study would be that of the Administration of Forests. The forest inspectors and their agents are called upon by their functions to travel over the high valleys of the Alps; they would thus be able, without great additional labour, to undertake the observation of glaciers.

As to the programme on which they should work, we would simplify it as much as possible, and reduce it to two points:—

1. To attentively survey the glaciers in order to fix for each one the year of maximum and the year of minimum extent in their successive variations.

2. To specially watch the dangerous glaciers, and warn the Administration of the danger they may cause by assuming exaggerated dimensions during their phase of development.

In order to carry out this double programme, the Government should charge each inspector of forests to study the glaciers of his district, and to inscribe on a register *ad hoc* the state of growth and decline of each glacier every year. For important glaciers, interesting or dangerous, he should have measurements made from fixed marks, and state in exact figures the changes in the dimensions of the glaciers; for little, uninteresting, or unimportant glaciers, occasional inspection and the reports of the mountaineers would suffice to ascertain their state of growth or decrease.

M. Antoine de Torrent, Inspector-General of the Forests of Le Valais, has long been occupied in collecting observations on the glacial variations of our Alps; it is from him that we have obtained all the facts recorded by science in this field of research in Le Valais; it is for him, not for us, to give instructions as to the way in which the observations should be organized.

This study is not an expensive one; it calls for no great outlay on the part of the State, nor does it make great demands on the powers and the time of the observers. It may lead to important and useful results. It can only be successfully carried out by the State, since that alone has the necessary persistence to continue it long enough. I therefore venture to recommend these studies on the variation of glaciers to your great benevolence, and to the enlightened solicitude with which you follow all questions interesting to the public welfare. Men of science, who consecrate their lives to the study of the phenomena of nature, are ready to help you to the best of their ability to study these questions from a theoretic point of view. But it is necessary, in order to arrive at practical results, to have a collection of materials of observation which the State alone seems to us capable of bringing together with success.

Accept, M. le Conseilleur de Etat, the expression of my very respectful and devoted consideration.

F. A. FOREL.

Morges, February 10, 1892.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 8.—M. de Lacaze-Duthiers in the chair.—The "Pythonomorphs of France," by M. Albert Gaudry. Announcing the discovery of the snout of one of the great chalk reptiles termed pythonomorphs by M. Cope, on account of their similarity to the sea serpent as imagined by the ancients. The specimen is from a pythonomorph 10m. long, and was found in the upper chalk of Cardesse, near Pau. It is similar to the *Mosasaurus giganteus* of Maestricht, and has been termed *Liodon mosasauroides.* A smaller and somewhat similar specimen was also found, and was termed *Liodon compressidens.* These and a few minor fragments are the first representatives of the pythonomorphs found in France.—On the production of sugar in the blood at the expense of the peptones, by M. R. Lépine.—On the lava of July 12, 1892, in the torrents of Bionnasay and Bon-Nant (catastrophe of Saint-Gervais, Haute Savoie), by M. P. Demontzey. After describing the probable course of the catastrophe, the writer comes to the following general conclusion:—That the lava of July 12 has behaved exactly like those which have been observed before in the torrents of the Alps and the Pyrenees. That its energy was all the more disastrous as the transport in masses commenced in the most elevated regions of the torrent basin after the sudden bursting forth of a large body of water concentrated more rapidly even than in the most violent hailstorms in the upper basins of torrents without glaciers. That the volume of the deposited materials of all sorts—estimated at about one million cubic metres—presents no anomaly in comparison with the relatively small amount of water, which effected the transport by a series of successive bounds, with alternate momentary accelerations and retardations of speed. That this torrent phenomenon has substituted for a simple and hitherto harmless rivulet a torrent whose activity can be mastered with a relatively short delay. That both in the Alps and the Pyrenees similar cases of the transformation of peaceful rivulets into formidable torrents can be cited, aggravated by the fact of their being caused by rain, which is even more difficult to predict and ward off than the dangers presented by a glacier. And lastly, that this great disaster could not have been provided against, since nobody had had the idea even of exploring the glacier of Tête-Rousse.—On a property of lamellar bimetallic conductors submitted to electromagnetic induction, by MM. Ch. Reignier and Gabriel Parrot. An arrangement recalling Faraday's disc is obtained by substituting for the ordinary copper conductors thin plates composed, along their thickness, of a very magnetic and a highly conducting metal, so placed that the lines of force are perpendicular to their thickness. The flow of induction emanating from the north pole is divided into several sheets of parallel lines very close together, which only traverse the magnetic portions of the bimetallic conductors, and the tubes of force become cylindrical. The available energy in such an arrangement increases at a rate which is sensibly proportioned to the height of the conductors. An apparatus constructed on this principle gave, with a weight of 750 kg. and a velocity of 500 revolutions, 32,000 watts giving an output of 42 watts per kg. of the machine.—The application of the measurement of density to the determination of the atomic weight of oxygen, by M. A. Leduc. The composition of water by volume, and thence its composition by weight, were determined by finding the density of a mixture of hydrogen and oxygen produced by the electrolysis of an alkaline solution. After an electrolysis of several days, during which the superfluous gas was allowed to escape through mercury, the liquid and the platinum poles were saturated with gas, and the density obtained by the method previously described did not vary by more than 0·0001 gr. The value within $\frac{1}{100}$ per cent. was 0·41423. The volume ratio between hydrogen and oxygen was 2·0037 at 0°, and the atomic volume of oxygen 1·9963. The atomic weight of oxygen by this method is 15·877, and by the synthetic method 15·882, so that 15·88 must be taken for the mean atomic weight. Hence the molecular weight of water vapour is 17·88, and its theoretical density 0·622.—On the general form of boiling-point curves for central substitution compounds, by M. G. Hinrichs.—Note on the existence in the earth of an acid mineral substance as yet undetermined, by M. Paul de Mondesir. If all the carbonic acid contained in lime be driven off by a strong acid, and the ratio of lime to carbonic acid be carefully measured, the lime is found to exceed the quantity necessary for saturation. The earth remains always acid and capable of decomposing carbonate of lime in the cold. That this acid residuum cannot be humic acid or free silica is proved by the total destruction of the organic substances by ignition or potassium permanganate, which leaves the property in question unaffected. The quantity of acid matter varies from ·2 to 1 per cent. of the earth. It is very stable, and its composition has not yet been determined.—Calcareous soap and boiler explosions, by M. A. Vivien.—Pupine, a new animal substance, by M. A. B. Griffiths. This is extracted from the skin of the chrysalis of several lepidoptera.—On the colouring matter of *Micrococcus prodigiosus*, by the same.—On the coccoid state of a nostoc, by M. C. Sauvageau.—On an alga living in the roots of the *Cycadeæ*, by M. P. Hariot.—On the presence of fossils in the azoic formations of Bretagne, by M. Charles Barrois.—On the discovery of cut flints in the quaternary *Rhinoceros Mercki* alluvium of the Saône valley at Villefranche, by M. Ch. Depéret.

ROME.

R. Accademia dei Lincei, June 5.—The 289th annual meeting, honoured by the presence of H. M. King Umberto I.—The President introduced the two committees charged with the examination of the works in competition for the two royal prizes of 10,000 lire each, one for social and economic sciences, the other for mathematical sciences. Senator Lampertico, reporting for the first committee, said that, although two essays, one on "Ancient Socialism," by Salvatore Cognetti de Martiis, and another on the laws of the distribution of wealth, bearing the motto, "Laboremus," had shown considerable merit, the committee had not felt justified in awarding the prize to either.

Professor Cerruti, on behalf of the second committee, reported that two candidates had been found equally deserving of the mathematical prize, viz., Professor Luigi Bianchi by his essays on the triple orthogonal systems of Weingarten and allied subjects, and Professor Salvatore Pincherle in virtue of his various works on the general theory of functions. It was therefore decided to divide the prize equally among these two candidates. —The last of the ministerial prizes for professors of secondary classical and technical schools, amounting to a total of 9000 lire for philological, and 9000 lire for physical and chemical subjects, were distributed among thirteen candidates, prizes of 3000 lire being obtained by Professors Nasini and Costa for their work "On the Variation of Refractive and Dispersive Power of Sulphur in its Compounds," and by Dr. Enrico Salvioni for his contribution "On the Construction of the Legal Ohm."—General Ferrero then addressed the meeting on the subject of scientific measuring instruments. Although, he said, the human eye, that natural model of the telescope, the microscope, and the photographic camera, can distinguish within a few hundredths of a millimetre whether two points are in contact; although the ear can appreciate sounds ranging from 32 to 70,000 vibrations per second, and is able, while following the rhythm of a full orchestra, to discover the slightest dissonance; yet the power of our senses is limited to a comparatively small portion of the infinite variety of external phenomena, that portion which is of more immediate value for our merely animal life. The errors which the unaided senses are liable to lead us into are mainly due to their subjectivity, which renders the impressions of one individual incomparable with those of another, or with his own under different conditions. The use of instruments enables us to submit these impressions to measurement, to compare them amongst themselves, and immensely to extend our field of investigation towards the infinitely great and the infinitely small. The progress made in this direction during the last few hundred years justifies the hope that the time is not far distant when the results of observation will be as far as possible beyond the personal influence of the observer. The disciple of science will read the truth in the book of nature, traced out by the phenomena themselves. The universe, which has always remained inaccessible to metaphysics, will willingly disclose its secrets to the researches of modern science. This owes its great progress during the last century mainly to the perfection and delicacy of its measuring instruments, which has made modern astronomical observations a thousand times more accurate than those of the Chaldees, and has, by making very minute differences of temperature appreciable and measurable, enabled biology to enter the ranks of the exact sciences. The accuracy of measurements of length and mass is ensured by the arrangements in connection with the International Office of Weights and Measures at Bréteuil. Some recent comparisons of standards gave a probable error in length of 1/20,000mm., while that for mass was 4/1000 mgr. The determination of weight has been carried to such a pitch of accuracy, that it has been found possible, at Bréteuil, at Monaco, and at Rome, to measure the slight differences of weight produced by varying the height above the ground by a few metres. For the measurement of time there has been no necessity of fixing a conventional standard. The marvellous invention of the pendulum has made it possible to subdivide almost indefinitely the natural fundamental unit, the duration of the rotation of the earth. In the determination of longitudes the error has been reduced to one or two hundredths of a second. Hipp's chronoscope, which may be called a microscope for time, enables the observer to subdivide time to a thousandth of a second. The impulse given to biological research by such instruments has been astonishing. The time of reaction to the various sensory stimuli has been fixed at 136 thousandths of a second for sound, at 150 for light, 133 for touch, 359 for taste, and 443 for smell, while the velocity of propagation of a nervous impulse has shown itself to be 37m. per second. In artillery, the chronoscope has been utilized for the study of the initial velocities of projectiles, and for the tracing of diagrams expressing the relations between spaces, times, and explosive pressures. Errors of observation may be due to the imperfection of the senses, to unavoidable faults in the construction of the instruments, and to external influences. These may be classified according as they are constant or accidental, or better as periodical or otherwise. Most of the errors due to the observer, and of those due to external influences, are periodical, and may be eliminated by repeating the observations under varying conditions. The calculus of probabilities shows that the precision of results, so far as the elimination of purely accidental errors is concerned, increases with the square root of the number of observations. But experience shows that beyond a certain number of observations the increase of precision is illusory. This is probably due to the existence of other errors of a constant character which escape analysis, and from which it is not possible to protect the observations. Experiment also proves that for all kinds of work the maximum error does not exceed a certain limit, which is a function of the mean error. For angular measurements, this does not exceed three times the mean error, so that according to Gauss's law of errors it would be safe to lay 1000 to 1 against the chance of an error greater than 3·2 times the mean error. The observer himself must above all have physical qualities enabling him to use his senses under the best possible conditions. In addition to well-trained senses and facility in managing his instrument, he must have a clear mind, a correct judgment, and a sound scientific preparation for the research he undertakes. Concentrated upon his research, he must abstract himself from the surroundings among which he lives, and possess a spirit unimpassioned enough to subject himself to a purely objective criticism. In concluding, the speaker pointed out that there is at present no science which treats of measurement in general, as a preparation to all the sciences which aim at quantitative results. Many treatises on astronomy, on geodesy, on physics are prefaced by theories of instruments and the compensation of errors. But even those works which profess to treat of the art of measuring are usually limited to geodetic and topographic measurements. It is to be hoped that this important vacancy may soon be filled up, and that a *Science of Measurement* will unite the elements dispersed among the various sciences in one compact and harmonious whole.

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