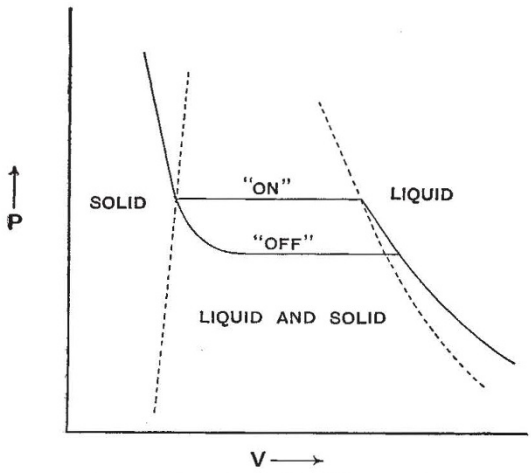
The curious cyclic shape of the isothermals is diagrammatically indicated in the figure, which also brings out another difference in the processes of fusion and solidification. For when the liquid begins to solidify there is a sharp angle in the curve, solidification being an abrupt phenomenon. When the solid melts, however, there is no such sharp angle, the inclined portion of the isothermal gradually curves round and merges into the horizontal portion which represents the condition of the substance when fusion has actually set in. By repeated tests the author satisfied himself that this curvature of the isothermal was not the result of imperfect experiment, but indicated a real condition of the substance, and it may therefore be taken to correspond to a portion of the continuous curve originally proposed by Prof. James Thomson to express what actually goes on during isothermal change of state, and which is predicted for liquids and gases by the equations of van der Waals and of Ramsay and Young. From a general survey of the isothermals obtained, it appears that the volume at which solidification begins, decreases, and the volume at which it ends remains constant, or perhaps slightly increases as temperature rises. These facts are indicated by the



General shape of a Liquid-solid Isothermal.

dotted lines in the figure. We are thus enabled to map out a diagram for solid-liquid in precisely the same way as for liquid-gas, and arrive at the conclusion that at sufficiently high temperatures and pressures we shall reach the solid-liquid critical point. As far as the present experiments go, this point lies in the region of pressures above 4000 atm. and of temperatures higher than 200°. When the critical point is reached, the observations also show that the cyclic character of the isothermals will disappear. There will be no "volume lag" during fusion.

This "volume lag" the author regards as but a special case of hysteresis, having, besides its electrical and magnetic analogues, its counterpart in the phenomena of supersaturation, and the occurrence of all such phenomena he attributes to changes of molecular state. That a similar change lies at the root of the phenomena of solid-viscosity is the aim of a special series of investigations by Mr. Barus, which are collected in No. 94 of the *Bulletin*. The results obtained, however, are beyond the scope of the present article.

The main importance attaching to this work on naphthalene lies in the fact that it constitutes the beginning of a systematic study of the phenomena of solidification, which in conjunction with what is known regarding liquefaction, will ultimately permit of the entire transition from gas to liquid and from liquid to solid being represented on a single diagram. When this has been accomplished, material will be to hand for framing a comprehensive theory of what goes on during the obscure processes of change of state. Enough has already been done to give some idea of the extent to which the complexity of an equation like that of van der Waals, which involves but the third power of the volume, must be increased when attempting to express the complete passage from gas to liquid and from liquid to solid.

J. W. RODGER.

NOTES.

IT is announced that an International Electrical Exposition will be held in Paris from July 1 to October 31, 1895.

DR. W. HAVELBURG has been appointed director of a laboratory recently established at Rio de Janeiro for the study of leprosy.

THE death is announced of Dr. L. Calderon, Professor of Chemistry in Madrid University, and of Dr. Karl Schmidt, Professor of Chemistry in Dorpat University.

WITH reference to the brief notice of the death of Mr. W. Pengelly, F.R.S., in our last number, Mrs. Pengelly points out to us that "he was spoken of as Secretary, instead of Honorary Secretary, of the Torquay Natural History Society, a title of which he was naturally and reasonably jealous, seeing that his connection with the Society was always of a donative, and never of a receptive, character."

MR. F. MOCKLER'S collection of relics of Dr. Jenner, recently exhibited at Bristol, is now on view at the First Avenue Hotel, Holborn. Admission to the exhibition is free to all members of the medical profession. A movement is on foot to purchase the relics as a whole by public subscription, and to offer them to the Royal College of Surgeons.

SIR PHILIP CUNLIFFE-OWEN, whose death occurred on Friday last, at the age of sixty-six, played an important part in the development of the Department of Science and Art. In 1857 he was appointed Deputy-General Superintendent of the South Kensington Museum, and three years later he became Assistant Director. He succeeded Sir Henry Cole as Director of the Museum in 1873, and held that position until last year, when he retired. He did much to organise the collections at South Kensington, and in the Bethnal-green Museum, of which he was also a Director. His ability to organise, and great energy, led to his appointment as executive commissioner on a number of exhibitions of the works of science and the arts, and for these labours, numerous British and foreign orders were conferred upon him. Though not a man of science, he claims our esteem for the many things he did to advance scientific interests.

THE British Museum has recently acquired a section of a trunk of *Sequoia gigantea* from California, having a diameter of somewhat over 15 feet. The annual rings have been carefully counted by Mr. Carruthers, and, two years ago, when the tree was cut down, it was 1330 years old. It was then still living and vigorous. It had, therefore, already attained a considerable age when St. Augustine introduced Christianity into Great Britain. The rings indicate a remarkably symmetrical growth on all sides of the tree. For the first five or six centuries they show a considerable annual increase in the girth of the trunk, getting gradually thinner as the superficies to be covered became larger, and becoming very thin for the last three or four centuries. It is satisfactory to learn, on the authority of Mr. Carruthers, that there were, in 1884, in all the groves which he visited, trees of various ages, so that the *Sequoia* is in no danger of early extinction.

THE committee appointed by the Council of the Royal College of Surgeons of England to state conditions for giving effect to the proposals of Mr. Charles Clement Walker for the foundation of a prize with a view to the encouragement of the investigation of cancer have, says the *Lancet*, recommen ded the adoption of the following regulations:—(1) The prize shall be awarded for the best work in advancing the knowledge of the pathology and therapeutics of cancer done either partially or wholly within the five years preceding the year in which the prize shall be awarded; (2) the first award shall be for the period ending December 31, 1895, after which the prize shall be awarded quinquennially; (3) the prize shall consist of £100 except on the first occasion, when it will be £60; (4) the prize shall be awarded at the quarterly meeting of the Coun cil in the April immediately following the termination of each period, and will not be awarded unless the committee appoin ted to judge shall consider some work deserving of it; (5) the committee shall consist of five members chosen by the Council, but not of necessity members of the Counci l, and they shall be appointed not less than one year prior to the date of the award of the prize; (6) the grounds upon which the prize is awarded shall be made public; (7) the prize shall be open to foreigners as well as British subjects, members of the Council of the Royal College of Surgeons alone being debarred from competition.

IN order to determine the heights of the highest cirrus clouds, only two methods have as yet been successfully attempted, namely, the measurement of altitude and azimuth by two or more observers some distance apart, and the determination of the exact time at which clouds are first seen illuminated by the morning sun, or last seen by the setting sun, coupled with which should be an approximate determination of the altitude and azimuth of the cloud. Prof. Cleveland Abbe gives an account of an observation of the latter kind in the U.S. *Monthly Weather Review*. On December 16, 1893, at 5.30 a.m. an observer at Potosi, Missouri, saw in the sky nearly overhead a bright redness of a tint like that of the rising sun. The phenomenon, which lasted for about fifty seconds, was not caused by a comet or meteor, nor was it auroral light, but was evidently the illumination by the sun's rays of a high, delic ate cirrus cloud. The time of observation was about 1 hour and 40 minutes before sunrise, and allowing for the refraction by the air, it was found that if the cherry-tinted rays of the sun were at that time to illuminate a cloud in the position seen by the observer at Potosi, the cloud must have had an altitude of at least ten miles. Prof. Abbe remarks that in the clear sky of the early morning, and especially in the dry weather of summer, observers will be surprised to find how very early in the morning these delicate clouds may be observed, whence it follows that they must be correspondingly high, in fact, at latitude 52°, and on the 20th and 22nd of June they are reported to have been seen at midnight, when the sun is only 15° below the northern horizon.

Himmel und Erde for February contains an important lecture on cloud-formation, by Prof. W. v. Bezold. He discusses at some length the three principal causes of clouds:—(1) loss of heat by contact with the cold surface of the earth or sea; (2) mixture of unequally heated masses of air at or near the point of saturation; (3) expansion of air owing to change of pressure without sufficient increase of heat; and he illustrates each case by simple experiments. The paper contains some good representative pictures of clouds from photographs taken by Prof. Riggenbach and Dr. Neuhauss; and attention is specially drawn to certain wave-clouds not included in the classifications, but which Prof. v. Helmholtz has shown must occur by the passage of one stratum of air over another of different density, similar in all respects to the waves caused by the wind passing over a cornfield, or over the surface of the water. These clouds become visible when the two strata of air possess sufficient humidity; they occur at very different heights, although they appear to belong more to the middle and higher regions of the atmosphere than to the lower. When they are high enough for several of them to be seen at one time, they form the cirro-cumulus cloud, or mackerel sky. Two pictures of these clouds are given in the text.

WE learn from the *American Meteorological Journal* for March, that the papers read at the Chicago Congress of Meteorology, Climatology, and Terrestrial Magnetism, held last August, are to be published by the United States Weather Bureau in several parts, corresponding to the different sections of the Congress. The first part is nearly ready, and the remaining ones are expected to appear shortly.

THE island of Sakhalin, in the extreme east of Asia, remains one of the least known regions of the Western Pacific, partly, it is probable, because of its use by the Russian authorities as a penal station reserved for the worst offenders, to which outsiders are rarely admitted. In the new number of *Petermanns Mitteilungen*, F. Immanuel gives an admirable epitome of the geography and the present condition of the island, collected from the most recent Russian authorities and illustrated by a map. The mountainous northern interior of Sakhalin is still practically unexplored, but the southern and middle portions are fairly well known. The island has mineral resources of considerable importance, over two million tons of coal having been raised at Dui in 1890. The climate is changeable and ungenial, rain or snow falling on more than half the days of the year, and snow more frequently than rain. The population in 1891 was estimated to include 16,400 Russians and 3200 natives, the latter being mainly Gilyaks (1700) in the north, and Ainu (1100) in the south.

FROM a note in *Insect Life* it appears that attempts are being made to introduce an effective system of quarantine against injurious insects in California. The State is now importing fruits, trees, shrubs, plants, and seeds from Europe, Australia, China, Japan, South Sea Islands, South and Central America, and other localities, and hardly a vessel arrives at its ports which does not bring such objects, many of which are infested with some insect or fungus pest. At the Cape of Good Hope a quarantine law is in operation giving the Governor the power to provide by proclamation for protection against the importation and spread of pests, and providing a heavy penalty for its contravention. It is proposed to adopt similar legislation in California, and if the State succeeds in making its measures in this direction effective, its example will in all probability be widely followed.

THE relation of the sounds of fog signals to other sounds forms the subject of an important paper contributed to *Science* by Charles A. White, of the Smithsonian Institution. The areas of inaudibility which occur well within the range of most, if not all, the fog signals which the various civilised governments have established along their coasts, usually in connection with a lighthouse, are of two kinds. For the first kind the author suggests the name of *montumbral* areas, since they are true acoustic shadows cast by mountain ridges or islands within the range of the signals. The other kind, which is found in the open sea, and whose origin is not yet understood, he proposes to call *pseudumbral*, since they imitate the phenomena of acoustic shadows. There is, however, one important difference. From experiments performed at Sandy Hook upon a pseudumbral area it appears that sounds such as that of a steamer's

whistle were audible at the lighthouse when proceeding from a point within the area, whilst the fog signal itself was inaudible on board the steamer. This would indicate a peculiar one-sided action of the boundary of the area, or a differential effect upon the two kinds of sounds. Another peculiarity of these areas of inaudibility is that they do not annul sounds except those coming in a particular direction. Thus a vessel may be in a montumbral area with respect to a fog signal. A schooner with all sails set and close-hauled may be proceeding outside this area in such a manner as to produce a sail-echo of the fog signal audible on the first vessel. The signal will then appear to those on board to come from the direction of the schooner. Of the two kinds, the pseudumbral areas are the more dangerous, since their place is never quite fixed, and they can only be discovered and mapped empirically—in the present state of our knowledge, at all events.

THE current number of the *Electrician* contains a note by Prof. Fitzgerald on a recent paper of Herr P. Lenard's, which appeared in *Wiedemann's Annalen*. Herr Lenard has continued his interesting observations on the cathode rays in gases under ordinary pressures and in extreme vacua. In the experiments with high vacua, exhaustion was carried on till a coil, capable of giving a spark 15 cm. long in air, could not produce any discharge between terminals sealed into the experimental tube. Herr Lenard estimates that, when he had condensed the mercury vapour in a connected globe by lowering its temperature to $-21°$ C., the pressure of the remaining gas was about $0{\cdot}03 \times 10^{-6}$ of an atmosphere, or about 0·03 dyne per square centimetre. In a tube in which the exhaustion had been carried to this extent nothing was visible on the path of the rays except where they impinged on the glass at the opposite end of a tube 150 cm. long, and when there were no magnets near, they were propagated in straight lines. From these and many other interesting observations Herr Lenard concludes that the cathode rays are phenomena in the ether, and are independent of the presence of matter. With reference to this point Prof. Fitzgerald says:—"If this be so they are a most remarkable addition to the properties of the ether. Phenomena that may all be classed under light propagation are the only known phenomena of propagation in free ether. There is a very essential difference between these cathode rays and ordinary light propagation, and only for this these rays might be very rapid ultra-violet waves, which are known to be rapidly absorbed by air and other gases, but which may be able to run the gauntlet of hundreds of thousands of molecules without being finally absorbed, and might, in accordance with the known transparency of gold leaf, be able to penetrate any solid, even though a conductor, because for their extremely rapid vibrations the molecular motions upon which ordinary conductivity depends may be much too slow to have any sensible effect. The fact that seems conclusive against this view is the deflection of the rays by a magnet. These rays are deflected in the same way as a conductor carrying a current of electricity away from the cathode. No such action has ever been observed on rays of light. It would be most natural to explain the action by the presence of the matter which is generally required in order to be acted upon by a magnet. There seems very little reason for supposing that a magnet would act upon electric displacement currents in the ether, even if displacement currents of the straight ray kind were possible in the ether without propagating themselves out sideways with the velocity of light. When we recollect that in the vacua described by Herr Lenard there are still 10^{10} molecules per cubic m.m. there does not seem sufficient reason for looking to an unknown property of the ether when there is so much matter present to explain the phenomenon."

PROF. KAYSER AND RUNGE'S seventh paper on the spectra of the elements, communicated to the Berlin Academy of Sciences in December last, has been published in separate form. The elements of which the spectra are described in the paper are tin, lead, arsenic, antimony, and bismuth. In the case of the spectrum of tin the lines extend from wave-length 2053·8 to 5631·91, and fourteen lines are marked as new. The spectrum of lead was investigated between λλ 2088·5 and 6002·08, and thirteen new lines were discovered. Lines are tabulated for arsenic from λ 2009·31 to λ 3119·69. The antimony spectrum is limited by a line at 2068·54 in the ultra-violet, and one at 5730·52 rn the red, seven new lines being included. Bismuth has had its spectrum observed between the wave-lengths 2061·77 and 5742·74, and twenty-two new lines have been discovered. At the end of the paper the authors discuss the distribution of the lines and groups in the different spectra, and show that the positions admit of being determined mathematically.

THE behaviour of the filtrate from tetanus cultures when exposed to sunshine is perhaps the most interesting of the numeous observations made by Fermi and Pernossi. Already in 1891 Kitasato tested the pathogenic properties of tetanus filtrates obtained from broth cultures kept in the dark and light respectively, and found that exposure to diffused light gradually rendered them innocuous; it was, however, a very slow process, for even after from nine to ten weeks the filtrate was still feebly toxic. On the other hand, similar filtrates preserved in the dark were still, after 300 days, just as actively pathogenic to animals as when they were originally prepared. In direct sunshine (35°–43° C.), however, such filtrates were rendered perfectly harmless in from fifteen to eighteen hours. On the other hand, Fermi and Pernossi found that the toxic properties were destroyed after from eight to ten hours of sunshine during which the maximum temperature reached was between 38°–41° C., whilst when similarly exposed, the temperature, however (owing to the experimental tubes being immersed in water), not rising beyond 37° C. it required fifteen hours to produce the same result. When, however, the filtrate was first dried and then exposed to sunshine, it remained toxic even after 100 hours' insolation, the same results being obtained when the desiccated filtrate was mixed with chloroform, ether, benzol, and amyl alcohol respectively, and exposed to sunshine. The elaborate nature of the experiments, as well as the large number undertaken and the conscientious care with which they have been conducted, combine to render this one of the most important memoirs which has been yet published on the subject of tetanus.

A FURTHER illustration of the singular media in which fungi will thrive is afforded by the observation of M. Heim, recorded in the *Bulletin* of the Société Mycologique de France, of an abundant fungus-mycele in a solution of sulphate of quinine. It produces a fructification which shows that it belongs to the genus *Aspergillus*, and M. Heim proposes for it the name *Aspergillus quininæ* sp. n. (?).

THE annual report of the Board of Regents of the Smithsonian Institution, showing the operations, expenditures, and condition of the institution to July 1891, has just reached us. The volume contains an appendix comprising a selection of miscellaneous memoirs of interest to collaborators and correspondents of the institution, teachers, and others engaged in the promotion of knowledge.

WE have received parts i. and ii. of the thirty-seventh volume of the *Transactions* of the Royal Society of Edinburgh, and vol. xx. (pp. 97–160) of the *Proceedings*. Among the investigations described in the volumes we note the work of Prof. Crum Brown and Dr. James on the electrolytic synthesis of

dibasic acids; of Prof. Tait on impact; of Mr. Aitken on the particles in fogs and clouds; of Dr. John Murray on the chemical changes which take place in the composition of sea-water associated with blue-muds on the ocean floor; and of Dr. Pole on colour-blindness. Prof. Copeland's paper on Nova Aurigæ is included; and also that of Prof. Knott on circular magnetisation; of Prof. Ewart on the lateral sense-organs of Elasmobranchs; of Prof. James Geikie on the glacial succession in Europe; of Dr. Noël Paton on the action of the valves of the mammalian heart; and of Dr. Macfarlane on the minute structure of plant hybrids in relation to that of their parents.

RATHER more than one hundred years ago Christian Konrad Sprengel gave to the world his investigations on flower-fertilisation. The acute observations contained in "Das Entdeckte Geheimniss der Natur im Bau und in der Befructung der Blumen"—the secrets of nature in the forms and fertilisation of flowers discovered—have been reprinted by Engelmann, of Leipzig, in Nos. 48–51 of Ostwald's Klassiker der Exakten Wissenschaften. Every naturalist now knows that Sprengel's theory of insect fertilisation was not a full interpretation of nature's secrets. His careful observations, however, were of prime importance in helping to establish the true theory of cross-fertilisation presented by Darwin some seventy years after the publication of his work. In addition to the above reprint we have received No. 44 of the same series, entitled "Das Ausdehnungsgesetz der Gase." The volume contains a capital collection of papers on the law of gaseous expansion, by Gay-Lussac, Dalton, Dulong and Petit, Rudberg, Gustav Magnus, and Regnault, published from 1802 to 1842.

THERE is a school of philosophers who insist that all in-investigation into the causes of things is wasted labour, and that science progresses solely through the study of phenomena and their laws. Mr. Lester Ward is not one of these, for in a lecture on the "Status of the Mind Problem," recently delivered before the Anthropological Society of Washington, he showed that the work of Ramón y Cajal, and others, indicated that protoplasm is not merely the physical basis of life, but is the physical basis of mind also. In his words, "the prevailing fashion among scientific men of emphasising the 'mystery of mind' is unnecessary and illogical, since mind is no more a mystery than matter, and all that there is any ground for confessing is that, in consequence of the greater complexity of mental phenomena, due to the higher state of development of the material basis of mind, we possess as yet much less knowledge of them than we do of many of the simpler phenomena of nature."

A SERIES of compounds of sugars with mercaptans, the sulphur alcohols, of a nature similar in many respects to that of the recently isolated glucosides formed by the combination of ordinary alcohols with the sugars, are described by Prof. Emil Fischer in the current *Berichte*. These new substances differ from the glucosides of the alcohols in their constitution, however, for they contain two equivalents of the sulphur alcohol to one equivalent of the sugar; hence they are more nearly allied to the similarly constituted compounds of mercaptans with ordinary aldehydes. The members of the series fully described are the ethyl mercaptals of grape sugar and of galactose, and the amyl mercaptal of the former. In addition to these Prof. Fischer has isolated the ethyl mercaptals of mannose, arabinose, rhamnose, and α-glucoheptose, and has qualitatively proved the generality of the reaction for xylose, maltose, and milk sugar. The compounds appear likely to prove of very great importance, for their formation occurs so readily, that they will serve admirably in many cases as valuable aids in the identification and isolation of either the well-known or newly-discovered sugars. The amyl compound in particular appears likely to be of great service, on account of its slight solubility. They are all substances of considerable stability, and crystallise well. Glucose ethyl mercaptal, $C_6H_{12}O_5(SC_2H_5)_2$, is prepared by mixing ethyl mercaptan with an ice-cold solution of grape sugar in fuming hydrochloric acid. Upon cooling, after the slight rise of temperature which accompanies the reaction, crystals of the new compound separate, and may be advantageously recrystallised from absolute alcohol. The reaction is simply an addition of two molecules of the mercaptan to one of glucose with elimination of a molecule of water.

$$C_6H_{12}O_6 + 2C_2H_5SH = C_6H_{12}O_5(SC_2H_5)_2 + H_2O.$$

Glucose ethyl mercaptal crystallises in colourless needles and plates, which possess a taste very different to that of sugar, being disagreeably bitter. The crystals melt at 127, and the liquid may be partially distilled at a higher temperature. The substance is only slightly soluble in cold water, and the solution is lævo-rotatory. It behaves as a weak acid, and it is somewhat remarkable that alkalies dissolve the crystals in large quantity, and upon the addition of a dilute acid the compound is precipitated. Indeed the sodium salt, $C_{10}H_{21}S_2O_5Na$, has been isolated in well-defined crystals by treating the compound with sodium dissolved in methyl alcohol. That the substance is very different in its nature from the original glucose is further evidenced by the fact that it does not reduce Fehling's solution. The other members of the series appear to be characterised by similar but graduated properties, the solubility, for instance, diminishing as the homologous series of mercaptans is ascended.

CHLORAURATE of silver, $AgAuCl_4$, an interesting compound of the very soluble and deliquescent chloride of gold with the particularly insoluble chloride of silver, is described by Dr. Hermann, of Aschaffenburg, in the same number of the *Berichte*. This compound has formed the object of previous unsuccessful researches, but its preparation is very simple when the necessary conditions are known. Four parts by weight of metallic gold is dissolved in aqua regia, and the solution evaporated over the water bath, until upon cooling the resulting chlorauric acid, $HAuCl_4$, crystallises. One part by weight of silver dissolved in dilute nitric acid is then added, when silver chloride is precipitated in its usual form. Upon repeated evaporation of the whole with concentrated nitric acid containing a trace of hydrochloric acid the silver chloride changes, becoming coloured bright red, and eventually is completely converted into a mass of crystals of silver chloraurate. The crystals are long prisms terminated by pyramids and dome-faces; they appear to be coloured bright orange-red when singly examined by reflected light, but are pure yellow by transmitted light, and the finely-powdered substance reflects bright yellow light. It is interesting to note that when enclosed in a sealed tube containing perfectly dry air the compound is quite stable and unaffected by bright sunlight, but the moment it is exposed to sunshine in ordinary moist air it commences to bronze, and eventually becomes superficially coated with a dark bronze metallic coating. Dilute hydrochloric acid instantly decomposes it with formation of silver chloride and a solution of chlorauric acid. Ammonia, on the other hand, decomposes it with production of the usual ammoniacal solution of silver chloride and deposition of fulminating gold.

THE additions to the Zoological Society's Gardens during the past week include a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, presented by Mrs. White; two Cockateels (*Calopsitta novæ-hollandiæ*) from Australia, presented by Mrs. Tidey; a Leadbeater's Cockatoo (*Cacatua leadbeateri*) from Australia, presented by Mr. J. Ward; a White-bellied Eagle (*Haliaetus leucogaster*) from Australia, presented by Mrs. Scales; a Ring-necked Parrakeet (*Palæornis torquatus*) from India, presented by Miss Castle; two Peregrine Falcons (*Falco peregrinus*) British, presented by Mr. Penn C. Sherbrooke; a

Great Eagle Owl (*Bubo maximus*) European, presented by Mr. H. Godman; two Black Apes (*Cynopithecus niger* ♂ ♂) from the Celebes, a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, deposited; two Alpine Accentors (*Accentor collaris*) European, purchased; a Coypu (*Myopotamus coypus*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

PHOTOGRAPHIC NEBULOSITIES IN THE MILKY WAY.—In the March number of *Astronomy and Astro-Physics*, and in several recent numbers of *Knowledge*, Prof. E. E. Barnard describes a number of wisps of nebulosity and diffused masses of luminous haze discovered upon photographs taken by him with a portrait lens six inches in aperture and having a focal length of thirty-one inches. A remarkable and large nebulous mass, situated about R.A. 21h. 34m. Decl. + 56° 50′ appeared upon a plate exposed for seven hours. The picture shows a straggling group of bright stars in the centre of the nebula, which is more than two degrees in diameter. The group of stars is visible to the naked eye as a hazy spot, about three degrees north-west of the variable μ Cephei, the brightest star in the group being D.M. + 56° 2617. The star D.M. + 57° 2309 (mag. 6·5) is also shown by the photograph to be surrounded by a rather unsymmetrical dense circular nebulosity. This object was not previously known to be nebulous, though Prof. Barnard says that with the telescope the nebulosity can be seen as a hazy glow about the star. The region of the Milky Way lying north and east of Orion appears to be singularly rich in large diffused nebulosities. Photographs show that ω Orionis and λ Orionis are nebulous, while there is a faint and large diffused glow near the stars ν and ξ Orionis. There was a suspicion of a large nebulosity about α Orionis on one of the plates, but this has not yet been verified. The existence of the other nebulosities, however, has been established either by telescopic observation or new photographs. A photograph obtained at the beginning of last month shows two very singular fan-shaped patches of nebulosity close to γ Cassiopeiæ. These are about 15′ in diameter and point towards the star. They could just be seen by Prof. Barnard with the 12-inch of the Lick Observatory, but he thinks they would never have been detected if the photographic plate had not revealed them. Photographs of the region about 15 Monoceros show that this group of bright stars is mixed up with misty matter having a diameter of about three degrees. The place of 15 Monoceros for 1860 is R.A. 6h. 33m. 16s. Decl. + 10° 1′·3, and the condensation of the remarkable nebula in question is 12′ south preceding the star. Prof. Barnard has now photographed the Milky Way from Scorpio to Orion, discovering many masses of nebulosity on the way. His pictures are not only beautiful views, but valuable records of the structure of the different regions portrayed.

MADRAS OBSERVATORY.—From the report of the Madras Observatory, just published in the Monthly Notices of the Royal Astronomical Society (vol liv. No. 4), it appears that the Secretary of State for India has given his sanction to the proposals made by the Government of India regarding the future of the observatory. The observatory, which has hitherto been under the Madras Government, will, from April 1, be transferred to the Imperial Government. According to the report, a new observatory for solar physics will be erected at Kodarkanal, on the Palani Hills, under the direction of the present officiating Government Astronomer, who will, for the present, also have charge of the existing observatory. The new institution will undertake the work of solar photography now carried on at Dehra Dûn, and will also take up spectroscopic work on the sun, and actinometric researches.

A NEW COMET.—The first comet of this year was discovered by Mr. Denning on Monday evening in R.A. 9h. 55m. Decl. +32° 15′. It was small and faint, and exhibited a short fan-shaped tail. The object was moving towards the east-south-east at the rate of nearly one degree per day.

RECENT INVESTIGATIONS AND IDEAS ON THE FIXATION OF NITROGEN BY PLANTS.

THREE totally different, though convergent, scientific controversies have arisen during the latter half of the present century concerning the *rôle* played in nature by nitrogen, as met with in the air, rain, and soil, free or combined, in connection with the ordinary plants of agriculture and forestry; and, quite apart from their real relations to one another, these three controversies have at times been somewhat confused in their issues.

One of these controversies turned on the question of the transformations of combined nitrogen, as met with in the forms of ammonia, nitrites, and nitrates, and as organic compounds of nitrogen resulting from the decomposition of the remains of living beings—plants and animals—in the soil. The outcome has been the proof that oxidations and de-oxidations of these compounds are intimately bound up with the physiological activities of living organisms, especially bacteria, in the soil; the investigations of Giltáy and Aberson, and Winogradsky's brilliant researches especially, have brought what had long been regarded as purely chemical problems into the domain of biology. "Nitrification" and "de-nitrification," to use the current terms, are phenomena incorporated with those of fermentation, respiration, &c., and therefore involve biological science for their elucidation.

Another of these controversies turned on the question whether the free nitrogen which forms so large a proportion of that huge gaseous ocean, the atmosphere, can be again directly employed by green leaves, and built up as combined nitrogen in plants; or whether, once having been disengaged from organic and other compounds, and passed into the air as gaseous nitrogen, it is for ever lost, except in so far as electric discharges and other energetic physical and chemical processes force this relatively inert element into combinations, which the rain then brings down as inorganic salts, and so help to restore the balance of nitrogenous substances in the soil.

This controversy, a long and involved one, started and for some time continued as a peculiarly chemical question, has passed through various phases and branched out into several subsidiary controversies, if we may so term them.

Thus the alleged "fixation" in the soil, especially investigated by Berthelot and André, became a scientific question apparently on definite lines of its own, and (so far as any such question can be independent) independent of the question whether ordinary green-leafed plants, such as peas, lucerne, wheat, &c. can assimilate the free nitrogen of the atmosphere by processes more or less comparable to those by which they are known to assimilate the carbon they wrench from the carbon-dioxide of that gaseous environment.

The latter question, again, became a divided one, chiefly owing to assertions that green leaves could directly assimilate the ammonia, if not the free nitrogen, of the air, and some time was occupied in arriving at the conclusion that ordinary green plants do not directly assimilate or fix either the gaseous ammonia or the free nitrogen of the atmosphere. This conclusion, in opposition to that arrived at by Ville, was regarded as so thoroughly established by the experiments of Boussingault and of Lawes, Gilbert, and Pugh, that it has been definitely accepted and taught for many years—and rightly so, from the evidence to hand.

The third of the three controversies referred to at the outset, is the more recent one concerned with the question whether certain of the higher green-leafed plants, particularly those known as leguminous plants (such as peas, beans, clovers, vetches, lupins, robinia, &c.), when living as they normally do in symbiotic association with certain microscopic and essentially parasitic fungoid organisms which invade their roots, are differently placed from other green plants as regards the power of "fixing," and assimilating, the free nitrogen of the atmosphere.

The present position of opinions on this last and most remarkable controversy is the subject of this article, so far as it can be done justice to in the short space at disposal.

It is now well known that leguminous plants are normally found to have certain nodosities or swellings on their roots, and that these swellings are caused by the activity of certain minute organisms which, as the writer of this article first proved, invade the roots from outside, after the manner of a parasitic fungus. The controversy as to the exact nature of these organisms—bacteria, according to Prazmowski, Beyerinck, and others, degraded allies of the Ustilagineæ, or some lower fungus, according to my observations, and the confirmatory evidence of Laurent—in no way affects the truth that these organisms do not kill the plants attacked, or even make them diseased, but incite them to more active life for a time. The evidence on