

## OUR ASTRONOMICAL COLUMN

THE SATELLITES.—The following table presents at one view the mean distances of the satellites from their primaries, expressed in equatorial semi-diameters of the latter, and founded upon the most reliable data hitherto available:—

	The Earth.	Mars.	Jupiter.	Saturn.	Uranus.	Neptune.
I. ...	60.27	2.72	5.70	2.98	7.71	14.55
II. ...	—	6.81	9.07	3.83	10.75	—
III. ...	—	—	14.46	4.75	17.63	—
IV. ...	—	—	25.44	6.08	23.57	—
V. ...	—	—	—	8.47	—	—
VI. ...	—	—	—	19.67	—	—
VII. ...	—	—	—	24.80	—	—
VIII. ...	—	—	—	57.28	—	—

It will be seen that the outer satellite of Saturn, Iapetus, is the only one revolving round its primary at a distance similar to that of our moon, with respect to the semi-diameter of the central body. The exterior satellites of Jupiter and Uranus are similarly placed in this respect, and as regards the former planet the reader will remember a suggestion of Sir John Herschel's, that a distant satellite, by which was intended one situate more nearly, as our moon or the Saturnian satellite Iapetus, might be "worth a search." At the end of the last century it was thought that if satellites of Mars existed they might be "distant many degrees from the principal planet," upon which idea the late Prof. D'Arrest argued that a search after a satellite situate many degrees from Mars would be an almost endless task; and further, that a satellite at a maximum digression of seventy minutes of arc would have a sidereal period greater than the synodical revolution of the primary. The same astronomer endeavoured to ascertain, at the opposition of 1864, to what magnitude stars were visible in the vicinity of Mars with the Copenhagen refractor, which has an aperture of about eleven English inches. He considered that a satellite as bright as the twelfth magnitude could hardly have escaped him, and that objects of a fainter class were only visible in such an instrument at distances of eight or ten minutes, and in the case of Mars opportunities of viewing a satellite in such position would occur comparatively seldom. Perhaps the more prevalent idea respecting possible satellites of Mars, prior to their actual discovery, was that they would be "very small and close to the planet." (Hind, in "Solar System," p. 78.)

TYCHO BRAHE'S STAR OF 1572.—It is to be hoped that the vicinity of the famous star in Cassiopeia, with which we are accustomed to associate Tycho Brahe's name, may continue to receive frequent attention, and in particular that the small star, which at present is so near to the most accurate position we are able to obtain of the star of 1572, may be assiduously watched and its brightness determined from time to time by comparison with its neighbours, and not merely by estimation of magnitude. It was Bessel who, as he states in a letter to Olbers, in 1824, first engaged Argelander to work up the position of the Nova Cassiopeæ, with all possible precision. Forty years later Argelander revised his calculations with improved positions for the reference-stars, and obtained a result differing in no material degree from the earlier one. The small star alluded to is so near to Argelander's last position [(differing only fifty seconds of arc), as to be within its possible limits of error; it is No. 129 of the catalogue of stars in the vicinity which was presented to the Copenhagen Academy in January, 1864, and an eleventh magnitude on Bessel's scale. It will be most readily identified by means of the star of the ninth magnitude, No. 300 of Oeltzen's Catalogue from Argelander's northern zones, the position of which for 1878.0 is in R.A. oh. 17m. 32s., N.P.D. 26° 22' 6"; the suspicious object follows Argelander's star 29.6s., and is south of

it 10' 4". The place of Nova for 1878.0 is in R.A. oh. 18m. 2's., N.P.D. 26° 31' 43".

THE AUSTRIAN COMET-MEDAL.—We have received from the Imperial Academy of Sciences at Vienna, the conditions upon which that body has resolved to renew, until further notice, the prizes for the discovery of telescopic comets, and which appear to be similar to those originally issued in June, 1872. The awarding of a prize, which will consist, according to the wish of the receiver, in a gold medal or its money value of twenty Austrian ducats, is connected with the following conditions: (1) Prizes will be awarded only for the first *eight* successful discoveries in each calendar-year, for comets that at the time of their discovery were telescopic, *i.e.* invisible to the naked eye, that had not been previously seen by any other observer, and which could not have been predicted, and it is important to observe that in the case of independent discoveries priority is to be decided by the epoch of the first position. (2) The discovery must be communicated to the Academy of Sciences immediately, by telegraph, where practicable, otherwise by the earliest mail, the Academy undertaking to make it known without delay to several observatories. (3) This first notice must necessarily contain the position and motion of the comet as accurately as they are known, with the place and time of discovery, and is to be supplemented at the next opportunity by later observations. (4) If the discovery should not have been verified by other observers, the prize will only be adjudged "when the observations of the discoverer are sufficient for determining the orbit." (5) The prizes will be awarded in the general sitting of the Academy held at the end of May in each year, and in cases where the first intimation of the discovery arrives between March 1 and May 31, the award will be decided in the general May session in the following year. (6) Application must be made for the prize to the Imperial Academy within three months after the first notice of discovery shall have reached it, later applications being rejected. Finally, the astronomers of the observatory of the University of Vienna are appointed judges, whether the conditions in (1), (3), and (4) have been fulfilled.

## GEOLOGICAL WORK OF THE U.S. SURVEY UNDER PROF. HAYDEN DURING THE SUMMER OF 1877

THE necessity of a careful examination of the various geological formations in the field, and a review by a practical palæontologist of the various districts that have from year to year been surveyed by the different geologists of this and other surveys, has been long felt. Such a work, indeed, was imperatively necessary, before a consistent and comprehensive classification of the formations could be established. This duty was assigned to Dr. C. A. White, the palæontologist of this survey, and he took the field at the beginning of the past season and continued his labours until its close. The special duty with which he was charged was to pursue such lines of travel as would enable him to make critical examination of the geological formations in succession as they are exposed to view on both sides of the Rocky Mountain chain, and also on both sides of the Uinta chain; to collect and study the fossils of these formations in such detail as to settle, as far as possible, the questions of the natural and proper vertical limits of the formations, their geographical range, their correlation with each other, and to define the palæontological characteristics of each. He has pursued his researches with such success during the past season as to demonstrate the necessity of continuing this class of investigations by various lines of travel across what is generally known as the great Rocky Mountain region, especially those portions of it that have

been surveyed, as well as those in which surveys are in progress.

Among other important results, he has shown the identity of the lignitic series of strata east of the Rocky Mountains, in Colorado, with the Fort Union group of the Upper Missouri River, and also its identity with the great Laramic group of the Green River Basin and other portions of the region west of the Rocky Mountains. He also finds the planes of demarcation between any of the mesozoic and cenozoic groups, from the Dakota to the Bridger, inclusive, to be either very obscure or indefinable; showing that whatever catastrophal or secular changes took place elsewhere during all that time, sedimentation was probably continuous in what is now that part of the continent, from the earliest to the latest of the epochs just named.

The general course of travel pursued by Dr. White during the season was as follows, not including the numerous detours, meanderings, and side trips, which the work necessitated. Outfitting at Cheyenne, he journeyed southward, traversing in various directions a portion of the great plain which lies immediately adjacent to the eastern base of the Rocky Mountains in Colorado. The most easterly point thus reached was some sixty miles east of the base of the mountains, and the most southerly point, about twenty-five miles south of Denver. Returning to Denver to renew his outfit, he crossed the Rocky Mountains by way of Boulder Pass, through Middle Park. After making certain comparative examinations of the mesozoic and cenozoic formations in Middle Park, he proceeded westward to the head-waters of Yampa River, following that stream down to the western foothills of the Park Range of mountains. Here, resuming his comparative examination of the mesozoic and cenozoic strata, he passed down the Valley of the Yampa as far as Yampa Mountain, one of those peculiar and remarkable upthrusts of palæozoic rocks through mesozoic strata. In all this area, as well as that between the Yampa and White Rivers, the Laramic group reaches a very great and characteristic development; and it received careful investigation, yielding some of the most important results of the season's work. Crossing the ground between the two rivers named, to White River Indian Agency; thence down White River Valley about 100 miles, thence to Green River, crossing it at the southern base of the Uinta Mountains, making many detours on the way, he reviewed the geology of the region which he had surveyed during the previous season. This review brought out not only the important palæontological facts before referred to but it also added materially to the elucidation of the geological structure of the region which lies between the eastern end of the Uinta mountain range on the west, and the Park range on the east.

Beyond Green River he pursued his travels westward, studying the mesozoic and cenozoic strata that flank the Uinta range upon its south side, and making comparisons of both their lithological and palæontological characteristics.

In this way he traversed the whole length of the Uinta range, crossing at its junction with the Wasatch range over into the valley of Great Salt Lake. Re-crossing the Wasatch to the north side of the Uinta range, he continued his examinations of the cretaceous and tertiary strata into and entirely across the Great Green River basin, leaving the field at the close of the season at Rawlin's station on the Union Pacific Railroad.

A general statement of the results of the season's work has been given in a previous paragraph, but the following additional summary will make the statement somewhat clearer, being made after the route of the season's travel has been indicated. The formations of later mesozoic and earlier cenozoic ages, especially those to which Dr. White, in former publications, has applied the provisional designation of "post-cretaceous," have received par-

ticular attention. The extensive explorations of Dr. Hayden in former years, and the palæontological investigations of the late Mr. Meek, pointed strongly to the equivalency of the Fort Union beds of the Upper Missouri River with the lignitic formation as it exists along the base of the Rocky Mountains in Colorado; and also to the equivalency of the latter, with the Bitter Creek series west of the Rocky Mountains. The investigations of the year have fully confirmed these views by the discovery not merely of one or two doubtful species common to the strata of each of these regions, but by an identical molluscan fauna ranging through the whole series, in each of the regions named. This shows that the strata just referred to all belong to one well marked period of geological time; to the strata of which Mr. King has applied the name of "Laramic group" (Point of Rocks, Group of Powell). His investigations also show that the strata which in former reports by himself and Prof. Powell, have been referred to the base of the Wasatch group, also belong to the Laramic group, and not to the Wasatch. He has reached this later conclusion not merely because there is a similarity of type in the fossils obtained from the various strata of the Laramic group with those that were before in question; but by the specific identity of many fossils that range from the base of the Laramic group up, into, and through the strata that were formerly referred to the base of the Wasatch. Furthermore some of these species are found in the Laramic strata on both sides of the Rocky Mountains. Thus the vertical range of some of these species is no less than three thousand feet and their present known geographical range more than a thousand miles.

Besides the recognition of the unity of the widely distributed members of the formation of this great geological period, bounded by those of undoubted cretaceous age below, and those of equally undoubted tertiary age above; his further observations have left comparatively little doubt that the "lake beds" of Dr. Hayden, as seen in Middle Park, the "Brown's Park group" of Prof. Powell, and the "Uinta group" of Mr. King, all belong to one and the same epoch, later than, and distinctly separate from, the Bridger groups. In that portion of the region which lies adjacent to the southern base of the Uinta mountain range, and which is traversed by Lake Fork and the Du Chesne River, not only the Uinta group, but both the Green River and Bridger groups also, are well developed, each possessing all its peculiar and usual characteristics, as seen at the typical localities in the great Green River Basin, north of the Uinta Mountains. This, added to the known existence of Bridger strata in White River Valley, and the extensive area occupied by the Green River group between White and Grand Rivers, has added very largely to our knowledge of the southward extension of those formations.

In all the comparative examinations of the formations or groups of strata that have just been indicated he has paid special attention to their boundaries or planes of demarcation, crossing and recrossing them wherever opportunity offered, noting carefully every change of both lithological and palæontological characters. While he has been able to recognise with satisfactory clearness the three principal groups of cretaceous strata, namely, the Dakota, Colorado, and Fox Hills, on both sides of the Rocky and Uinta Mountains respectively, they evidently constitute an unbroken series so far as their origin by continuous sedimentation is concerned. While each of the groups possesses its own peculiar palæontological characteristics, it is also true that certain species pass beyond the recognised boundaries of each within the series.

The stratigraphical plane of demarcation between the Fox Hills, the uppermost of the undoubted cretaceous groups, and the Laramic group, the so-called post-cretaceous, is equally obscure; but the two groups are palæon-

tologically very distinct, inasmuch as the former is of marine origin, while the latter, so far as is now known, contains only brackish-water and fresh-water invertebrate forms. He reports a similar obscurity or absence of a stratigraphical plane of demarcation between the Laramic and Wasatch groups, although it is there that the final change from brackish to entirely fresh waters took place over that great region. Furthermore, he finds that while the three principal groups of the fresh-water tertiary series, west of the Rocky Mountains, namely, the Wasatch, Green River, and Bridger groups, have each peculiar characteristics, and are recognisable with satisfactory distinctness as general divisions, they really constitute a continuous series of strata, not separated by sharply-defined planes of demarcation, either stratigraphical or palæontological.

During the progress of the field work, as above indicated, large and very valuable collections of fossils have been made, all of which will constitute standards of reference in the future progress of the work, and quite a large number of the species are new to science. These are now being investigated, and will be published in the usual palæontological reports of the survey.

### NOTES

AT the moment of going to press we have received the report of the *Inflexible* Committee. The impression a first glance over it gives is that the *Inflexible* is a passable ship, but that the Committee strongly urge the Admiralty not to proceed with any more like it, which practically puts an end, we presume, to the *Ajix* and *Agamemnon*, in their present form, as well as to the fourth ship which the Admiralty proposed to build. It is proper, however, to state that a closer perusal of the report shows the *Inflexible* herself to be open to the gravest objections in several respects, and that the Committee recommend considerable modifications in her. In our next number we shall fully review the report.

WE have received several letters from India, showing that great interest is being taken in that country with reference to the best methods of determining the amount and variation of solar radiation. We may state that both Prof. Stewart and Mr. Lockyer have recently devised instruments to secure these data. The latter proposes to utilise Capt. Abney's method of obtaining photographs of the red end of the spectrum, so that variations in thermal and chemical intensity may both be recorded automatically.

SIR WILLIAM THOMSON has been elected a Foreign Associate of the Paris Academy of Sciences, to fill the place vacated by the death of von Baer.

PROF. SIR WYVILLE THOMSON has been created a Knight of the Royal Order of the Polar Star by the King of Sweden.

M. TEMPEL is to continue henceforth the publication of Donati's *Bollettino* of the Arcetri Observatory, of which only one number had been issued when Mr. Donati died.

GEN. NANSOUTY, Director of the Observatory situated on the top of the Pic du Midi has been nominated "Officier de l'Université" by M. Faye, the new Minister of Public Instruction. The General, as our readers know, spends his winters on that precipitous mountain for meteorological observations. We are glad to register such an acknowledgment of his devotion to science.

DR. BURDON-SANDERSON gives notice that the first of his annual course of lectures on comparative pathology will be delivered at the University of London, Burlington Gardens, on Saturday, December 15, at half-past five o'clock. The subject of the lecture will be, "The Infective Processes of Disease."

The succeeding lectures will be on the Monday, Wednesday, and Friday of the following week, at the same hour, for which days "The Nature and Causes of Septic Infection," "The Germ Theory," and "The Theory of Contagium Vivum," are among the topics to be discussed.

THE German postal department has issued a complete series of regulations for the use of the telephone in the various offices where it has been established. In § 15 we notice the rule that the speaker shall pronounce each syllable slowly and separately, and make a pause at the end of every six words to give time for the receipt of the message. The receiver repeats the whole message at the end at an ordinary rate of delivery. Proper names and foreign messages are spelled. The Postmaster-General, Dr. Stephan, who wages an unmerciful war in his department against all foreign words where a German equivalent is possible, has christened the new invention as the *Fernsprecher* (far-speaker), and excluded entirely the Greek *telephone* from his regulations.

IN consequence of the large numbers who were unable to obtain admission to the recent lecture at the Society of Arts on the "Telephone," Prof. Bell, at the special request of the Council of the Society, has consented to repeat his lecture on Wednesday, the 19th inst. As there is certain to be a large attendance, it is suggested that those members who heard the first lecture, should refrain from exercising their privilege of being present on the second occasion.

PROF. KEKULÉ, of Bonn, the originator of the present benzene theory has been nominated for president of the German Chemical Society for the coming year. The policy which the society adopted at its last annual election of choosing its chief officer from among the leading German chemists at a distance from the headquarters of the society, seems to meet general favour, and Prof. Wöhler, the Nestor of organic chemistry, will certainly be ably succeeded by Prof. Kekulé, whose classical researches and theoretical deductions form the basis of the present atomistic theory. The German Chemical Society would do well to copy one of the customs of its sister society in London, viz., to require an inaugural address from its newly-elected presidents. We notice that the library of the society will be enriched by the bequest of the extensive chemical library of the late Prof. Oppenheim, an accession which will double the present number of volumes.

DR. VOHL, of Cologne, has adopted an ingenious method of determining the impurities in the Rhine, which consists in analysing the boiler incrustations of the river steamers, as well as the concentrated residues remaining in the boilers after passing over a certain distance. By this means he has detected the presence of a large amount of arsenious acid in the river water—resulting chiefly from the aniline and dyeing establishments—as well as other poisonous substances. An unusually high percentage of phosphoric acid showed that the sea was daily absorbing vast quantities of the most valuable fertilising material from the soil of Germany.

THE Scientific Congress of France will meet at Nice from January 10 to 20, 1878. The locality is likely to attract many visitors at such a cold period of the year.

ANOTHER sitting of the enlarged Council of the Observatory of Paris was held on December 9. The councillors passed a resolution for an increase of the salary of the astronomers and auxiliary astronomers, the maximum pay of the former to be 10,000 francs instead of 8,000, and of the second 7,000 instead of 6,000. They propose to the Government to place the appointment of the director of the establishment partly in the hands of the Academy of Sciences and partly in the hands of the Council, the Minister to have only the privilege to choose