

The uses to which this "dust" is put when ultimately fetched away are surprising: without being freed from its organic refuse it is used to fill up hollows in building-ground, and even for the repair of roads. A few weeks ago I passed along a road which was being treated according to the iniquity of Macadam. Over the broken stones had been shot, to consolidate them, a complex of ashes, cabbage-leaves, egg and periwinkle shells, straw, potato-parings, a dead kitten (over which a few carrion-flies were hovering), and other promiscuous nuisances. The road in question, be it remarked, is highly "respectable," if not actually fashionable. The houses facing upon it are severely rated, and are inhabited chiefly by "carriage people." What, then, may not be expected in lower districts?

Much attention has lately been drawn to the fish trade of London. It has not, however, come out in evidence that the fish retailers, if they find a quantity of their perishable wares entering into decomposition, send out late in the evening a messenger, who, watching his opportunity, throws his burden down in some plot of building land, or over a fence. When I say that I have seen in one place, close alongside a public thoroughfare, a heap of about fifty herrings, in most active putrefaction and buzzing with flies, and some days afterward, in another place, some twenty soles, it will be understood that such nuisances can only be occasioned by dealers. To get rid of, or at least greatly diminish, carrion-flies, house-flies, and the whole class of winged travelers in disease, it will be, before all things, essential to abolish such loathsome malpractices. The dustbins must cease being made the receptacle for putrescent and putrescible matter, the destruction of which by fire should be insisted upon.

The banishment of slaughter-houses to some truly rural situation, where the blood and offal could be at once utilized, would be another step toward depriving flies of their pabulum in the larva state. An equally important movement would be the substitution of steam or electricity for horsepower in propelling tram-cars and other passenger carriages, with a view to minimize the number of horses kept within greater London. Every large stable is a focus of flies.—*Journal of Science.*

ON THE RELATIONS OF MINUTE ORGANISMS TO CERTAIN SPECIFIC DISEASES.

At the recent Medical Congress in London, Professor Klebs undertook to answer the question: "Are there specific organized causes of disease?"

A short historical review of the various opinions of mankind as to the origin of disease led, the speaker thought, to the presumption that these causes were specific and organized.

If we now, he said, consider the present state of this question, the three following points of view present themselves as those from which the subject may be regarded:

I.—We have to inquire whether the lower organisms, which are found in the diseased body, may arise there spontaneously; or whether even they may be regarded as regular constituents of the body.

II.—The morphological relations of these organisms have to be investigated, and their specific nature in the different morbid processes has to be determined.

III.—We have to inquire into their biological relations, their development inside and outside the body, and the conditions under which they are able to penetrate into the body, and there to set up disease.

First.—With regard to the first question, that of the possibility of spontaneous generation, the speaker gave a decided negative.

Second and third.—There is in microscopic organisms a difference of form corresponding, as a rule, to difference of function. The facts regarding these various lower forms are briefly reviewed.

Three groups of hyphomycetæ, algæ, and schizomycetæ, have been demonstrated to occur in the animal and human organism in infective diseases. Their significance increases with the increase of their capacity for development in the animal body. This depends partly upon their natural or ordinary conditions of life, but partly also, and that in a very high degree, upon their power of adaptation, which, as Darwin has shown, is a property of all living things, and causes the production of new species with new active functions.

1. The hyphomycetæ, on account of their needing an abundant supply of oxygen, give rise to but few morbid processes, and these run their course on the surface of the body, and are hence relatively of less importance. It will be sufficient here to refer to the forms, achlorion, trichophyton, oïdium, aspergillus, and the diseases produced by them, favus, ringworm, and thrush, to show this peculiarity. Nevertheless, we see that these organisms also (as was proved by the older observations of Hannover and Zenker) may, under certain circumstances, penetrate into the interior of the organs. Grawitz, moreover, has recently shown that their faculty of penetrating into the interior of the organism, and there undergoing further development, depends on their becoming accustomed to nitrogenous food.

2. Only one of the algæ, viz., leptothrix, has as yet acquired any importance as a producer of disease. It gives rise to the formation of concretions, and that not only in the mouth, but also, as I have shown, in the salivary ducts and urinary bladder.

Another alga, the sarcina of Goodsir, may indeed pass through the organism, without, however, producing in its passage either direct or indirect disturbances. It seems more worthy of note that many schizomycetæ, and especially the group of bacilli, are evidently nearly allied to the algæ in their morphological and vegetative relations—so as to be assigned to this class by several authors, and especially by Cienkowski.

The schizomycetæ furnish, without doubt, by far the most numerous group of infective diseases. We distinguish within this group two widely different series of forms, which we will speak of as bacilli and cocco-bacteria respectively. The former, which was first exhaustively described by Ferdinand Cohn, and the pathological importance of which, especially in relation to the splenic disease of cattle, was first shown by Koch, consist of threads, in the interior of which permanent or resting-spores are developed. These spores becoming free, are able, under suitable conditions of life, again to develop into threads. The whole development of these organisms, and especially the formation of spores, is completed on the surface of the fluids, and under the influence of an abundant supply of oxygen.

The number of affections in which these organisms have been found, and which may be to a certain extent produced artificially by the introduction of these organisms into healthy animal bodies, has been largely increased since the discovery of Koch, that the bacteria of splenic fever

(anthrax) belong to this group. Under this head must be placed the bacillus malarie (Klebs and Tommassi-Crudeli), the bacillus typhi abdominalis (Klebs, Ebert), the bacillus typhi exanthematici (Klebs, observations not yet published), the bacillus of hog-cholera (Klein), and, finally the bacillus leprosus (Neisser). It would exceed the time appointed were I to attempt to describe these forms more minutely. This may, perhaps, be better reserved for discussion and demonstration.

Alongside of these general infective diseases produced by bacilli, local affections also occur, which indicate the presence of these organisms at the point where disease begins. As an example of these processes, which probably occur in various organs, I would mention gastritis bacillaris, of which I shall show you preparations. In this, we can trace the entrance of the bacilli into the peptic glands, as well as their further distribution in the walls of the stomach, and in the vascular system.

The second group of the pathogenetic schizomycetæ I propose to call, with Billroth, cocco-bacteria, because they consist of collections of micrococci, which are capable of transforming themselves into short rods. The former usually form groups united by zoöglea; by prolongation of the cocci rods are formed, which sprout out, break up by division into chains, and further lead again to the formation of resting masses of cocci. I distinguish, further, in this group, two genera—the microsporina and the monadina; in the former of which the micrococci are collected into spherical lumps, in the latter into layers. The one class is developed in artificial cultivation fluid, the other on the surface. The former requires a medium poor in oxygen, the latter a medium rich in oxygen, for their development.

Among the affections produced by microsporina, I reckon especially the septic processes, and also true diphtheria. On the other hand, to the processes produced by monadina belong especially a large series of diseases, which according to their clinical and anatomical features, may be characterized as inflammatory processes, acute exanthemata, and infective tumors, or leucocytoses. Of inflammatory processes, those belong here which do not generally lead to suppuration, such as rheumatic affections, including the heart, kidney, and liver affections, which accompany this process, sequelæ which, as is well known, lead more especially to formation of connective tissue, and not to suppuration. Here, also, belong croupous pneumonia, the allied disease erysipelas, certain puerperal processes, and finally, parotitis epidemica, or mumps.

Among the acute exanthemata, the following may, up to the present time, be placed in this group; variola-vaccina, scarlatina, and measles.

The group of infective tumors is represented by tuberculosis, syphilis, and glanders. Throughout the whole group of cocco-bacteria the demonstration of organisms in the diseased parts encounters difficulties which vary considerably in the different kinds.

The speaker concluded by describing the methods (now well known) by which the powers of the different organisms are tested.

He also referred to Pasteur's, Chauveau's, and Toussaint's recent experiments.

His conclusion was that the specific communicable diseases are produced by specific organisms.

THE CENTENARY OF THE DISCOVERY OF URANUS.

By W. F. DENNING, F.R.A.S.

THE year 1781 was signalized by an astronomical discovery of great importance, and one which marked the epoch as memorable in the annals of science. A musician at Bath, William Herschel by name, who had been constructing some excellent telescopes and making a systematic survey of the heavens, observed an object on the night of March 13 of that year, which ultimately proved to be a large planet revolving in an orbit exterior to that of Saturn. The discovery was as unique as it was significant. Only five planets, in addition to the Earth, had hitherto been known; they

were observed by the ancients, and by each succeeding generation, but now a new light burst upon men. The genius of Herschel had singled out from the host of stars which his telescope revealed an object the true character of which had evaded human perception for thousands of years!

The centenary of this remarkable advance in knowledge naturally recalls to mind the circumstances of the discovery, and makes us inquisitive to know what new facts have been gleaned of Herschel's planet, now that a hundred years have passed away, and we are enabled to look back and review the vast amount of labor which has been accomplished in this wide and attractive field of astronomical research. We may learn what new features have been discerned of the new body, and what additional discoveries in connection with other planets unknown in Herschel's day, have been effected by aid of the powerful telescopes which have been devoted to the work. We do not, however, intend dealing with the general question of planetary discovery, for at a glance we are impressed with its magnitude. While a century ago five planets only were known, we now have some two hundred and thirty of these bodies, and the stream of discovery flows on without abatement through each succeeding year. The detection of Uranus seems, indeed, to have been the prelude to many similar discoveries, and to have

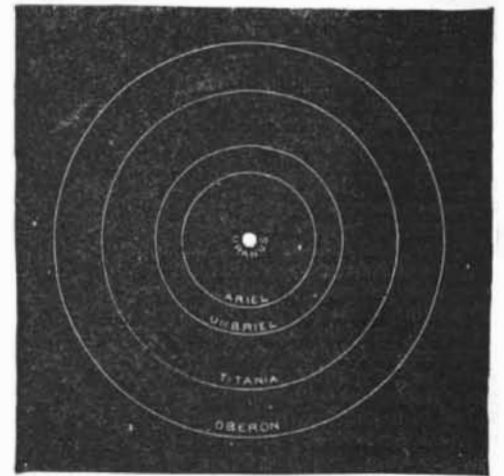


FIG. 2.—ORBITS OF THE URANIAN SATELLITES.

offered the incentive to greater diligence and energy on the part of observers in various parts of the world.

Many great discoveries have resulted from accident; and the leading facts attending that of Uranus prove that, in a large measure, the result was brought way. Herschel, as he unwearingly swept the heavens night after night, was in quest of sidereal wonders—such as double stars and nebulae—and he happened to alight upon the new planet in a purely chance way. He had no expectation of finding such a remarkable object, and indeed, when he had found it, wholly mistook its character. There could be no doubt that it was a body wholly dissimilar to the fixed stars, and it was equally certain that it could not be a nebula. It had a perceptible disk, for when it had first come under the critical eye of its discoverer he had noticed immediately that its appearance differed widely from the multitude of objects which crossed the field of his telescope. He had been accustomed to see hosts of stars pass in review, and their aspect was in one respect similar, namely, they were invariably presented as points of light incapable of being sensibly magnified, even with the highest powers. True, there was a great variety of apparent brightness in these objects and a singular diversity of configuration, but there was no exception to the invariable feature referred to. The point of light was constant, and no striking exception

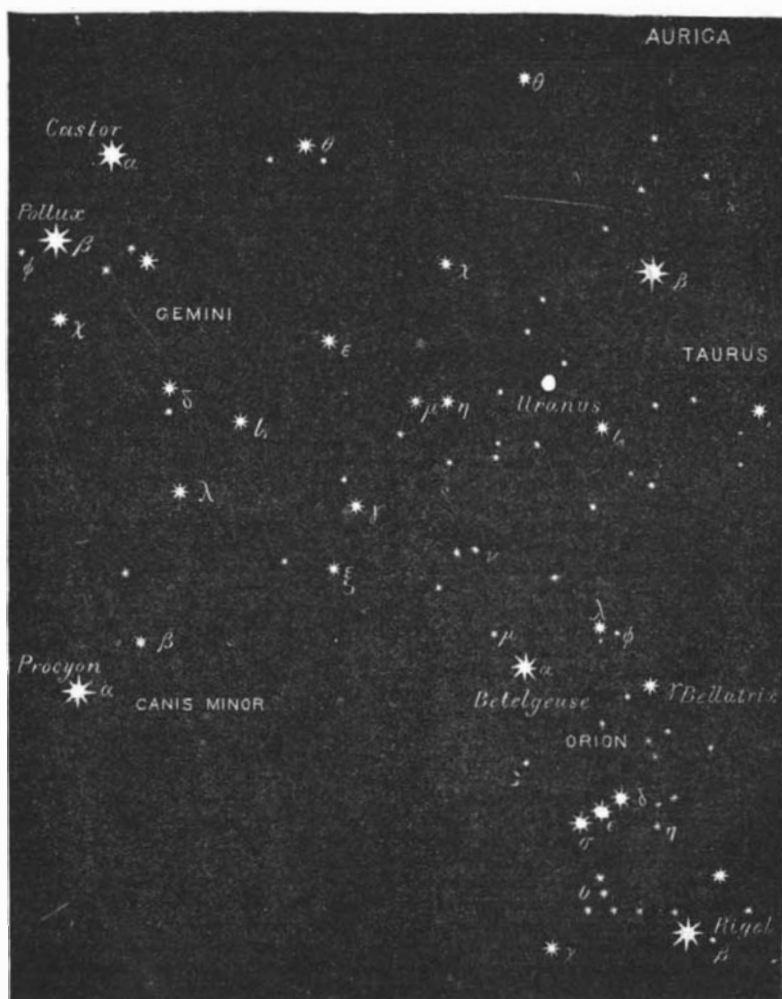


FIG. 1.—APPROXIMATE PLACE OF URANUS AMONGST THE STARS AT ITS DISCOVERY ON MARCH 13, 1781.

was anticipated until one night—March 13, 1781—Herschel being intently engaged in the examination of some small stars in the region of Gemini, brought an object under the range of his telescope, which his eye at once selected as one of anomalous character.

Applying a higher power, he noticed that it exhibited a planetary disk, but his instrument failed to define it with sufficient distinctness, and hence he became doubtful as to its real nature. The object was found to be in motion, and subsequent observations led him to the assumption that it must be a comet of rather exceptional type. This appeared to be the best explanation of the strange body, for history contained many records of curious comets, some of which were observed as nearly circular patches of nebulous light, and probably of similar aspect to the object then visible; and apart from this it must be remembered that the idea of a large planet exterior to Saturn was a fact of such momentous import that Herschel, with a due regard to that modesty which accompanies true genius, refrained from attaching such an interpretation to his observations. He was content to direct the notice of astronomers to it as a phenomenon requiring close attention, and suggested that it might be a comet in consequence of its motion and the faint and somewhat ill-defined character of its appearance.

From the earliest ages five planets only were known, and the discovery of another large planet beyond the sphere of Saturn must at once revolutionize existing ideas as to the range of the solar system, and immediately take rank as a scientific event of equal interest to the discovery of the moons of Jupiter or the rings of Saturn, which each in their day impressed men with new ideas of the celestial mechanism. But the truth could not long be delayed. The new body being watched and its orbit rigorously computed from a series of observed positions revealed its true character, and Herschel was awarded the honor due to the author of a discovery of such importance. His diligence and pertinacity alone had enabled him to search out from among the multitude of stars thickly strewn over the firmament this unknown and well-nigh invisible planet which, during all the preceding years of the world's history, had eluded human perception. Men had been all unconscious of its existence as it had been slowly completing its circuits around the sun, obedient to the same laws as the other planets of the solar system, and awaiting the hour when the unflinching eye of Herschel should introduce it as the faint and far-off planet girding our system within its expansive folds.

As soon as the existence of the new orb was confirmed and the fact rendered indisputable, the question naturally arose whether it had ever been seen in former years by the authors of star catalogues, who could hardly have overlooked an object like this though its planetary nature had manifestly escaped detection. It was just perceptible to the naked eye, shining like a star of the sixth magnitude, and ought to have been distinguished by those who had reviewed the heavens with the purpose of determining and mapping the positions of the stars. Reference was, therefore, made to the chief catalogues, when it was found at once that the planet had been unquestionably observed by Tobias Mayer, Le Monnier, Bradley, and Flamsteed. It was several times noted by these observers: by Le Monnier no less than twelve times, and by Flamsteed on six occasions; and it is remarkable that in every instance its true character escaped detection. Neither its special appearance nor its motion attracted attention, so that it was merely catalogued as an ordinary fixed star. Thus Herschel was not anticipated in his discovery. It remained for him, in 1781, to note its exceptional aspect, and to specify it as an object requiring critical investigation. But the early observations above alluded to served a useful purpose in testing the accuracy of the computed orbit, for without waiting many years to compare the theoretical and observed positions, astronomers had in these old records a reliable series of points through which the previous course of the planet could be traced.

The calculations showed that its mean distance from the sun was some 1,750,000,000 miles, and that a revolution was completed in about eighty-four years. It was also found to be a very large planet, greatly exceeding either Mercury, Venus, the Earth, or Mars, though considerably inferior to either Jupiter or Saturn.

Here, then, was a discovery of the utmost importance, and one of the most salient additions to our knowledge which the telescope had ever achieved. The new planet was now definitely assigned its proper place in the solar system, and was regarded as of equal significance with the old planets. True, the new planet of Herschel could not be compared as regards its visible aspect with the other previously known members of our system, but it was nevertheless an object of equal weight. Its vast distance alone rendered it faint. It formed one of the constituent parts of the solar system, which, though separated by immense intervals of space, are yet coherent by the far-reaching effects of gravitation. There is, indeed, a bond of harmony between the series of planetary orbits, which exhibit a marked degree of regularity in their successive distances from the sun; and though they are not connected by any visible links, they are firmly held together by unseen influences, and their motions are subject to certain laws which have been revealed by centuries of observation.

The question of suitably naming the new planet soon came to the fore. Herschel himself proposed to designate it the "Georgium Sidus," in honor of his patron, George III., just as Galileo had called the satellites of Jupiter the "Medicean stars," after Cosmo de' Medici. But La Place proposed that the planet should be named after its discoverer; and thus it was frequently referred to as "Herschel," and sometimes as "The Herschelian planet." Astronomers on the continent objected to this system of personal nomenclature, and argued that the new body should receive an appellation in accordance with those adopted for the old planets, which had been selected from the heathen mythology. Several names were suggested as suitable (on the basis of this principle), and ultimately the one advanced by Bode received the most favor, and the planet thereafter was called "Uranus."

The varying positions of the new body as observed on successive nights were determined by comparisons with a group of six small stars, termed by Herschel α , β , γ , δ , ϵ , ζ , and afterwards formed into a constellation under the designation of "Britannia," though it does not appear that this little asterism is acknowledged as one of our constellations. Its position is about midway between Taurus and Gemini, and the following are the principal stars computed for 1881-0, as given by Mr. Marth:

Star.	Magnitude.	Right Ascension.	Declination.
		h. m. s.	
α	9.0	5 42 6.06	23° 35' 6.7" N.
η	8.7	5 43 17.82	23 26 7.2 N.
θ	8.8	5 44 0.99	23 53 30.8 N.
ϵ	8.8	5 45 40.68	23 34 46.8 N.

The stars are therefore merely telescopic, and are confined to a small area of space, so that the propriety of adopting the group as a distinct constellation is very questionable. Their positions close to Uranus at the time of its discovery, and the fact that the planet's motion was detected by means of comparisons with them, has given to these stars an historical interest which in future years must often attract the student to their reobservation. But it would be unwise, as forming a bad precedent, to accept a group of stars of this inferior type as meriting to rank among the old constellations, when we have numbers of richer groups, situated on their confines, which first deserve such a distinction. However special or unique the circumstances connected with certain telescopic stars may be, and however necessary it may appear to signalize them by a specific title, we are inclined to question the adoption of such means as likely to exercise a wrong influence, inasmuch as it may hereafter originate further innovations of a similar character, and ultimate complications will be certain to arise.

Soon after the discovery of Uranus it was suspected that the planet was encircled, like Saturn, by a luminous ring, but on subsequent observation this was not confirmed, and no such appendage has ever been revealed in the more perfected instruments of our own times. Indeed, if Uranus displays a peculiarity of constitution in any way analogous to the ring system of Saturn, it must be of the most minute character so as to have thus evaded telescopic scrutiny during a hundred years.

The discovery soon attracted the notice of royalty, and the reigning sovereign, George III., anxious to practically express his appreciation of the valuable labors of Herschel, awarded him a pension of £200 a year and furnished him with a residence at Slough, near Windsor, and the means to erect a gigantic telescope with which he might be enabled to continue his important researches. This instrument consisted of a reflector on the "Front-view" construction, with a speculum 4 feet in diameter and of 40 feet focal length. Upon its completion, Herschel immediately began to observe the region of the new planet with the idea of discovering any satellites which might belong to it, for analogy suggested that it was surrounded by a numerous retinue of such bodies. He was soon successful, for, on the night of January 11, 1787, he saw two minute objects near the planet, which renewed observations revealed to be satellites; and he detected two additional ones in 1790, and two others in 1794, making six in all. But the observations were of extreme difficulty. The path of the planet frequently passed near minute stars, and it became hard to distinguish between them and the suspected satellites. Herschel, however, considered he had obtained conclusive evidence of the existence of six satellites with sidereal periods ranging from 5d. 21h. 25m. to 107d. 16h. 39m., and his means of observation being much superior to those possessed by any of his contemporaries it was impossible to have corroborative testimony.

The matter was thus allowed to rest until the middle of the present century, when Lassell, in the pure sky at Malta, endeavored to reobserve the satellites with a two-foot reflector. This instrument was considered superior to Herschel's telescope; and the atmosphere at this station being decidedly more suitable for such delicate observations than in England, it was removed there for the express purpose of dealing successfully with objects of extreme difficulty. The results were very important. Mr. Lassell became convinced that Uranus had only four satellites, and that if any others existed they remained to be discovered. Two of these were found to be identical with those seen by Herschel in 1787, and now called Titania and Oberon. The other two, Ariel and Umbriel, could not be identified with any of those alleged to have been previously detected by Herschel, so that the inference was that they were new bodies, and that the priority of discovery was due to Mr. Lassell; whence it also followed that the older observations were erroneous, and that in fact Herschel had been entirely mistaken with regard to the four satellites he believed he had detected subsequently to 1787.

In November, 1873, a fine twenty-six-inch object glass, by Alvan Clark, was mounted at the U. S. Naval Observatory at Washington, and it was soon employed upon the difficult task of solving the problem as to the exact periods of the Uranian satellites. This was very satisfactorily effected, and with distinct and conclusive favor to Mr. Lassell, whose observations were fully corroborated. Only four satellites could be distinguished by the American observers, and their periods, as computed from a valuable series of measures, agreed with those previously derived at Malta. In Appendix I. to the "Washington Observations" for 1873, Prof. Newcomb gave a valuable summary of results—the first obtained, be it noted, with that splendid instrument which soon afterward, in 1877, revealed the satellites of Mars—which included the elements of the satellites of Uranus as follows:

Satellite.	Mean Longitude. Epoch 1871. Dec. 31, W.M.T.	Radius of Orbit.	Period of Revolution in days.
I. Ariel	21° 33'	13.78"	2.52038
II. Umbriel	136 52	19 20	4.14418
III. Titania	229 93	31 48	7.70590
IV. Oberon	154 83	42 10	13.46327

Speaking of the comparative brightness of the satellites, Prof. Newcomb says:

"The greater proximity of the inner satellites to the planet makes it difficult to compare them photometrically with the outer ones, as actual feebleness of light cannot be distinguished from difficulty of seeing arising from the proximity of the planet. However, that Umbriel is intrinsically fainter than Titania is evinced by the fact that, although the least distance of the latter is somewhat less than the greatest distance of the former, there is never any difficulty in seeing it in that position. From their relative aspects in these respective positions I judge Umbriel to be about half as bright as Titania. Ariel must be brighter than Umbriel, because I have never seen the latter unless it was farther from the planet than the former at its maximum distance. I think I may say with considerable certainty that there is no satellite within 2° of the planet, and outside of Oberon, having one-third the brilliancy of the latter, and therefore that none of Sir William Herschel's supposed outer satellites can have any real existence. The distances of the four known satellites increase in so regular a way that it can hardly be supposed that any others exist between them. Of what may be inside of Ariel it is impossible to speak with certainty, since in the state of atmosphere which prevails during our winter all the satellites named disappear at 10' from the planet."

Prof. Newcomb mentions that no systematic search for new satellites was undertaken because it must have interfered with the fullness and accuracy of the micrometer measures of the old satellites, which constituted the main

purpose of the observations. Some faint objects were occasionally glimpsed near the planet, and their relative places determined, but they were never found to accompany Uranus. The fact, therefore, that no additional satellites were discovered is not to be regarded as a strong point in favor of the theory of their non-existence, because the great power and excellence of the telescope was expressly directed to the attainment of other ends; and moreover the season in which the planet came to opposition was distinctly unfavorable for the prosecution of a rigorous search for new satellites. There can, however, be no doubt that the analogies of the planetary systems interior to Uranus plainly suggest that this planet is attended by several satellites which the power of our greatest telescopes has hitherto failed to reveal; and that it is in this direction and that of Neptune we may anticipate further discoveries in future years when the conditions are more auspicious and the work is entered upon with special energy, aided by instruments of even greater capacity than those which have already so far conducted to our knowledge of the heavenly bodies.

Notwithstanding the extreme difficulty with which the Uranian satellites are observed, the two brighter ones, Titania and Oberon, discovered by William Herschel in 1787, have been occasionally detected in telescopes of moderate power, and identified by means of an ephemeris which has shown that the computed positions approximately agree with those observed. During the last few years Mr. Marth has published ephemerides of the satellites of both Saturn and Uranus, and many amateurs have to acknowledge the valuable aid rendered by these tables, which supply a ready means of identifying the satellites, and thus act as an incentive to observers who are induced to pursue such work for the sake of the interesting comparisons to be made afterward. In one exceptional instance the two outer satellites of Uranus appear to have been glimpsed with an object glass of only 4.3 inches aperture, and the facts are given in detail in the "Monthly Notices of the R. A. S.," April 1876, pp. 294-6. The observations were made in January, February, and March, 1876, by Mr. J. W. Ward, of Belfast; and the positions of the satellites, as he estimated them on several nights, are compared with those computed, the two sets presenting tolerably good agreement. Indeed the corroborations are such as to almost wholly negative any skepticism, though such extraordinary feats should always be received with caution.

In this particular case the chances of being misled are manifold; even Herschel himself fell into error in taking minute stars to be satellites and actually calculating their periods; so that when we remember the difficulties of the question our doubts are not altogether dispelled. Extreme acuteness of vision will, in individual instances, lead to success of abnormal character, and certainly in Mr. Ward's case the remarkable accordances in the observed and calculated positions appear to be conclusive evidence that he was not mistaken.

It will be readily inferred that the great distance and consequent feebleness of Uranus must render any markings upon the disk of the planet beyond the reach of our best telescopes; and indeed this appears to have been a matter of common experience. Though the surface has been often scanned for traces of spots, we seldom find mention that any have been distinguished. Consequently the period of rotation has yet to be determined. It is true that an approximate value was assigned by Mr. T. H. Buffham from observations with a nine-inch reflector in 1870 and 1872, but the materials on which the computation was based were slender and necessarily somewhat uncertain, so that his period of about twelve hours stands greatly in need of confirmation. The bright spots and zones seen on the disk in the years mentioned appear to have entirely eluded other observers, though they are probably phenomena of permanent character and within reach of instruments of moderate size. Mr. Buffham* thus describes them:

"1870, Jan. 25, 11h. to 12h. in clear and tolerably steady air; power 132 showed that the disk was not uniform. With powers 202 and 320, two round, bright spots were perceived, not quite crossing the center but a little nearer to the eastern side of the planet, the position angle of a line passing through their centers being about 20° and 200°—ellipticity of Uranus seemed obvious, the major axis lying parallel to the line of the spots.

"Jan. 27, 10h. to 10½h.; some fog, and definition not good, but the appearance of the spots was almost exactly the same as on the 25th."

On March 19 glimpses were obtained of a light streak and two spots. On April 1, 4, 6, and 8, a luminous zone was seen on the disk, and in February and March, 1872, when observations were resumed, certain regions were noted brighter than others, and underwent changes indicating the rotation of the planet in a similar direction to that derived from the results obtained in 1870. Mr. Buffham points out that, if this is admitted, then the plane of the planet's equator is not coincident with the plane of the orbits of the satellites. Nor need we be surprised at this departure from the general rule, where such an anomalous inclination exists. In singular confirmation of this is Mr. Lassell's observation of 1862, Jan. 29, where he says: "I received an impression which I am unable to render certain of an equatorial dark belt, and of an ellipticity of form."

Some observations made in 1872-3 with the great six-foot reflector of Lord Rosse may here be briefly referred to. A number of measures, both of position and distance, of Oberon and Titania, were made, and a few of Umbriel and Ariel, but "the shortness of the time available (40 minutes) each night for the observation of the planet with the six-foot instrument, the atmospheric disturbance, so often a source of annoyance in using so large an aperture, and other unfavorable circumstances, tended to affect the value of the observations, and to make the two inner satellites rarely within detection."

On Feb. 10, 1872, Lord Rosse notes that all four satellites were seen on the same side of the planet. On Jan. 16, 1873, when definition was good, no traces of any markings were seen. Diameter of Uranus 5.29". Power 414 was usually employed, though at times the inner satellites could be more satisfactorily seen with 625.

It may be mentioned as an interesting point that, some fifty years after the first discovery of Uranus by Herschel, it was accidentally rediscovered by his son, Sir John Herschel, who recognized it by its disk, and had no idea as to the identity of the object until an ephemeris was referred to. Sir John mentions the fact as follows, in a letter to Admiral Smyth, written in 1830, August 8:

"I have just completed two twenty-foot reflectors, and have got some interesting observations of the satellites of Uranus. The first sweep I made with my new mirror I re-

* "Monthly Notices R. A. S.," January, 1873.

† "Monthly Notices R. A. S.," March, 1875.

discovered this planet by its *disk*, having blundered upon it by the merest accident for 19 Capricorni."

In commenting upon the centenary of an important scientific discovery we are naturally attracted to inquire what progress has been made in the same field during the comparatively short interval of one hundred years which has elapsed since it occurred. We have called it a short interval, because it cannot be considered otherwise from an astronomical or geological point of view, though, as far as human life is concerned, it can only be regarded as a very lengthy period, including several generations within its limits.

Since Herschel, in 1781, discovered Uranus, astronomy has progressed with great rapidity, so that it would be impossible to enumerate in a brief memoir the many additional discoveries which have resulted from assiduous observation. A century ago only five planets were known (excluding the Earth), now we are acquainted with about two hundred and thirty of these bodies; and one of these, found in 1846, is a large planet whose orbit lies exterior to that of Uranus. In fact, the state of astronomical knowledge a century ago has undergone wonderful changes. It has been rendered far more complete and comprehensive by the diligence of its adherents and by the unwearied energy with which both in theory and practice it has been pursued. A zone of small planets has been discovered between Mars and Jupiter just where the analogies of the planetary distances indicated the probable existence of a large planet. The far-off Neptune was revealed in 1846 by a process of analytical reasoning as unique as it was triumphant, and which proved how well the theory of planetary perturbations was understood. The planet was discovered by calculation, its position in the heavens assigned, and the telescope was then employed merely as the instrument of its detection. The number of satellites which a century ago numbered only ten has now reached twenty, and the discovery in 1877 of two moons accompanying Mars shows that the work is being continued with marked success.

In other departments we also find similar evidence of increasing knowledge. The periodicity of the sun spots, the existence of systems of binary stars, meteor showers, and their affinity with cometary orbits may be mentioned as among the more important, while a host of new comets, chiefly telescopic have been detected. Large numbers of nebulae and double stars have been catalogued, and we have evidence every year of the activity with which these several branches are being followed up.

In fine, it matters little to what particular department of astronomical investigation we look for traces of advancement during the past hundred years, for it is evident throughout them all, and sufficiently proves that the interest formerly taken in the science has not only been well sustained but has become more general and popular, and is extending its attractive features to all classes of the community.

In Herschel's day large telescopes were rare. A man devoting himself to the study of the heavenly bodies as a means of intellectual recreation was considered a phenomenon, and indeed that appellation might be fittingly applied to the few isolated individuals who really occupied themselves in such work. How different is the case now that the pleasant ways of science have called so many to her side and so far perfected her means of research as to make them accessible to all who care to see and investigate for themselves the unique and wonderful truths so easily within reach! Large telescopes have become common enough, and there is no lack of hands and eyes to utilize them, nor of understanding, ever ready to appreciate, in sincerity and humbleness, those objects which display in an eminent degree the all-wise conceptions of a great Creator! It is, therefore, a most gratifying sign to notice this rapid development of astronomy, and to see year by year the increasing number of its advocates and the record of many new facts gleaned by vigorous observation.

The character of recent discoveries distinctly intimates that, in future years, some departments of the science will become very complicated, owing to the necessity of dealing with a large number of minute bodies, for the tendency of modern researches has been to reveal objects which by their faintness had hitherto eluded detection. And when we consider that these bodies are rapidly increasing year by year, the idea is obviously suggested that, inasmuch as their numbers are comparatively illimitable, and there is likely to be no immediate abatement in the enthusiasm of observers, difficulties will arise in identifying them apart and forming them into catalogues with their orbital elements attached, so that the individual members may be redetected at any time.

In this connection we allude particularly to minor planets, to telescopic comets, and to meteoric streams, which severally form a very numerous group of bodies of which the known members are accumulating to a great extent. As complications arise, some remedies must be applied to their solution, and one probable effect will be that astronomers will be induced each one to have a specialty or branch to which his energies are mainly directed. The science will become so wide in its application and so intricate in its details that it will become more than ever necessary for observers to select or single out definite lines of investigation and pursue them closely, for success is far more likely to attend such exertions than those which are not devoted to any special end, but employed rather in a general survey of phenomena.

We have already before us some excellent instances in which individual energies have been aptly utilized in the prosecution of original work in some specific branch of astronomy, and we are strongly disposed to recommend such exclusive labors to those who have the means and the desire to achieve something useful. Observers who find one subject monotonous and then take up another for the sake of variation are not likely to get far advanced in either. In the case of amateurs who use a telescope merely for amusement, and indiscriminately apply it to nearly every conspicuous object in the firmament without any particular purpose other than to satisfy their curiosity, the matter is somewhat different, and our remarks are not applicable to them. We refer more pointedly to those who have a regard for the interests of the science and whose enthusiasm enables them to work habitually and with some pertinacity.

History tells us that the Great Alexander wept when he found he had no other worlds to conquer, and we fear that some astronomers will lament that they have little prospect of discovering anything fresh in a sphere to which our faint telescopes have been so often directed, but this is founded on a palpable misconception. Certain objects, such as comets for example, do not require great power, and the revelation of new meteor showers is entirely a question for the naked eye. In fact, it may be confidently asserted that observations undertaken with energy and persistency will,

if rightly directed, more than compensate for defects of instrumental power.

It is true, however, that in certain quarters we must look to large instruments alone for new discoveries. It would be useless searching for an ultra-Neptunian planet, or for additional satellites to Uranus or Neptune, or for the materials to determine the rotation periods of these planets with a small telescope. Every observer will find objects suited to the capacity of his instrument, and he may not only employ it usefully but possibly make a discovery of nearly equal import with that which rendered the name of Herschel famous a century ago.—*Popular Science Review*.

THE VARYING SUSCEPTIBILITY OF PLANTS AND ANIMALS TO POISONS AND DISEASES.

MUCH attention is being devoted to the causes which determine the aptitude or immunity with animals for maladies. This is in a general sense called medical geography, as a physician who has prescribed for patients in various parts of the world, and belonging to different races—the white, yellow, and black—has been able to note the diversities in the same disease, and the contradictions in the remedies employed.

The true social peril, hardly discovered before we became aware how to conjure it, lies in those legions of animalcules or microbes that surround us and in the middle of which we live. M. Pasteur has revealed them to us as the factors in infectious diseases. Claude Bernard has demonstrated the community which exists between animals and vegetables—phenomena of movement, of sensibility, of production of heat, of respiration, of digestion even, for there are the *Drosera* and kindred carnivorous plants. Iron cures chlorosis in vegetables as well as in animals, and chloroform and ether render both insensible. There resemblances are more striking still between animals. After Baudrimont, insects are, in presence of alcohols, chloroform, and irrespirable gases, similarly affected as man. Many maladies, too, are common to man and several species of animals; and this organic identity is best illustrated in the relationship between epidemics and epizootias, cancer, asthma, phthisis, smallpox, rabies, glanders, charbon, etc., afflict alike man and many species of animals.

The differences between races are not less remarkable—odor and taste, for example. According to anthrophophagy, negroes are best, and white people most detestable. Broca remarked, that, in the dissecting room, the muscles of the negro putrefied less rapidly than those of whites. It is perhaps to these anatomical differences that the diverse action of the same poison, in the case of races or species, may be attributed. On certain rodentia belladonna exercises no influence; morphine for a horse is a violent stimulant; a snail remains insensible to digitalis; goats eat tobacco with impunity; and in the Tarentin the inhabitants rear only black sheep, because a plant abounds which is noxious for white sheep.

The nature of these conditions is a mystery for science. The *Solana* tribe of plants furnish a principle which, as its name implies, produces consolation or forgetfulness, by acting on the tissues of the brain where resides the organ of thought; now, on the authority of Professor Bouchardat, these opiates have the less of effect in proportion as the animals possess the less of intelligence.

To the same anatomical peculiarities must be ascribed the choice that disease makes in such or such a race. Glanders, for instance, so virulent with the horse, the ass, and man, produce in the case of the dog only a local accident; peripneumonia, so contagious among horned cattle, is more benign in its action on Dutch than other breeds of stock; the cattle plague that decimates so many farms is communicated by cattle to each other from the slightest contact, while the closest and most constant association is necessary to communicate the disease to sheep, and even when they are affected its action is not severe. Further, that plague only attacks ruminant animals—oxen, goats, sheep, zebras, gazelles, etc. Ten years ago this plague broke out in the Jardin d'Acclimatation; not a ruminant escaped, and also one animal not of that class, a little tenant nearly related to the pig—the peccari.

Now, Dr. Condereau has demonstrated recently that the stomach of the pig has a rudimentary organization recalling that of the ruminants. Clearly, the stomach of the peccari, and perhaps that of the pig, present a favorable medium for the parasitical microbe peculiar to the rinderpest. In the potato disease, again, all the varieties are not affected with the same degree of violence; it is more marked in its action on the round yellows than the reds, and on the latter rather than the pink. But the symptoms even of the same malady differ, the parasite's attacks on the tissues being dissimilar. Oak galls are produced from the prickings of insects; now around the same larva often four varieties of galls are recognized. In the case of consumption in cattle, the disease marches slowly; in that of pigs it takes the galloping form, as with man.

Each people or nation has its peculiar pathology and also its peculiar cures. A negro can take a dose of tartar ten times more excessive than a white; the same dose of brandy given to a black, a yellow, and a white, will not produce on the three men either drunkenness at the same moment, or intoxication at all. Mulattoes can sustain more drastic aperients than other races; the negro does not suffer from yellow fever, but he readily falls to phthisis; he will catch the cholera more quickly than a white. Human races, where they may catch the same intermittent fever at the identical moment and in the same swamp, will not the less display different types of fever. Dr. Crevaux has shown that a certain insect with the North American Indian is not the same as with the negro or the maroon, and both differ from that peculiar to Europeans.

M. Pasteur's beautiful experiments have conclusively demonstrated that fowls do not catch the *charbon*; now the vital warmth of birds is from seven to nine degrees higher than in the case of mammiferous animals; he imagined that if the fowl was cooled down by baths to the lower temperature, it would be liable equally to become affected; he tried, and the result proved he was correct.

The absence, then, of a certain temperature would be the reason why birds are exempt. The microbes are the agents of infectious disease; when these swarm in the blood of an individual they seem to leave there something pernicious for parasites resembling themselves, or to bring away with them something necessary to the life of their successors. A glass of sugar and water, where leaven has already fermented and yielded alcohol, is incapable of producing a second crop of leaven; similarly the blood of an individual, once contaminated, becomes uninhabitable afterward for like microbes. The individual has acquired immunity. Such is the principle of vaccination.—*Paris Correspondent of the Kansas City Review*.

KIND TREATMENT OF HORSES.

It has been observed by experienced horse trainers that naturally vicious horses are rare, and that among those that are properly trained and kindly treated when colts they are the exception.

It is superfluous to say that a gentle and docile horse is always the more valuable, other qualities being equal, and it is almost obvious that gentle treatment tends to develop this admirable quality in the horse as well as in the human species, while harsh treatment has the contrary tendency. Horses have been trained so as to be entirely governed by the words of his driver, and they will obey and perform their simple but important duties with as much alacrity as the child obeys the direction of the parent.

It is true that all horses are not equally intelligent and tractable, but it is probable that there is less difference among them in this regard than there is among his human masters, since there are many incitements and ambitions among men that do not affect animals.

The horse learns to know and to have confidence in a gentle driver, and soon discovers how to secure for himself that which he desires, and to understand his surroundings and his duties. The tone, volume, and inflection of his master's voice indicate much, perhaps more than the words that are spoken. Soothing tones rather than words calm him if excited by fear or anger, and angry and excited tones tend to excite or anger him. In short, bad masters make bad horses.

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