea level, is sufficient to warrant us in hesitating before we receive the evidence as to the rate of elevation furnished from these colonies, which I quoted from Mr. Clarke's report. Some few months since it occurred to me that it would be desirable to put a self-recording gauge on Lake George, with a view of keeping a continuous record of evaporation and other changes of level in it; and as soon as the instrument could be got ready I put it up on the west side of the lake, in front of Douglas House, which is about a mile from the present southern end. The work of erecting the instrument was completed on the afternoon of February 18, and the pencil was put down on the paper to begin its curious record at 7 p.m. on that day. At the time the lake seemed calm as a millpond, and, looking at its smooth surface, no one would have dreamed that such changes were going on in it as began to reveal themselves so soon as the pencil touched the paper, and in two hours the pencil had recorded a rise and fall of about 2 inches. This is not a motion like the ordinary wind-made waves, which pass by in two or three seconds, but a slow and gradual rise, occupying an hour, and then a corresponding fall in about the same time, to do which a current must first have set from north to south for an hour, and then reversed; and if we consider for a moment the force necessary to put a body of water 18 miles long, 5 wide, and 15 or 20 feet deep, in such motion, we shall get some idea of the magnitude of the forces at work. The record had not been going 24 hours when it became obvious that these periodic motions in the level of the water had a period of about two hours, and on the afternoon of the second day a heavy thunderstorm passed over the south end of the lake, and threw a little light on the cause of the pulsations. The storm rain was very heavy and much of it must have run into the lake, tending to raise the waters there. With the storm there came a violent squall of wind from the south, on to the south end of the lake; in a few minutes great foam-crested waves could be seen in the middle, and the recording gauge at once showed what was the matter; the wind had blown the water away from the south end and reduced the general level 3 inches. In 10 minutes the squall was over, and the water began to recover its level, in doing which the current set towards the south end of the lake, and could be seen running past the jetty at the rate of about two miles per hour. But it did not stop when the old level was reached, the momentum carried it beyond that point, and raised the water up at the south end of the lake. Then it turned and ran back again, repeating this process time after time at intervals of about two hours, the rise and fall getting gradually less until in about eight hours the water was almost still, when suddenly, at 11.30 p.m., the water began to rise faster than ever, and in 30 minutes had risen 4 inches; it then turned and fell nearly as fast as it had risen, and reached its lowest point in 1 hour 41 minutes, having fallen exactly 6 inches. At Douglas House the night was fine and calm, without the sign of a storm. Yet it seems probable that a storm passed over the north end of the lake, and started the motion, which kept on at intervals of about two hours for 14 hours, the rise and fall gradually getting less. I was fortunate enough to be present and see so much of the record and the corresponding weather. You have no doubt noticed that one set of pulsations was started by a sudden fall, and the other by a sudden rise, in the lake, and that the impulse which caused the water to rise was greater than the other. Similar impulses have kept the lake in almost constant motion ever since, and when once under way, they will go on throughout a gale of wind with just as much regularity as in a calm. Ordinarily such a set of motions lasts 10 or 12 hours, decreasing gradually as if the friction of the water stopped it; but on several occasions they have kept on for days together. The most remarkable impulse yet recorded was on the 14th of April, when the water was remarkably still, and had been so during the 11th, 12th, and 13th. At 11 a.m. on that day Mr. Glover, who has charge of the gauge, saw a thunderstorm coming down from the north, and went into the recording-house to see its effect. The lake was rising fast, and in 30 minutes rose 4 inches; as the storm passed overhead the rising ceased, and the lake at once began to fall, getting back to its previous level in 15 minutes; passing this point it fell 2 inches more– in all 6 inches—and then began to rise again, so starting a series of pulsations that lasted five days. Rain came with this storm, and on the 14th and 15th measured by gauges at each end of the lake 1·10 inch rain fell, and this caused a rise of 1½ inches in the lake, which can be distinctly seen in the record as something independent of the pulsations. With the rain there was a strong breeze of wind, and by the third day after the water had returned to its old level, all the rain having evaporated in three days. In each of the cases I have mentioned so far the impulses seem to have been given by a sudden storm breaking over the lake, but there are other instances in which the impulse was of a totally different character, and it seems as if a small force properly managed was made to do duty for a large one, just as we should set a heavy weight suspended by a string in motion by giving it first a little push, and then adding impulse at each swing. So the force, whatever it be, which in these cases acts on the water in the lake, gives it a little start and gradually gets it in motion. The best instance of this occurred on the afternoon of April 5, at the time the lake was very quiet, and suddenly the water rose an inch, and fell again within 30 minutes; next time it rose an inch and a half, and fell 2 inches in three-quarters of an hour; the next time it rose 2 inches, and fell 3½ inches in an hour; it then rose 3¾ inches in 40 minutes, and so started a series of pulsations which settled down to two-hour intervals, and lasted twenty hours. Usually, the rise and fall take about equal times, but now and then the whole fall will take place in 14 or 15 minutes, and the corresponding rise takes 116 minutes, and it is not very unusual to find one in a set of twice the period of the others, as if one had been left out. In fact the variations in the conditions of vibration are very puzzling. With a view of finding out the most common period I have measured 54 of the best defined amongst those already recorded. Of these 33 have a period of 2 hours 11 minutes, five a period of 2 hours 5 minutes, six a period of 2 hours 17 minutes, and ten a period of 1 hour 12 minutes. The periods of those on the Lake of Geneva are 72 minutes and 35 minutes. Of those in Lake George which have a period of 2 hours 11 minutes, some are the largest yet recorded, and others only a half or a quarter of an inch rise and fall; so that there must be something which makes or tends to make the period 2 hours 11 minutes. It is noteworthy that at Lake George as well as the Lake of Geneva, the short seich is not half the long one; but they bear about the same proportion one to the other in each case. As to the cause of these motions in the lake I am not prepared to say much at present. Further investigation is needed, and I hope, by the aid of a recording aneroid already there, and a recording anemometer to be erected shortly, to be able to compare the changes of wind and pressure with the changes in the lake; but I do not expect to find everything. Changes of level, &c., are going on in the earth surface, which, from an astronomical point of view, are intensely interesting, because they affect the instruments, and therefore the measures. They are very minute, and we have no means of keeping a continuous record of them; but it is possible that if such changes affect the lake they will be so magnified by its comparatively enormous extent as to show themselves on the recording instruments there. The baragraph at Sydney has shown long since that thunderstorms come on with a sudden rise of the barometer, which at times amounts to a tenth of an inch. If such a change could affect one end of the lake for a few minutes it would be equivalent to putting suddenly on to it an inch of water, which would make itself known at once by a rush to the other end; but although such changes must have some effect, I do not think it can be considerable, because, as I have elsewhere shown, these storms move at the rate of about 60 miles per hour, and are often 70 miles wide, so that such a storm coming on to the lake would spread all over it too rapidly to cause much motion in the water. I am here assuming that the storms there are of the same character as those which pass over Sydney, but they may be smaller when passing the lake, and travel more slowly. Certainly the storm which I saw coming down the lake did not traval with anything like such velocity. M. Vaucher, who studied for years the motions of the same kind which take place in the Lake of Geneva, considered himself justified in saying: "The lake is disturbed when the barometer is unsteady, and because of the varying pressure." From what I have seen so far, the first part of this is true of Lake George, but it is not because the barometer is unsteady, but because at such times the wind is puffy and variable, and imparts to the water its own peculiarity. Of the power of the wind to set the water in motion I have mentioned several instances to-night, which I need not repeat, but I may add that the large impulses come from the north, because, as it seems to me, the wind from that direction acting on the water, the whole length of the lake has greater power than when blowing from the south over a short stretch of water, the gauge is fixed about a mile from the south end. But, although the wind is such an obvious cause of the phenomena under discussion, I think the barometric changes have some share in it, and there are some changes recorded which, so far, I am unable to refer to any cause. Mr. Russell then entered into details of the surroundings of Lake George, which, he stated, are of very great interest, viewed in the light of discussions as to the possible change in the amount of rainfall in the colony during long periods. The persistence of level in Lake George, he pointed out, is very strong evidence in favour of the view that there has been no great change in the rainfall there for thousands of years, and probably the same may be said of Australia. The rainfall on the lake in 1870, Mr. Russell said, was 50 inches, double the average rainfall, which is 25 inches, and it is not to be wondered at that the lake rose at an unusual rate. Still this rain, heavy as it was, only served to cut little gutters in the older deposits which had been brought down the gullies. The primary object in placing the recording gauge on Lake George was to ascertain the rate of evaporation from such a large body of water, the conditions at the lake being very favourable for such an investigation. The record began on February 18, and the time since is too short to justify any assumption of the rate of evaporation there; but I may mention some of the facts that have been recorded bearing upon this question. In 68 days the level of the lake has fallen 7 inches by evaporation; in this interval, according to the records of rain-gauges at each end of the lake, 3·55 inches of rain has fallen, so that, ignoring the water which may have run from the hills during these rains, the lake has lost all the rain falling into it and 7 inches more, that is, 10½ inches. During the past 14 years the lake has lost by evaporation 12 feet; and in May, 1878, the railway survey carried down the western side showed that the lake was then

6 feet below its 1871 level, or 2225 feet above the sea. It appears, therefore, that in 7 years, 1871 to 1878, the lake lost 6 feet; and again, from May, 1878, to February, 1885, say seven years, the lake again lost 6 feet by evaporation, and this of course in addition to all the rain which fell during that period. Taking the records at Goulburn and Gungahleen, near the lake, the average rainfall for the first 7 years was 27·95 inches, and during the next 7 years 23·68 inches. One would expect to find more evaporation during the drier years, but this is not borne out by observations. From the rainfall and recorded evaporation the lake, therefore, lost by evaporation at least 3 feet per annum. I say at least, because some rain water must have run into the lake in addition to that which fell into it directly, but its amount cannot be determined. In future the recording gauge will determine this, and perhaps then we may apply the experience gained to estimating how much ran in during the past fourteen years. Lake George is called a fresh-water lake, and some have even gone so far as to propose to use it as a reservoir for the supply of towns. When there I ascertained that no one could use the water on account of its purgative properties, one glass full being quite enough to satisfy those who made use of it; and it is there said that the water running into the lake from the Currawang copper mine had poisoned all the fish. This is not literally true, for there are still fish in the lake; but very many were killed some years since, presumably by the cause mentioned. I obtained some of the water, and am indebted to Mr. Dixon, of the Technical College Laboratory, for the following interesting information as to what the water contains:—It is quite evident that with 187·5 grains of mineral matter per gallon the water cannot be used for domestic purposes, and from the fact that this matter is constantly being added to, it cannot improve, unless it were possible to withdraw large quantities of the water, and supply its place with rain-water; but during by far the greater number of years during which the lake has been known, viz., 64 years, the supply of rain-water going into it annually has not been equal to the evaporation, and there is no other outlet. After the great flood of 1870 the lake, during the last 14 years, has gradually decreased by nearly a foot per annum, and similar conditions existed before; and it is therefore obvious that it would not be possible to wash out the salts with rain-water and artificial drainage except in wet years—perhape once in 20 years. Extract Mining Department's report, 1880:—'Three samples of water from the Currawang Copper mines were sent for analysis, with special reference to their poisonous action on the fish in Lake George, and were therefore only examined with regard to the metals in solution. The metals were present as sulphates, and are stated below:—Water from the creek contains: Sulphate of copper, 1·12 grains per gallon; sulphate of zinc, 16·78 grains per gallon; sulphate of iron, 0·43 grains per gallon. Water from the working shaft: Sulphate of copper, 17·67 grains per gallon; sulphate of zinc, 53·54 grains per gallon; sulphate of iron, 1·42 grains per gallon. Water from the old shaft: Sulphate of copper, 6·42 grains per gallon; sulphate of zinc, 7·20 grains per gallon; sulphate of iron, 0·98 grains per gallon.' This water would necessarily be poisonous to fish, and flowing into a lake without outlet, would ultimately render the whole water poisonous. 'Technical College Laboratory, Sydney, 2nd May, 1885. My dear Mr. Russell,—The water from Lake George contains 187·5 grains per gallon of solid matter dried at 212° F. The residue has a strongly alkaline reaction, effervesces with acid, blackens much on ignition, but does not show the presence of nitrates in doing so. The metals present are aluminium, calcium, and magnesium; the acids chlorine, carbonic acid, sulphuric acid, and phosphoric acid, the last two in small quantity. The salts are probably arranged as chloride of sodium, sulphate of sodium, phosphate of sodium, carbonate of sodium, and carbonates of calcium and magnesium. The purgative properties of the water are probably due to the salts as a whole, and especially the carbonate of magnesia. It should be borne in mind, however, that waters containing much organic matter frequently have a purgative effect.—Signed, W. A. DIXON. P.S.—Zinc and copper are entirely absent.'"

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

SCIENCE AND ART DEPARTMENT.—The following Prizes, Scholarships, Associateships, &c., have been awarded in connection with the Normal School of Science and Royal School of Mines, South Kensington.

First Year's Scholarships: — James Rodger, Andrew McWilliam, Tom. H. Denning, John Richards.

Second Year's Scholarships:—Arthur E. Sutton, Thomas Rose.

The following Prizes were also awarded:—Alfred V. Jennings, the "Edward Forbes" Medal and Prize of Books for Biology; Arthur E. Sutton, the "Murchison Medal" and Prize of Books for Geology; and the "Tyndall Prize" of Books for Physics, Course I.; Henry G. Graves, the "De la Beche" Medal for Mining; John C. Little and James Allen, "Bessemer" Medals with Prizes of Books from Prof. W. Chandler Roberts for Metallurgy; Arthur W. Bishop and Peter S. Buik, the "Hodgkinson" Prizes for Chemistry.

Associateships, Normal School of Science:—Isaac T. Walls (Chemistry, 2nd Class); Alfred Fowler (Mechanics, 1st Class); George H. Wyatt (Physics, 2nd Class); Martin F. Woodward (Biology, 1st Class).

Associateships, Royal School of Mines:—John C. Little (Metallurgy, 1st Class); Thomas A. Rickard (Metallurgy, 1st Class); Percy E. O. Carr (Metallurgy, 1st Class); Walter A. A. Dowden (Metallurgy, 2nd Class); Henry G. Graves (Mining, 1st Class); Ernest Woakes (Mining, 1st Class).

DR. REDWOOD has retired as Emeritus Professor from the Chair of Chemistry at the Pharmaceutical Society. The vacancy has been filled by the appointment of Mr. Wyndham Dunstan, Demonstrator of Chemistry in the University Museum of Oxford.

SCIENTIFIC SERIALS

Rendiconti del Reale Istituto Lombardo, May 21.—A science of criminal legislation in connection with the projected Italian Penal Code, by E. A. Buccellati.—Note on the inscribed Etruscan arms and mirrors in the Fol Museum, Geneva, by Prof. E. Lattes.—The system of projected homogeneous co-ordinates for the elements of ordinary space, by Prof. F. Aschieri.—On the separation of cream from milk, and the conditions tending to accelerate the process, by Prof. G. Morosini.—Further researches on the functions that satisfy the differential equation $\Delta^2 u = 0$, by Prof. Giulio Ascoli.—Remarks on the Mexican skulls deposited in the Civic Museum, Milan, by E. A. Verga.—Meteorological observations made at the Brera Observatory, Milan, during the month of May.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, June 18.—"A Memoir introductory to a General Theory of Mathematical Form." By A. B. Kempe, M.A., F.R.S.

The object of the memoir is the treatment of the "necessary matter" of exact or mathematical thought as a connected whole; the separation of its essential elements from the accidental clothing—algebraical, geometrical, logical, &c.—in which they are usually presented for consideration; and the indication of that to which the infinite variety which those elements exhibit is due.

The memoir opens with the statement of certain fundamental principles, viz.:—Whatever may be the true nature of things and of the conceptions which we have of them (as to which points we are not concerned in the memoir to inquire) in the operations of reasoning they are dealt with as a number of distinct entities or *units*.

These units come under consideration in a variety of guises—as points, lines, statements, relationships, arrangements, intervals or periods of time, algebraical expressions, &c., &c.—occupy various positions, and are otherwise variously circumstanced. Thus, while some units are undistinguished from each other, others are by these] peculiarities rendered distinguishable. For example, the angular points of a square are distinguishable from the sides, but are not distinguishable from each other. In some instances where distinctions exist they are ignored as not material. Both cases are included in the general statement that some units are distinguished from each other and some are not.

In like manner some *pairs* of units are distinguished from each other while others are not. Pairs may be distinguished even though the units composing them are not. Thus the angular points of a square are undistinguishable from each other,