in the valleys. The hills covering most of the country, of hard and compact red clay, through which blocks of granite crop largely up, are not fertile. To the west of the capital, in the very centre of the province, is a large plain, about 30 km. long by as many broad, formerly a lake or marsh, now an immense field of rice, where emerge hamlets and houses like so many islets. There is also an interesting account of the Fuegians. The fluctuations of the Indian population in the United States are discussed by M. de Semalle in an article to which M. Simonin shortly replies. The kingdom of Perak, the Peninsula of Malacca, is described by M. De La Croix. Commandant Gallieni, of the French Naval Infantry, furnishes a mass of information on the races and populations of the Upper Niger, while Dr. Audray relates at considerable length his personal impressions and reminiscences of Hué during the eighteen months he passed there at the French Legation. M. Fernandez also communicates a paper on the Argentine Republic.

THE *Bulletin of the American Geographical Society* has a paper on the Philippine Islands by Dr. Kneeland, and another on the currents of the Pacific Ocean, by Dr. Antisell.

IN an article in the last number of the *Bremen Geographical Journal* on the inhabitants of the Chukche Peninsula, in the north-east extremity of Asia, Dr. Aurel Krause, after a brief sketch of voyages of discovery and scientific expeditions to that region, sums up the views of the different authorities with reference to the population of the peninsula, and endeavours to reconcile and supplement them with immediate observations of his own. As the result of his studies he distinguishes two different races on the peninsula—the Chukches and the Eskimo. The Chukches, again, are either nomadic or settled. The nomadic Chukches, who are also distinguished by the possession of reindeer, are scattered over the country to the west of Behring Strait, as far as Chaun Bay and the sources of the Great and Little Anjui, and south to the Anadyr River, some 5000 (German) square miles of land, with a population hardly numbering over 2000. The settled Chukches dwell on the shores of the Arctic Ocean from Chaun Bay to Behring Straits, and in some spots on the east coast in villages counting up to forty huts. There is also a third class of Chukches, intermediary between the aristocratic reindeer proprietors and the fishers, a class of merchants. A different race, looked down upon by the Chukches, occupy the south coast from Point Chaplin (or Indian Point) to Anadyr, as also parts of the east coast. That these are of the same race as the Eskimo of the opposite American coast their mode of living, their language, and bodily structure testify beyond all doubt, according to Herr Krause, his opinion on this point differing from that of the *Vega* staff. According to Dall these Eskimo are slowly drifting southwards towards Kamtschatka. The Eskimo on the Asiatic side of Behring Straits, including those of St. Lawrence Island and of the Diomedes Islands, should hardly exceed 2000. An ethnographical map and a list of Chukche and Eskimo words in connection with the Chukche Peninsula are appended to this valuable paper.

DR. EMIL RIEBECK of Halle, the well-known traveller, is preparing for a second African journey, which will be directed to the Niger. He will be accompanied by the naturalist Herr G. A. Krause, well known as an excellent linguist and mathematician.

THE NOVEMBER MEETING OF THE NATIONAL ACADEMY OF SCIENCES[1]

FOR the first time in nineteen years, and the second time in its history, the National Academy held its mid-year meeting in New Haven, November 13–16. Thirty-three of the ninety-three members were in attendance, and during its four days' session twenty papers were presented.

The meeting was conspicuous for the discussion which most of the papers called forth, and for the general participation of the members in these discussions. It was interesting also, for the report of the committee on the solar eclipse of last May, which included the detailed reports of the expedition to Caroline Island, undertaken under the auspices of the Academy, by the principal participants, Profs. Holden and Hastings. It will further be remembered by the members from other cities for the marked hospitalities they received at the hands of their *confrères* of New Haven, and for its many social pleasures, culminating in the brilliant public reception given them by the president, Prof. Marsh, at his residence. The new buildings recently finished, or in process of erection, for the furtherance of scientific research and instruction in Yale College, were also examined with interest, together with the treasures of the Peabody Museum, where the finely-mounted collections of Profs. Verrill and E. S. Dana, and the fossil vertebrates of Prof. Marsh, called forth much admiration.

The generous discussion to which the papers gave rise was provoked at the very start by the paper of Dr. Graham Bell upon the formation of a deaf variety of the human race, which had a broad, practical interest, and which consumed the entire morning session of the first day. Mr. Bell claimed that, from purely philanthropic motives, we were pursuing a method in the education of "deaf-mutes" distinctly tending to such a result, supporting his assertions by statistics drawn from the published reports of the different institutions in this country devoted to the care of these unfortunates. They are separated in childhood from association with hearing-children, and taught what is practically a foreign language—a practice which isolates them from the rest of the community throughout their lives, and encourages their intermarriage. Such marriages were increasing at an alarming ratio, and with calamitous results. As a remedy for this danger, Dr. Bell would have the children educated in the public schools, thus bringing them into contact with hearing-children in their play, and in instruction wherever they would not be placed at a disadvantage, as in drawing and blackboard exercises. He would also entirely discard the sign-language, and cultivate the use of the vocal organs, and the reading of the lips.

The report on the solar eclipse covered a variety of topics, and will fill some hundred and fifty printed pages. In presenting it, Prof. E. S. Holden merely touched upon the principal points, and gave the leading results, in much the same form as they have already been given in this journal. The objects of the expedition were successfully carried out; and Prof. Holden regarded his special work—the search for a possible planet interior to Mercury—as proving the non-existence of the small planets reported by Profs. Watson and Swift.

Dr. C. S. Hastings read in full the greater portion of his report upon the spectroscopic work, which concluded with a critical review of the generally-received theories of the solar atmosphere, and suggested, instead, that the corona was a subjective phenomenon, largely due to the diffraction of light.

The presentation of these reports occupied the entire morning session of Wednesday, and their discussion the greater part of the afternoon session.

In criticising the current use of the word "light" in physics, Prof. Newcomb opened a long and interesting discussion. He urged that photometric measurements were comparatively valueless, because they estimate a part only of the radiant energy of the sun; whereas the quantity which should be determined was the number of ergs received per square centimetre. Prof. Langley, however, asserted that it would be impossible to estimate the radiant energy received from the stars with our present appliances; not all the stars combined would produce deflection, even in so sensitive an apparatus as the bolometer.

Another feature of marked interest was Prof. Rowland's exhibition of photographs of the solar spectrum, obtained by his new concave gratings, by which he had prepared a map of the spectrum much more detailed than heretofore secured, and free from the defects of scale found in previous photographs.

Prof. Asaph Hall communicated the results of his researches upon the mass of Saturn, based upon new measurements of the distances of the outer satellites. He determines the mass of the sun to that of Saturn to be as 1 to 1/3482.

Prof. Brewer took the occasion of the Academy's meeting in the city of his residence to exhibit samples of his experiments of many years' duration upon the subsidence of particles in liquids. They showed the action of saline and organic matter, of acids and of freezing, upon the precipitation of sediments. Most of the samples had been undisturbed for five or six years, and showed varying degrees of opalescence, resulting from the suspension of matter in the fluid.

We have mentioned only the more important papers, or those which provoked a fuller discussion than usual. The following complete list will show how largely the physical side of science predominated at the meeting. In astronomy, besides the reports on the eclipse of May 6, papers were read by A. Hall, on the mass of Saturn; by S. P. Langley, on atmospheric absorption;

[1] *Science*. From advance sheets; favoured by the Editor.

and by O. T. Sherman (present by invitation), on personality in the measures of the diameter of Venus: in mathematics, by S. Newcomb, on the theory of errors of observation, and probable results: in physics, by S. Newcomb, on the use of the word "light"; by W. H. Brewer, on the subsidence of particles in liquids; and by H. A. Rowland, on a new photograph of the solar spectrum: in meteorology, by E. Loomis, on the reduction of barometric observations to sea-level: in geology, by T. S. Hunt, on the Animikie rocks of Lake Superior; by J. D. Dana, on the stratified drift of the New Haven region; by B. Silliman, on the mineralogy and lithology of the Bodie mining district; and by J. S. Newberry, on the ancient glaciation of North America: in chemistry, by W. Gibbs, on phospho-vanadates, arsenio-vanadates, and antimonio-vanadates, and on the existence of new acids of phosphorus: in physiological chemistry, by R. H. Chittenden (present by invitation), on new primary cleavage forms of albuminous matter: in palæontology, by J. Hall, on the Pectinidæ and Aviculidæ of the Devonian system; and by O. C. Marsh, on the affinities of the dinosaurian reptiles: and in anthropology, by A. G. Bell, on the formation of a deaf variety of the human race; and by J. W. Powell, on marriage institutions in tribal society.

The report of the Committee on Glucose, appointed by the President in conformity with a request from the Governmen', was accepted by the Academy, and will be transmitted to Congress with the President's report. This will also embody the proceedings of recent meetings of the Academy, the report of the Committee on Alcohol, and that on the eclipse of the sun, together with the thanks of the Academy to the Secretary of the Navy and the officers of the *Hartford* for their cooperation in the expedition to Caroline Island. It will also include an expression of the approval of the Academy of the efforts now making to secure a system of uniform time.

The next stated session of the Academy will be held in Washington in April next, and it is probable that the following mid-year session will be held in Cambridge.

RIPPLE-MARKS[1]

IN the first series of experiments a cylindrical vessel, like a flat bath, with upright sides, was placed on a table, which was free to turn about a vertical axis. Some fine sand was strewn over the bottom to a depth of about an inch, and water was poured in until it stood three inches deep over the sand. It was found that rotational oscillation with a jerking motion of small amplitude gave rise almost immediately to beautiful radial ripples all round the bath. If the jerks were of small amplitude the ripples were small, and if larger they were larger. The radiating ripples began first to appear at the outer margin of the bath and grew inwards; but the growth stopped after they had extended to a certain distance. If the jerking motion was violent, ripples were not formed near the circumference, and they only began at some distance inwards.

An analysis of the observations was made on the hypothesis that the water remained still, when the bath oscillated with a simple harmonic motion. The problem was to find whether λ, the wave-length of ripple (in inches) was directly proportional to v, the maximum velocity of the water relatively to the bottom during the oscillatory motion; also to find the values of v_1 and v_2, the least and greatest velocities of the water compatible with the formation of ripple-mark.

It appears that, for the particular sand used, v_1 is half a foot per second, and v_2 a foot per second; and that the wave-length of ripple, λ, is $\cdot 00245v$ when v is measured in inches per minute. The several results were as fairly consistent with one another as could be expected. The hypothesis that the water as a whole executes a simple harmonic oscillation relatively to the bottom is not, however, exact, and does not give the maximum velocity of the water in contact with the sand relatively thereto. The quantity called v is not in reality the maximum velocity of the water in contact with the bottom relatively thereto, but it is 6·283 times the amplitude multiplied by the frequency. Thus we cannot conclude that a current of half a foot per second is just sufficient to stir the sand. In the state of oscillation corresponding to v, it is probable that part of the water at the bottom is moving with a velocity much greater than half a foot per second relatively to the sand.

[1] "On the Formation of Ripple-mark in Sand." Abstract of a paper by G. H. Darwin, F.R.S., Plumian Professor and Fellow of Trinity College, Cambridge, read before the Royal Society on November 22, 1883.

It was after making these experiments that what appears to be the key-note of the whole phenomenon was discovered.

A series of ripples extending inwards for some distance having been made by oscillation, and the water having come to rest, the bath was turned slowly and nearly uniformly round. The uniform current flattened the tops of the ripples, but made the lee-side steeper.

It was conjectured that there would be eddies or vortices on the lee-side, and in fact minute particles lying on the surface of the sand were observed to climb up the lee-slope of the ripples apparently *against* stream. This proved conclusively the existence of the suspected vortices.

If when the bath was at rest a sudden motion was given in one direction, the sand on the lee-side of each ripple was observed to be churned up by a vortex. By giving a short and sudden motion the direct stream might be seen to pile up the sand on the weather-side and the vortex to pile it up on the lee-side. The sand so displaced formed two little parallel ridges, that on the lee-side being a little below the crest of the ripple-mark.

For the purpose of examining the vortices a glass tube was drawn out to a fine point and fitted at the other end with a short piece of india-rubber tube. With this a drop of ink could be squirted out at the bottom of the water. This method was adopted in all subsequent observations, and it proved very valuable. It may be worth mentioning that common ink, which is heavier than water, was better than aniline dye.

A drop of ink was placed in the furrow between two ripples; as soon as the continuous stream passed, the ink was parted into two portions, one being sucked back apparently against stream up the lee-side of the ripple-mark, and the other being carried by the direct stream towards the crest. These points being settled, it remained to discover how the vortices were arranged which undoubtedly must exist in the oscillatory formation of regular ripples.

The observations were made in two ways, first with a glass trough so arranged that it could be gently rocked by hand, and secondly with an oscillating sheet of glass.

When the trough is half filled with water, and sand is sprinkled on the bottom, it is easy to obtain admirable ripple-marks by gently rocking the trough.

When a very small quantity of sand is sprinkled in and the rocking begins, the sand dances backwards and forwards on the bottom, the grains rolling as they go.

Very shortly the sand begins to aggregate into irregular little flocculent masses, the appearance being something like that of curdling milk. The position of the masses seems to be solely determined by the friction of the sand on the bottom, and as soon as a grain sticks, it thereby increases the friction at that place.

The aggregations gradually become elongated and rearrange themselves. As soon as the formation is definite enough to make the measurement of the wave-length possible, it is found that the wave-length is about one-half of what it becomes in the ultimate formation.

Some of the elongated patches disappear, and others fuse together and form ridges, the ridges then become straighter, and finally a regular ripple-mark is formed, with the wave-length double that in the initial stage.

If, after the formation of regular ripples, and the deposition of a drop of ink at the bottom, a very gentle oscillation be started, the layer of ink on the crest of a ripple becomes thicker and thinner alternately, swaying backwards and forwards; then a little tail of ink rises from the crest, and the point of growth oscillates on each side of the crest; the end of the tail flips backwards and forwards. Next the end of the tail spreads out laterally on each side, so that a sort of mushroom of ink is formed, the stalk of the mushroom dancing to and fro. The height of the mushroom is generally less than a millimetre.

The elongated hollows under the mushroom are the centres of vortices, and the stem is the upward current. If the ink be thick, these spaces are clouded, and the appearance is simply that of an alternate thickening and thinning of the ink on the crest. The oscillations being still gentle, but not so gentle as at first, streams of ink from the two mushrooms on adjacent crests creep down the two slopes into the furrow between the adjacent ridges, and where they meet a column of ink begins to rise from the part of the water whose mean position is in the centre of the furrow.