Besides the seasonal variations, there was a gradual lowering of the temperature which produced the phenomena known as Glacial, and which characterized the Glacial period, as it is generally termed. The appearance of man at this stage may be conveniently studied from the point of view of the river deposits of Crayford, in Kent, a place remarkable for the large number of mammoths, bisons and horses, which have there been exhumed. Numerous flint splinters of unmistakeable human workmanship were discovered in the Spring of the present year, under conditions which indicated the exact spot on which an ancient hunter sat and chipped them, and these chips being so little disturbed that it was found possible to put together several large masses, and to restore some of the original nodules from which the implements were made. In one case I was fortunate enough to discover an implement rudely chipped all around which indicated that the primeval hunter of the mammoths, bisons and horses of that neighborhood was in the same state of culture as the man who hunted reindeer in the valley of the Thames in the next or the latest stage of the Pleistocene period. The river valleys of the south of England are covered with sheets of gravel termed river drift, and these contain vast numbers of reindeer, as well as bisons and horses, and were accumulated at a time when the climate was severe. In these, numerous implements were discovered, extending from Peterborough, in the north, as far as the channel. Similar implements are also met with in France, and occur .n Spain, Italy, Greece, Northern Africa, and Egypt; they also occur in Asia Minor, and have been found throughout the peninsula of India. They indicate a primeval condition of savagery from which mankind has emerged, which was uniform over the whole of this area. It is not a little strange that the river-drift hunter should have used implements of precisely the same shape and material in the Indian jungles, in the forest-clad shores of the Mediterranean, and in the wilds of Middle and Northern Europe. No human remains assignable to this age are sufficiently perfect to allow of our passing opinion of man's physique, but they tell us that he was a man and not a "missing link." The researches of Dr. Abbott on the river gravels of Trenton appear to establish the fact that the river-drift man was an inhabitant of America during the time when the mammoth was living in the valley of the Delaware. The paleolithic implements of the ate Pleistocene river beds are rude and simple, although they show a considerable advance from the simple flake, which is the only trace left by the man of the middle Pleistocene. As regards the man of that period, it is probable that the plateau of Central Asia was the centre from which the race diverged.

On the bottom of the caves of Creswell, in Yorkshire, were found river-drift implements in association with vast numbers of gnawed bones of both living and extinct animals, brought in by hyenas, while in the upper portions were found implements of a higher type, composed of flint and carved bone. Among these was the incised figure of a horse; these imply a higher type than that of the river-drift, and belong to a state of culture known as that of the cave man. It seems to be unquestionable that the cave men were preceded in their habitations by the river-drift men, in some places at least, and that of the two sets of implements now found the ruder belongs to the latter race. It has been a debated question whether the civilization of the cave man was the outcome of the development of that of the river-drift man. The evidence seems to indicate that they must be classed either as two distinct races or as two sections of the same race, which found their way into Europe at widely different times—the river-drift men being of far greater antiquity in Europe than the others. The discoveries of late years tend to confirm the identification of the cave men with the Esquimaux. We infer that the cave men clothed themselves with skins, for instruments for dressing skins are found precisely like those now employed for that purpose by the Esquimaux. That they wore gloves is shown by carvings which represent them, and there is reason to believe that they were in the habit of decorating their persons in various ways. The art of representing wild animals in carvings and by sculpture was carried to a high stage of excellence by the cave-dwellers, and it is doubtful if an artist of the present time could do better work, or even as good, with the rude instruments used by them. One of the most interesting examples of their skill is shown by representation of a mammoth, and we know that the extinct creature is faithfully por-trayed, because its remains have come down to us perfectly preserved in the ice of the northern latitudes. In various ways the habits of the cave men correspond to those which now prevail among the Esquimaux.

NATURAL SELECTION.

A curious instance has occurred showing the difficulty of explaining the true theory of "Natural Selection," even to scientific men; it is therefore not surprising to find that those who are opposed to the principle from religious motives, fail to realize what is understood by the term. In a letter to *Nature*, Mr. Charles Darwin states he is sorry to find Sir Wyville Thompson does not understand this principle of natural selection as explained by himself and Dr. Wallace, as, if he had done so, he would not have wrttten a sentence found in his introduction to the voyage of the *Challenger*, as follows; "The character of the abyssal fauna refuses to give the least support to the theory which refers to the evolution of species to extreme variation, guided only by natural selection." This, says Mr, Darwin, is a standard of criticism not uncommonly reached by theologians and metaphysicians, when they write on scientific subjects, and asks, "can Sir Wyville Thompson name any one who has said that the evolution of species depends only on natural selection?" and continues, "as far as concerns myself, I believe no one has brought forward so many observations on the effect of the use and disuse of parts, as I have done in my 'Variations of Animals and Plants under Domestication,' and those observations were made for that special object. I have also there adduced a considerable body of facts, showing the direct action of external conditions on organisms, though, no doubt, since my books were published, much has been learnt on this head."

PROPAGATION OF SOUND BY LIGHT IN 1811.

In searching a volume, dated 1811, for papers relating to the introduction of illuminating gas, we noticed a paper by Modeste Parolette, entitled "Inquiries Concerning the Influence of Light on the Propagation of Sound," taken from the *Journal de Physique*, Vol. LXVIII.

Although Parolette cannot be said to have anticipated those physical facts, the knowledge of which enabled Edison to design that wonderful instrument, the *Tasimeter*, and since developed by Bell in his *Photophone*, still Parolette seemed to be on the right track.

In opening his subject, Parolette states that the object of his inquiry was the relation which subsists between the action of light and the vibrations of sonorous bodies, and he actually made an instrument for measuring the effect of light on sound-vibrations, and called it the *Phonometer*.

Parolette's experiments were rude compared with those of more recent date, but it most be remembered that they were made seventy years ago. He used no mirrors for concentrating a beam of light, but relied merely on the natural properties of light without such aids. He says, "As it is known that the vibrations of elastic fluids are always analogous to those of the particles of the sounding body, and that if two strings, belonging to two instruments, be in unison, when one is touched the other will vibrate and emit a perceptible sound; I availed myself of these properties in the construction of my apparatus, and in determining the object of my inquiry.

The *Phonometer* consisted of two violins placed on a horizontal plank ten feet long and eight inches wide. Having tuned these instruments to the Paris diapason, he fixed a piece of paper to the second string of one of them to serve as an index during the course of his experiment—one violin being fixed and the other moving in a grooved sliding rest. The second string was then vibrated in a uniform manner, which produced an oscillatory motion, which was heard on the corresponding string of the other violin. The paper on the string showed the vibration at a distance, and the violins were separated from each other until the agitation of the paper ceased. This point was marked as the limit of the vibrations and marked 100, the intermediate portion being marked off to represent the one thousandth part of the distance.

Experiments made at noon with this instrument, and often repeated, indicated the same distance within a few thousandths. The whole extent of the scale was seven feet, and this distance was the limit of the greatest propagation of sound under the influence of light in the apparatus. Parolette further states that experiments in darkness gave, as a result, a mean temperature of 0.98, and that the mean difference of this propogation at noon and midnight was two degrees on the scale. In conclusion, Parolette tries to explain the results arrived at by stating that during the day, the atmosphere is more nearly saturated with oxygen than in the night, but he says it remains to be proved that this excess is sufficient to cause such a difference in the propagation of sound during the two periods, and adds, " rather, may not light be the true cause of this increased propagation in oxygen and nitrous gas ; as it is known that the former has a great capacity for light, and the latter cannot be formed without its presence." As the velocity of light is 900,000 times greater than that of sound, it does not appear unreasonable to explain, in this way, its effects on the vibrations which proceed from sonorous bodies. J. M.

THE NATIONAL ACADEMY OF SCIENCES.

As the meeting held on the 16th of November last, and those of the three following days, were devoted to the reading of scientific papers only, little executive business was transacted and no new members were elected.

At the meeting of the Council the following deaths of members were announced :

J. Homer Lane, of Washington, in May. S. S. Haldeman, of Chickies, Pa., in September, and Count L. S. Portalès, of Cambridge, Mass., in October.

The decease of Professor Benjamin Peirce, of Harvard College, one of the original active members of the Academy, but whose connection with it had been severed, was also announced.

Resolutions, thanking the Trustees of Columbia College for providing rooms for the meeting, and to President Barnard and officers of the college and other members of the Academy in New York for liberal entertainment of its members, were adopted.

THE FOLLOWING PAPERS WERE PRESENTED :

1. On the Basin of the Gulf of Mexico.—J. E. Hilgard.
2. On the Origin of the Coral Reefs of the Yucatan and Florida Banks.—Alexander Agassiz.
3. Observations on Ice and Icebergs in the Polar Regions.—F. Schwatka.
4. On the Duration of the Arctic Winter. —F. Schwatka.
5. Mineralogical Notes.—Benjamin Silliman.
6. The Relationship of the Carboniferous Euphoberia to living and extinct Myriapods.—Samuel H. Scudder.
7. Report on the Dredging Cruise of the U. S. Steamer *Blake*, Commander Bartlett, during the Summer of 1880.—Alexander Agassitz.
8. On Some Recent Experiments in Determining the Electro Motive Force of the Brush Dynamo-electric Lamps operating by Incandescence.—Henry Morton.
9. On the Intimate Structure of certain Mineral Veins. —Benjamin Silliman.
10. On the Ellipticity of the Earth as Deduced from Pendulum Experiments.—C. S. Peirce.
11. On an Improvement in the Sprengel Air Pump.—O. N. Rood.
12. On the Thermal Balance.—S. P. Langley.
13. On the Measurment of Radiant Energy.—S. P. Langley.
14. Causes which Determine the Progressive Movements of Storms.—Elias Loomis.
15. On the Antimony Mines of Southern Utah.—J. S. Newberry.
16. On the Conglomerate Ore Deposits of the United States and Mexico.—J. S. Newberry.
17. On Photographing the Nebula in Orion.—Henry Draper.
18. On Condensers for Currents of High Potential.—George F. Barker.
19. On Sigsbee's Gravitating Trap.—Alexander Agassiz.
20. On the Deposits of Crystalline Iron Ores of Utah. —J. S. Newberry.
21. On the Origin of Anthracite.—T. Sterry Hunt.
22. On the Star-List of Abul Hassan.—C. H. F. Peters.
23. Dimensions of the Brain and Spinal Cord in some extinct Reptiles.— O. C. Marsh.
24. On the Rimravidæ.—E. D. Cope.
25. On the Miocene Canidæ.—E. D. Cope.
26. On a New General Method in Analysis.—Wolcott Gibbs.
27. Note on the Relations of the Oneonta and Montrose Sandstones with the Sandstones of the Catskill Mountains.—James Hall.

ON THE MEASUREMENT OF RADIANT ENERGY.*

By Prof. S. P. Langley.

Sir William Herschel showed that a thermometer indicated more heat beyond the darkest red of the spectrum of a prism than in the brightest part of the color ; therefore, he concluded that light and heat were essentially different things. This view has apparently been confirmed by numerous other European experiments, and has been set forth in all but the most recent text-books, where different curves are drawn to exhibit the light and the heat of the sun. Of late years many leading minds have recognized that these were only different manifestations of radiant energy. Prominent among these is Dr. John W. Draper, who asserted this principle long ago, and who has always maintained that if the heat in a pure diffraction spectrum could be accurately measured, its distribution would be found almost identical with that of light. This was an experiment, which, however, could never have been satisfactorily performed had it not been for the skill of Lewis M. Rutherfurd, Esq., of this city, who has made at his private expense the exquisitely delicate apparatus which can produce pure spectra, with a success far greater than any attained by the most skillful professional artisans of Europe.

By the use of one of these "gratings," made on Mr. Rutherford's engine by Chapman, and the employment of the thermal balance described in another paper, I succeeded in obtaining for the first time full and exact measurements of the distribution of energy in a pure spectrum, where no lens or prism had been used, and of fixing its relative amount, as determined accurately by the wave-lengths of light in all parts of the visible spectrum and in the ultra red. It remained to make some minute corrections for the selective absorbtions of the reflecting apparatus employed. The essential result, however, is of high theoretical interest ; it is, that heat and light as received from the sun are now experimentally proved, so far as such measurements can prove it, to be in essence the same thing. The old delineations of

* Read before the National Academy of Sciences, N. Y., 1880.