world, had been the scene of operations, and the results, though not all that could be desired, are nevertheless well worthy of the time and money expended in obtaining them.

M. André, of the Paris Observatory, a well-known French astronomer, was appointed director of the expedition, whilst to M. Angot, Professor of Physics in the Normal School, Paris, the photographic portion of the work was entrusted. The instruments to be used consisted of five telescopes of various powers; a very complete photographic apparatus which will be described hereafter; a meridian instrument; an apparatus for producing an artificial transit, with electric chronograph carrying four pens attached; and lastly, two instruments for accurately determining the magnetic inclination and declination of Nouméa, which up to the present time have never been exactly known. The largest of the telescopes (7·5 in.), as well as three others (5 in.), was provided with an objective silvered by M. Foucault's process, the fifth having an unsilvered lens of $3\frac{3}{4}$ in. diameter, and of extremely good definition. All the instruments were equatorially mounted, three of them being connected with the chronograph, whilst the other two obtained their time by means of clock and chronometer. The telescope used for the photographic part of the work had an objective of 5 in. diameter and 13 ft. focal length, and was firmly fixed in a horizontal position on stone pillars, the image of the sun being directed along the axis by a large silvered mirror placed outside and moved at will from the interior by means of long wooden rods on either side of and parallel to the telescope. During the transit an assistant stood near this mirror, and at every command "*Découvrez*," removed the cover (placed on the mirror to prevent it becoming heated, and thereby causing distortion of the sun's image), and replaced it immediately after the plate had been exposed. With this apparatus, the daguerreotype process of sensitising a silvered plate of copper by means of iodine and bromine, developing in a mercury bath and fixing with hyposulphite of soda, was alone employed, and with the greatest success.

Though the day was somewhat cloudy, considerably over 100 very well-defined pictures of Venus during the Transit were obtained, together with 130 others, rendered less distinct by the intervention of clouds. When it is known that for several days previous to the 9th, the weather had been so bad that all hopes even of a glimpse of the transit of the planet were abandoned, and that dense clouds hung over the whole sky, and heavy showers of rain fell up to within four hours of the first contact, M. Angot may well be congratulated on the success of his labours. These daguerreotype pictures are not quite $1\frac{1}{2}$ in. in diameter, and were obtained by exposures of the plates varying from $\frac{1}{100}$ to $\frac{1}{50}$ of a second in duration. M. Janssen's method was not employed, but a very simple plan was adopted of placing the sensitised plate in a frame fixed at the focus of the chemical rays, and causing the exposure by sliding in front of it a metallic screen with a slit in it, whose width of course varied with the time necessary for exposure. A clock connected electrically with the sidereal one in the main observatory was placed in a convenient position above the telescope, and the instant of each exposure accurately noted. The assistants in this work, four in number, were all convicts, who performed their share with the neatness and readiness for which Frenchmen, whatever their position in life may be, are so remarkable; and, indeed, nothing has struck me more during the progress of the work here than the aptitude which seems innate in the French race for work of this kind; and it is no disparagement to English soldiers to say that it would have taken them days to learn to read chronometers with the accuracy which their French brethren-in-arms acquired in a few hours and apparently without the slightest difficulty. The main features in all the telescopic observations are the $3\frac{1}{2}$ minutes' difference between the estimated and observed times of first contact, the absence of the drop, and, in the case of the instruments furnished with silvered objectives, the clear tangential contact of the planet and the sun's limb, which enabled four out of the five observers to obtain the instant of second contact with very great accuracy. With these objectives, which appear to be especially well adapted for observations of this nature, the planet was seen to pass clear and distinct on to the sun's disc, without any appearance of distortion or cloudiness whatever; but with the unsilvered objective an appearance was observed as if a drop, such as those described by English astronomers, was about to form. Without forming, however, it changed almost imperceptibly into a tremulous haziness, which rendered it impossible to say when the actual contact took place, and compelled the observer to note two instants, one when this haziness first appeared, and the other when it had so far disappeared in the increasing brightness in the rear of the planet that he was confident that Venus was fairly on the solar disc. These two instants are separated by an interval of thirty-four seconds, and their mean corresponds within two or three seconds with the instant of tangential contact observed with the other instruments. Whether the slight cloudiness of the sky, or a constant error peculiar to all unsilvered objectives, or the fact that the latter telescope was focussed on a spot much nearer to the sun's limb than the other instruments, is to be put down as the cause of this difference or not, seems at present a matter of doubt only to be cleared up when other observations with unsilvered lenses are recorded.

The third and most important contact in New Caledonia was not observed, owing to a cloud which, much to our chagrin, strayed over the sun's face some 6′ before the estimated time of egress, and completely shut out our view for about 20′, after which the fourth contact was observed, but with a considerable degree of uncertainty, on account of the undulatory appearance of the sun's limb.

I may mention, in conclusion, that the times of duration of the whole transit, *i.e.* the interval between the first and fourth contacts, obtained by three of the observers, differed by only 8″, but these were considerably at variance with the estimated duration of the transit as given in the *Nautical Almanac*. Besides MM. André and Angot, three French officers, Capts. Derbés, Bertin, Ribout, and Mr. Abbay, took part in the observations. A.

On board the *Rangatira*,
Jan. 5, 1875

SCIENTIFIC REPORT OF THE AUSTRO-HUNGARIAN NORTH POLAR EXPEDITION OF 1872–74 *

THE real object of the expedition was not particularly that of reaching high latitudes, but rather the investigation of the large unknown sea north of Siberia; the explorers thought they might eventually reach Behring's Straits, without cherishing very sanguine hopes on this point. When during 1871 Lieut. Weyprecht made a preliminary expedition into those regions, he found the whole large sea between East Spitzbergen and Nowaja Semlja so completely unknown, that in spite of his stopping six weeks at Tromsö, and making inquiries of all Finnmark skippers and whalers, he could not learn anything definite as to the conditions of climate and ice in those parts; few vessels had succeeded in reaching the 76th degree of north latitude. During the two Austrian expeditions this unknown sea has been investigated from 40° to 70° East long. (from Greenwich), and beyond the 79th degree of latitude on the west side and the 80th on the east side; an extensive, hitherto unknown tract of land has been discovered, and Lieut. Julius Payer has made sledge journeys into this land, reaching very nearly 83° N. lat.

In 1871 the explorers had found the sea completely free from

* Die 2. Oesterr.-Ungarische Nord Polar Expedition unter Weyprecht und Payer, 1872–74. (Petermann's Geogr. Mittheilungen, 1875; heft ii.)

ice as far as 78° N. lat., north of Nowaja Semlja, and their intention at the second expedition was to investigate this sea in an easterly direction, taking the Siberian coast as basis, and depending on the influence of the great Siberian rivers, whose great quantities of comparatively warm water probably free the coast from ice almost every summer.

Unfortunately the year 1872 was one of the most unfavourable ever seen. Already in 74°·5 N. lat. the explorers found ice; they could only reach Cape Nassau with great difficulty,. and were finally blocked up by packed ice in a locality where, in the previous and following years, there was no ice for one hundred German miles round. They never got within the reach of the Siberian rivers, and the uncertainty with regard to their influence upon the ice along the Siberian coast is still the same as ever. But one point is clearly proved, namely, that the conditions of ice between Spitzbergen and Nowaja Semlja are highly variable from year to year; this circumstance, more than any other, speaks against the advisability of future expeditions to be made on the basis of Franz-Joseph's Land. In 1874 the explorers found the ice again in the same position as in 1871; there is perhaps a certain periodicity in this.

Lieut. Weyprecht formerly thought that marine currents were the principal cause of the general motion of the ice in Arctic regions; he is now of a different opinion, as he maintains that during the drift of their vessel, which was frozen in, in packed ice, and drifted in this state for over fourteen months, the influence of currents was imperceptible compared to that of winds upon the drifting ice. The existence of Gulf-stream water in the great area between Norway, Spitzbergen, and Nowaja Semlja is undeniable; the current cannot, however, be traced directly by its course, but rather by the unproportionally high sea-temperatures in those high latitudes. As a natural consequence of this, the Gulf-stream does not regulate the limits of ice, but the ice, set in motion by winds, regulates the limits of the warmer Gulf-stream water, depriving the same of the last degrees of heat which it contains. A comparison of the *Hansa* drift with the winds would show whether on the east coast of Greenland the drift of ice is only produced by the latter; Sir L. M'Clintock proves with figures that this decidedly is the case in Baffin's Bay. The speed of the drift of course depends upon the force of the winds, local conditions, vicinity of coasts, and the more or less open water. The great influence of the wind upon the ice-fields is explained by their ruggedness; each projecting block represents a sail.

In the vicinity of coasts it is somewhat different; immense currents are often perceived there, originating through the tides, or perhaps through the motion of the ice itself and the winds.

There is a decided general tendency in the ice to move southward during the summer; the reason of this may be the flowing off of melted water in all directions, which causes a breaking-up of the whole Arctic mass of ice. But all other influences upon the motion of the ice are nearly imperceptible when compared to that of winds, and can only be traced in their most general effects. It is quite certain, however, that in the south of Franz-Joseph's Land there is a constant flow of ice from east to west, *i.e.* from the Siberian sea. If the field of ice which held Lieut. Weyprecht's ship a prisoner had not attached itself to Wilczek Island, it would have drifted towards the northern end of Spitzbergen; he arrives at this conclusion from observing the winds of last winter.

To the influence of winds Lieut. Weyprecht also ascribes the existence of open water near all west coasts in those regions: he found the main direction of winter-storms in Franz-Joseph's Land to be E.N.E.; the ice under west coasts is therefore constantly broken up. Lieut. Payer, on the northernmost point he reached, was stopped from extending his sledge journeys further by open water near a west coast, upon which he was travelling.

Also, with regard to quality, the ice in those seas is very variable. While in the summer of 1873 the explorers could not see the end of the field in which their ship was frozen in, they never met fields of such an extent during their retreat; also, with regard to thickness, there was great variety. In 1873 their field formed an irregular frozen mass, with high ice walls in all directions and immense protuberances; in 1874 they found much greater evenness, and although thawing had begun so late that they almost perished with thirst during a month and a half, the ice was so thin in some places at the end of July that they often broke through while drawing their sledges. During the drift the whole mass was doubtless packed very closely; the field, in spite of the constant drifting motion, did not turn round, the bow of the ship pointing always in the same direction; only in September, when the field was greatly reduced, it began to turn; in October and November large holes were seen in it in the vicinity of the coast, towards the south.

Whether Franz-Joseph's Land can again be reached by ship, Lieut. Weyprecht thinks mainly dependent on favourable conditions of weather and ice; in any case a very warm summer will be necessary, and then it could be done only late in the year. As the most favourable point to start from in such an expedition, he indicates 45° East long., as here he found the barrier of ice in 1871 to be fifty German miles more to the north than in 60° E. long.

In the preliminary expedition of 1871, Lieut. Weyprecht found sure signs of the vicinity of land in 43° E. long. and 78°.75 N. lat., and accordingly he proposed this unknown land as the basis for future expeditions sent to reach the pole. The mysterious Gillis-Land is situated upon 30° E. long. The south coast of Franz-Joseph's Land was seen by Payer at least as far as 50° E. long. Lieut. Weyprecht now thinks he may be permitted to conclude that these three points are connected. Thus Franz-Joseph's Land would become greatly extended in a western direction. Numerous icebergs floating along the coast seem to confirm this idea, and it is hardly necessary to point out how much the interest in Arctic investigation would be increased by this idea proving a correct one.

During a year and a half the explorers had constant opportunities closely to observe the behaviour and formation of packed ice. The phenomenon is instructive, as it is the same in the whole of the Arctic regions. With the exception of land-ice, which clings to the coasts and never reaches far out into the sea, all ice—icebergs as well as fields—is in constant motion, winter and summer; and this, as has been shown, is through the influence of winds. The motion, however, is a different one almost with every field, and thus a certain pressure results wherever two fields touch; this naturally leads to the breaking up of the fields, and the contraction of the ice during sudden low temperatures plays its part in a similar way. If one considers the great extent of the fields, sometimes of many miles, and their enormous masses, one can easily imagine the colossal forces which are active in these phenomena, and the greatness of their effects. When two fields meet, a combat body to body ensues, often lasting only a few minutes, but sometimes even for days and weeks. The edges are then turned up on both sides, upwards and downwards, an irregular wall of ice consisting of wildly-mixed blocks begins to build itself, the pressure increases more and more, masses of ice eight feet long and broad are lifted 30 to 40 feet high, and then fall to make room for others. At last one of the fields begins to shift itself for some distance underneath the other one; often they separate for a while, only to renew the struggle. But the end of it always is that the intense cold unites all into one solid mass; a single field results from the two, and the next storm or quick change of temperature cracks the new field in some other direction, the pieces renewing the old struggle. This is the origin of the ice-fields, which are quite irregular above and below, sometimes only consisting of blocks that have frozen together, and filling up the whole Arctic region as so-called pack-ice.

During winter, snow-storms fill up all smaller irregularities completely. As soon as the sun begins its action, the crushing of the ice decreases, the winterly ice walls diminish considerably, immense masses of ice and snow are melted, and the resulting sweet water forms large lakes on all the lower even parts of the fields. During the summer, about four feet of ice are thus melted down from above; of course the whole field and everything upon it—the explorer's ship, for instance—is raised so much higher. In the following winter it grows below in the same ratio, and thus the whole of the ice is in an uninterrupted process of renovation, from below upwards; we may conclude that all the old pack-ice is replaced by new in the course of two years.

The spaces of open water which naturally occur during the great crushes are soon again covered by fresh ice in winter; the intense cold keeps repairing the broken field of ice. Lieut. Weyprecht observed that within twenty-four hours, and with a temperature of −30° to 40° R. (37·5 − 50° C.), the new crust becomes about a foot thick. The salt of the sea-water has not time to be displaced entirely, the formation of ice going on too quickly, and a considerable quantity freezes into the upper strata of the ice; this quantity decreases downwards as the ice takes more time to form. Beginning at a certain thickness, the ice is almost free from salt. The upper strata, however, on account of the salt they contain, attract moisture in a great degree, and form a tough, leathery mass which bends under foot without breaking. This, however, is only the case with new ice, as after a short time the salt crystallises out of the ice, and the surface covers itself with a snowy layer of salt, sometimes reaching two inches of thickness. Even in the most intense cold this layer retains so much moisture that it makes the impression of a thaw; only little by little, evaporation and drizzling snow do their work, and the ice itself becomes brittle.

In this way almost all the salt, which was frozen in, crystallises out, and is washed off and back into the sea by the melted water in the next summer. The melted water at the end of the summer is therefore almost free from salt, and has a specific gravity of 1·005. It is evident that a smooth plane of ice, as is found on sweet water, is a very rare occurrence in Arctic regions.

The finest and most interesting phenomenon, the only change in the long night of winter, is the Aurora Borealis; no pen can describe the magnificence of this phenomenon in its greatest intensity. In February 1874 Lieut. Weyprecht saw an aurora, which ran beyond the zenith from east to west like an immense stream of fire, and constantly showed intense prismatic colours running like flames, and as quick as lightning, from one side of the horizon to the other. At the same time flashes of fire came from the southern horizon and reached to the magnetic pole; it was the most stupendous natural display of fireworks he had ever been able to imagine. With regard to the intensity of the aurora, Lieut. Weyprecht says he can prove by data that it differs, independently of the geographical latitude, in the different parts of the Arctic zone, and that the district he visited was a maximal district; when the sky was clear, traces of auroræ could be uninterruptedly observed; in the second winter he even kept an "aurora journal," which, however, gave only few positive results, and was left behind in the ship. The phenomenon is past all description and classification, changing constantly and showing new forms at every moment. Lieut. Weyprecht was never able to describe the origin of an aurora; the phenomenon is there, and it is impossible to say whence it came.

Only in a very general way three forms of auroræ can be distinguished: first, quiet, regular arcs, slowly passing from the southern horizon and disappearing in the northern one; then, bands of light of great variety of forms, ever changing place and intensity; and lastly, the so-called corona, *i.e.* radiations from or towards the magnetic pole. Generally the colour is an intense white with a greenish hue; with greater motions and stronger radiations the prismatic colours are often seen in great intensity.

Lieut. Weyprecht spent much time and trouble on spectral observations of the auroræ, but unfortunately his spectroscope was too small and imperfect. He could never see more than the well-known green line; compared with the spectral observations of the Swedish Expedition, which were made with much more perfect instruments, his observations are of no value. One interesting fact with regard to the auroræ was, however, ascertained. It was found that upon very intense auroræ storms followed almost every time; this is proved by meteorological data, and Lieut. Weyprecht thinks he is justified in the conclusion that the Aurora Borealis is an atmospheric phenomenon and closely connected with meteorological conditions; he arrived at this conviction through observing hundreds of auroræ, but says he cannot give any positive or important reason for his conclusion.

(*To be continued.*)

JOHN EDWARD GRAY, F.R.S.

WE have to record the death, on Sunday morning last, at his residence in the British Museum, of Dr. J. E. Gray, late Keeper of the Zoological portion of the National Collection.

Dr. Gray was born in 1800 at Walsall, in Staffordshire, being the eldest of the three sons of Mr. S. F. Gray, a chemist of that town. He was educated for the medical profession, and very shortly exhibited his biological taste, by writing a work on the then new "natural" arrangement of plants. In 1824 Dr. Gray was appointed an assistant in the Natural History department of the British Museum, where, with the assistance of Dr. Leach, he commenced the study of zoology to such good purpose that in 1840 he succeeded Mr. Children as Keeper of the Zoological Collection of the Museum. At that time biology held but a small place in popular favour, especially in the eyes of those most active in the superintendenc of the extension of the British Museum. Against the opposing influences thus affecting his department, not the least of which was the antagonism of Mr. Panizzi, Dr. Gray, by his indefatigable zeal and courage to face obstacles, nevertheless succeeded in bringing the national collection of osteological and skin specimens, during the thirty-five years of his keepership, to so high a standard of excellence, that no other museum, not even Leyden itself, is equal to it.

Most of the biological societies which now exist include Dr. Gray amongst their founders or earliest members. The Zoological Society owes much to him, the number of papers communicated to it by him being very great. He was the leading spirit of the *Annals and Magazine of Natural History*, and was the author of the *Zoological Miscellany*, *Knowsley Menagerie*, and other works. In his Catalogue of the Mammals in the British Museum, which is far advanced towards completion, is incorporated much of the author's work in that direction, published originally in separate short papers.

The qualities which most distinguished Dr. Gray as a naturalist were his great industry in combination with an acute perception of minute distinctions. His imperfect acquaintance with anatomy in many of its branches much limited his generalising powers, and in some cases distorted his view of the relative importance of character based only on osteological features. To all students of the groups of animals which were touched upon by Dr. Gray—and there are but few that were not—that author's work will be found invaluable, both from the independent light which it throws on the subject, and from the careful review which it gives of the previous investigations of other naturalists.

Dr. Gray was elected a Fellow of the Royal Society in 1832; he resigned the Keepership of the British Museum at Christmas last. He leaves a widow, but no children.

NEW ORDER OF EOCENE MAMMALS

AT the last meeting of the Connecticut Assembly, February 17, Prof. O. C. Marsh made a communication on a new order of Eocene Mammals, for which he proposed the name *Tillodontia*. These animals are among the most remarkable yet discovered in American strata, and seem to combine characters of several distinct groups, viz., Carnivores, Ungulates, and Rodents. In *Tillotherium*, Marsh, the type of the order, the skull has the same general form as in the bears, but in its structure resembles that of Ungulates. The molar teeth are of the ungulate type, the canines are small, and in each jaw there is a pair of large scalpriform incisors faced with enamel, and growing from persistent pulps, as in Rodents. The adult dentition is as follows:—Incisors $\frac{2}{2}$; canines $\frac{1}{1}$; premolars $\frac{3}{2}$; molars $\frac{3}{3}$. The articulation of the lower jaw with the skull corresponds to that in Ungulates. The posterior nares open behind the last upper molars. The brain was small, and somewhat convoluted. The skeleton most resembles that of Carnivores, especially the *Ursidæ*, but the scaphoid and lunar bones are not united, and there is a third trochanter on the femur. The radius and ulna, and the tibia and fibula are distinct. The feet are plantigrade, and each had five digits, all terminated with long, compressed and pointed, ungual phalanges, somewhat similar to those in the bears. The other genera of this order are less known, but all apparently had the same general characters. There are two distinct families, *Tillotheridæ*, in which the large incisors grew from persistent pulps, while the molars have roots; and the *Stylinodontidæ*, in which all the teeth are rootless. Some of the animals of this group were as large as a Tapir. With *Hyrax* or the *Toxodontia* the present order appears to have no near affinities.