dernesses of the Hudson Bay country (though that he has ever personally visited the latter region is not clear), the moose in the wilds of Maine, the caribou on the northern shores of the St. Lawrence, the wapiti deer among the upper waters of the Missouri, the Virginian deer in the Adirondacks or among the Alleghanies, the prong-horned antelope on the plains of Sonora and Northwestern Mexico, grizzly bears among the Rocky Mountains, wolves and foxes any where in the far West, and birds of all descriptions, from a snipe to an eagle. His counsel to the American people respecting the preservation of fish and game deserves to be heeded, but will not be. And the next generation will perhaps read in this volume of species, hunted in this age by "Ubique," which will in that age be extinct, or nearly so. For the hunter there are practical directions as to outfit, seasons, and methods which we judge to be valuable. We can speak from personal knowledge of the wisdom of his counsel only as to fishing tackle. The general reader will find some useful information as to the natural history of American birds and animals, and some entertaining adventures. Like most camp stories, there is occasionally room for suspicion that the incidents are colored and improved for the hearer's benefit. Yet they are simply told and modestly, and there is none either of that egotism or that palpable exaggeration which too often mars and sometimes quite destroys the value and even the true interest of books of hunting adventure.—Very timely is the little treatise on *Hydrophobia: Means of Avoiding its Perils and Preventing its Spread* (Harper and Brothers). The author, H. Bouley, is described as a member of the Institute of France and general inspector of the veterinary schools of France, and it is evident from the language of his lecture that he has had a large personal experience in dealing with this dread disease. The translator, his pupil, A. Liautard, is a professor in the New York College of Veterinary Surgeons. The author describes in great detail the *early* symptoms of rabies in a dog. Most frequently manifesting itself in the canine species, it is also not unknown in other animals, and is even more dangerous in the cat; for the dog will obey his master even after the disease is considerably advanced; the cat will not. He warns us against the caresses of sick dogs, for if the saliva from the mouth comes in contact with even a scratch, there is danger that the poison may be communicated; and in the early stages of the disease the symptoms are not easily recognizable by any except one thoroughly familiar with it. He repudiates muzzling as useless, since the rabid dogs are almost uniformly those that have escaped from home, where they are never muzzled. He recognizes no remedy but an instant and vigorous cauterization of the wound, but shows from statistics that less than half of those persons who are bitten by even rabid animals die from the bite, which is therefore by no means necessarily fatal. The book, which is a pamphlet of only sixty-one pages, is not only helpful, but on the whole hopeful; we only wish it could have been published six months ago. It is worth reading, and the *résumé* at the close is worth cutting out and keeping for easy reference by all owners of dogs.

Editor's Scientific Record.

SUMMARY OF SCIENTIFIC PROGRESS.

OUR *Astronomical Record* for August begins with the announcement of the discovery of a new comet, the fifth of this year, on the 19th of the month, by Coggia, at Marseilles. The absence of Watson and Peters, and the short nights and long twilights of the summer season, seem to have combined to interfere with the search for asteroids, of which no new ones have been reported since June by either American or European observers.

In *Solar Physics* Professor Langley, of the Pittsburg Observatory, announces that he has during the past year been at work upon the relative temperatures of different portions of the sun's surface. At the recent meeting of the American Association he stated that he had used a delicate thermopile, such as was first employed in similar investigations by Professor Henry, of the Smithsonian Institution. Langley's observations fully confirm those published in 1845 by Professor Henry, showing that the solar spots are colder than the adjacent photosphere, but not necessarily colder than the portions of the photosphere near the solar limb, since the heat from the latter is mainly absorbed by the sun's atmosphere.

Stone reports from the Cape of Good Hope that, at the recent solar eclipse observed by him, he certainly saw the Fraunhofer lines in the spectrum of the corona, and that at the moment of totality the spectrum of the disappearing edge of the sun showed all the principal Fraunhofer dark lines reversed to bright ones: the former observations seem to show that the light of the corona is reflected from the photosphere of the sun.

The United States government expedition to the Southern Pacific Ocean for the observation of the transit of Venus has been heard from at the Cape of Good Hope, where the parties stopped on the 5th of August.

Professor Wright states as the result of some observations made with a delicate polariscope upon Coggia's comet that its light was polarized in a plane passing through the axis of the tail, that is, as nearly as could be estimated, in a plane passing through it and the sun. The percentage of polarized light was not large.

Secchi has also observed the appearance of Coggia's comet, and announces the undoubted evidence of polarization. The linear spectrum of the nucleus was by careful examination resolved into a banded spectrum.

The possibility that the diurnal rotation of the earth may be, within small limits, a somewhat irregular movement has been suggested by Professor Newcomb as a possible explanation of certain apparent inequalities of long period in the motion of the moon. A test as to the plausibility of this explanation was found by Newcomb in the observations of the eclipses of the satellites of Jupiter, and at his request the necessary numerical investigations have been made

by a young Russian astronomer, Mr. Glasenapp; from his results Newcomb concludes that although the observations are too uncertain, and the residuals too irregular to prove the hypothesis, yet it seems to be rendered worthy of reception as being in the present state of our knowledge the most probable explanation of the outstanding differences of long period between the theoretical and observed longitude of the moon.

Dr. Gould has communicated a few of the results arrived at by himself in the prosecution of his labors on the "Uranometria Argentina." He states that a great circle or zone of bright stars girds the southern sky, intersecting the Milky Way at the Southern Cross. A trace of this zone of bright stars is also perceptible in the northern sky.

To the two stars, Procyon and Sirius, whose irregular movements enabled astronomers to predict the places of their disturbing companions, Mr. Rogers, of Cambridge, adds a third, Eta Draconis, whose movements are also irregular.

Pogson, at Madras, announces that the means at his command have been lately increased so that he expects to clear away the large arrears of work accumulated at that observatory. Hitherto this has been impossible.

The formation at Prague of a mathematical society is announced.

In the study of the *Physics of the Globe* we notice that Mallet, having carefully examined the volcano of Stromboli, concludes that its mechanism is very similar to that of a geyser. He finds its special phenomena explained by assuming that the lowest portion of its crater, which is of a funnel shape, is prolonged as a tube to a depth of 400 feet or more, until it reaches to a little below the level of the sea. Into the lower end of the tube small quantities of lava find their way, thereby heating up the sea-water that percolates into the interior, and forcing out water, lava, and stones at regular spasmodic bursts. He finds that nothing distinct can be gathered from the inhabitants of the surrounding islands in support of the long-established tradition according to which atmospheric changes were supposed to produce the volcanic eruptions.

The changes of level that have been noticed in Great Salt Lake have been by some referred to the marked variations from year to year in the climate of the basin that drained into this lake, while others have very plausibly contended that besides meteorological influences there are others equally important to be considered; thus the slow seismic changes, by reason of which one portion of the basin may be elevated while another is depressed, may in a short time completely alter the relative depths of the water on opposite sides of the lake. As a standard to which to refer these changes, Dr. Park, of the Deseret University, has, at the request of Professor Joseph Henry, erected a monument near the shore at Black Rock: four such monuments on opposite sides of the lake would, we apprehend, be necessary in order to afford information sufficient to satisfactorily answer several interesting queries concerning this subject.

Captain Dutton, in some remarks on the contractional hypothesis as explanatory of the phenomena of volcanoes and earthquakes, concludes that Fourier's theorem relative to the cooling of the earth shows that the greatest possible contraction due to secular cooling is insufficient to account for the phenomena attributed to it; by far the larger portion of this contraction must have taken place before the commencement of the paleozoic age, and the larger portion of the residue must have occurred before the beginning of the tertiary; and yet the whole of this contraction would not be sufficient to account for the disturbances which have occurred since the close of the cretaceous.

The earthquake of 1873, October 22, in Germany, has been made the subject of some study by Professor V. Lafaulx and Professor Kortum, of Bonn, who conclude that the origin of the shock was at a depth of between three and six English miles. The velocity with which the earthquake wave ran along the earth's surface was about eleven miles per minute.

Under the new organization of the *Meteorological* service of France, Rayet, astronomer at the Paris Observatory, has official care of the observations taken in France; Froat investigates the disturbances, and sends storm warnings to the principal French sea-ports; Sainte-Claire Deville is general inspector for meteorology. The storm warnings sent from England to the French sea-ports will probably also be continued.

The publication at Paris of the atlas of general movements of the earth's atmosphere having ceased some years ago, Hoffmeyer, director of the Danish Meteorological Office, proposes to publish an equivalent atlas for the North Atlantic and European stations, which work will respond to a long-felt desideratum.

In the last annual of the Hungarian Meteorological Institute Schenzl gives the results of observations made during eight years at Ofen on the temperature of the earth at depths of from four to twenty feet. On the average, he finds that twenty-one days are required by the temperature to penetrate to a depth of three feet. The stratum at which the temperature is constant is at Ofen not so deep as at Munich.

The first report has been received from the new Magnetic Observatory at Zi-ka-Wei, in China. This institution possesses a complete set of self-recording magnetic instruments, and promises to constitute an important station for magnetic observations, the only other prominent magnetic station in that country being that at Pekin, under the direction of Fritsch.

In the *Molecular Sciences, Optics, Acoustics, Electricity*, etc., we note that Becquerel announces that experiments made at his suggestion on the possibility of rendering photographic plates sensitive to every color have been productive of remarkably interesting results. Following Dr. Vogel's idea of coating the plates with transparent films, he has been able by the use of chlorophyll to obtain a spectral image of much greater length than when plain collodion is used. The characteristic absorption band of chlorophyll dissolved in collodion was well photographed.

The fact that two differently colored spots, when viewed each with but one eye, are by the mind combined into a single spot of an intermediate color, exactly as if the two colors had been combined by a rapid rotation of each before the eye, has long been an inexplicable phenomenon, the solution of which seems at last to have been found by Von Bezold.

The modified form of the spectroscope suggested by Professor Eaton, of Philadelphia, promises to be exceedingly convenient and economical. Eaton's modification consists principally in attaching to one of the faces of an ordinary bisulphide of carbon prism or dense glass prism a thick plate of glass with *parallel sides*. With this apparatus the dispersion is four times greater than that of the ordinary sixty-degree prism.

Professor Mayer continues his experimental researches in acoustics, in which he has by a series of brilliant experiments laid bare the hidden processes of hearing in both insects and mankind.

Professor Barker, in an interesting discussion of the relations announced by Professor F. W. Clarke relative to atomic heats, urges the claims upon scientists of the "chemical physics," "a field of research avoided," as he says, "by the chemists, and ignored by the physicists."

Mr. Thayer, student in the physical laboratory at Harvard College, publishes some experiments showing that in the case of condensers made with solid dielectrics the slowly diminishing current which is observed when the plates of a polarization battery are connected may be due to a decomposition of the material separating the plates of tin-foil; the current was not sensible when the dielectrics were absolutely dry.

The theory elaborated during the past five years by Edlund, of Stockholm, as to the physical nature of electricity has lately received an excellent support by the review by Emsmann of all the arguments for and against its correctness. Edlund assumes, as we have formerly stated, no new imponderable substance, but merely makes use of that property of the ether of the opticians which was of no importance in the theory of light. He shows, namely, that the inertia and slightly imperfect elasticity of the ether molecules, by reason of which they require a small amount of time in order to effect their movements, is that property that gives rise to the peculiarities of electrical phenomena. In short, electricity, galvanism, and magnetism are but manifestations of the workings of that same ether that suffices to explain the phenomena of light and heat.

Among *Ethnological* communications worthy of notice we have one by Mr. Lawson Tait, in which he draws attention to an arrow-head, figured in a late number of the *Scientific American*, having a feathered edge, "so that if the weapon with which it was armed was propelled with any great rapidity its revolution would be a matter of necessity, and would result in a greater steadiness in its line of trajectory."

Evidence seems to be accumulating upon us that while mankind have invented many of the instruments of comfort and happiness, they have borrowed many from the animal world. In other words, man is not the only "tool-using" animal. Sir John Lubbock tells us, "Elephants break off boughs and use them as fans. Monkeys use clubs, and throw sticks and stones at those who intrude upon them. They also use round stones for cracking nuts." Mr. George J. Romanes several months ago called attention in *Nature* to the "care of monkeys for their dead." He has made experiments upon the same subject with reference to rabbits, and observed that rabbits shot near the warren crawl if possible into it, and after dying will be brought out by their companions.

The seventh session of the International Congress of Anthropology and Prehistoric Archæology, which was announced in a previous number of this magazine, was closed on Sunday, the 16th of August, at Stockholm. The meeting was a triumphant success, over half the members being present. The only American whose name we notice among the officers was Professor Whitney. The king and the city of Stockholm extended the most hearty welcome to the distinguished guests. The next meeting will be held at Buda-Pesth.

In the *Revue d'Anthropologie* M. Topinard discusses Camper's system of facial-angle measurement, and attributes the disrepute into which it has fallen to the carelessness and want of mutual understanding among those who have used it. The same may be said of every branch of ethnology. But the time has come for the establishment of a better and more uniform terminology. The abandonment of a merely geographical arrangement of objects, and a disposition to adopt a more rigidly scientific classification, will be instrumental in effecting greater uniformity of terms.

Under the head of *Microscopical Science* we notice in the July number of the *Quarterly Journal of Microscopical Science* the following simple and easily made cement, which is highly recommended by Mr. Busk, and possesses the advantage that it can be used under water or weak spirit, so that the cover can be affixed beneath the surface of the fluid, and the admission of air bubbles thus effectually prevented. This caoutchouc size, as he terms it, is prepared by melting caoutchouc in an iron or porcelain cup till it is reduced to a viscid tar. When cold it is dissolved in benzine to the consistency of thick gold size. After application to the edges of the glass cell it is allowed to dry fifteen minutes to evaporate the benzine; after which the cover, completely immersed in fluid if desired, is applied and pressed firmly into place. When the surfaces are dry, a solution of shellac or other varnish completes the mounting.

Careful microscopic examination has shown that caries in teeth is largely due not merely to the acids of the mouth, but to a vegetable parasite, *Leptothrix buccalis*. Besides this there are other vegetable and even animal growths; these are not much affected, except as to their abundance, by the ordinary means employed to clean the teeth, but soapy water appears to destroy them. The fungus attains its greatest size in the interstices of the teeth, and after the action of acids, taken with the food or in medicines, or such as are formed in the mouth itself by some abnormality in the secretions, which make the teeth more or less porous or soft, the fungi penetrate the canaliculi both of the enamel and of the dentine, and by their proliferation produce rapid softening and destructive effects. Those interested will find an able article upon this subject in the *Lancet*, December 13, 1873.

We find in the *Medical Record*, July, 1874, an account of two cases of the fatal malady called malignant pustule, and known, when occurring in cattle, as "the blood," and to which the French give the name charbon, and the Germans that of Milzbrand. A microscopic examination showed

in the blood and in the greenish-yellow spots and in the parenchyma of the gastric walls enormous quantities of Bacteria; the disease was communicated from the first patient to the *post-mortem* assistant of the hospital, and both cases were fatal. Subsequently, Dr. Orth inoculated a rabbit with the fresh blood of the second case, and from this one another, and so on till eight were injected. Masses of Bacteria were found in the blood and connective tissue of all these animals.

In *Zoology* the most interesting discovery is that of Professor E. Van Beneden, of Liege, who shows that of the two membranes of which the hydroid polyps are composed, the outer (ectoderm) gives rise to the testes and spermatozoa, and the inner to the ovaries, so that the outer layer is male and the inner female. He considers that the process of fecundation in animals consists in the union of an egg with a certain number of spermatozoids, this act having no other end than bringing together chemical elements of opposite polarity, which, after having united for a moment in the egg, separate again; for in most animals, as soon as the division of the yolk into two portions appears, the elements out of which the outer layer is formed are already separated from those which constitute the internal layer of the embryo. The new individual is formed at the moment when the union between the elements of opposed polarity is effected, as absolutely as the molecule of water is formed by the union of atoms of hydrogen and oxygen.

Van Beneden maintains, from the facts afforded by other embryologists, that the same sexual differences occur in the two embryonal layers of the vertebrates, and he thinks it probable they will be found to exist in all animals. This bears out the prevalent idea that the sex of animals is determined at the time of fecundation of the egg.

Through the explorations of Dr. Packard in the caves of Kentucky, Indiana, and Virginia, in connection with the geological survey of Kentucky, some forty additional species of insects have been added to our cave insect fauna. In the famous Weyer's Cave, near Staunton, Virginia, about twenty species were discovered where none were before known to exist. The larvæ of the two blind cave beetles (*Adelops* and *Anophthalmus*) were found, and many facts bearing on the distribution and origin of cave animals collected.

In the *Monthly Microscopical Journal* is appearing a series of papers on the nervous system of the sea-anemone (*Actinia*), by Professor P. Martin Duncan. In the August number he gives a *résumé* of our knowledge on the subject. He substantiates the discovery made by Schneider and Rötteken of isolated nerve cells near the pigment cells at the base of the tentacles of the *Actinia*, supposed to be eyes. In connection with these nerves are certain round refractive cells (Haimean bodies) and other long cells, called the Rötteken bodies. The former, he thinks, carry light more deeply into the tissues than the ordinary epithelial cells. This is also the case with the elongated Rötteken cells and others similar to them, called bacilli. All these, he believes, with Schneider and Rötteken, when in combination, concentrate light. "When they are brought together in this primitive form of eye they concentrate and convey light with greater power, so as to enable it to act more generally on the nervous system, probably not to enable the distinction of objects, but to cause the light to stimulate a rudimentary nervous system to act in a reflex manner on the muscular system, which is highly developed." "The evolution of an eye," he adds, "probably took the path which is thus faintly indicated in the *Actinia*, which doubtless has an appreciation of the difference between light and darkness." Duncan discovers, as he thinks, very fine nervous filaments at the base of the body of the *Actinia*.

A noteworthy paper has been published by Mr. H. N. Moseley, of the *Challenger* expedition, in the proceedings of the Royal Society, on the anatomy and affinities of a singular terrestrial articulate animal known as *Peripatus*, and usually regarded as a worm. It seems, however, that the young breathe air through tracheæ, which are wanting in the adult. *Peripatus* would for other reasons be regarded as related to the insects were it not that the two nervous cords are widely separated, instead of being united at intervals into ganglia, as among true insects. Moseley shows that *Peripatus* has affinities both to the true insects and the myriopods. He then speculates on the derivation of insects from some form, such as *Peripatus*, and thinks it "may well be placed among Professor Häckel's *Protracheata*." "If these speculations be correct," he adds, "the crustacea have [had] a different origin from the tracheata"—a view already suggested by Packard, who had previously, unknown to the author, regarded *Peripatus* as a stem form of insects, and connected them with the worms.

Professor Peters finds new coincidences between the development of the *Cæciliæ* and other batrachians. He states that these creatures possess neither amnion nor allantois, that they are, at least in part, viviparous, and that at a certain period of the year they are aquatic.

M. Dareste gives in the *Archives of Experimental Zoology* a memoir on the origin and mode of formation of double monsters.

An interesting paper on the sound produced by European fishes, by M. Dufosse, appears in the *Annales des Sciences Naturelles*, while M. Baudelot prints in the *Archives de Zoologie Expérimentale* a paper on the scales of the bony fishes.

Some valuable contributions to *Agricultural Science* have appeared in the reports of the Connecticut Board of Agriculture for 1873, in which, among other articles, we find the proceedings of the winter meeting of the Board of Agriculture, and the reports of the pathologist, pomologist, and chemist of the board. The winter meeting, was, in fact, a large farmers' convention, in which lectures were delivered and discussions held of considerable scientific value. A lecture was delivered by Professor Atwater, on "Commercial Fertilizers at Home and Abroad," in which it was shown that the fertilizers are very much better and cheaper in Europe, and especially in England and Germany, than in our own country, and that this difference was largely due to the control exercised by means of chemical analysis over the trade in commercial fertilizers.

The establishment of an agricultural experiment station in Connecticut was discussed at the meeting, and steps taken for the presentation of

the subject to the people of the State, and of a petition to the Legislature for an appropriation of money to found and carry on a station.

The report of Professor Johnson, chemist of the board, contains analyses of thirty-one specimens of fertilizers in common use in the State. "The analyses of the manufactured fertilizers reveal perhaps but one positive adulteration, viz., a sample of ground bone largely mixed with oyster shells. They demonstrate, however, the fact that in most cases the consumer has no guarantee that he gets his money's worth, commercially considered, when he purchases them, and they confirm the view that he will never be able to buy with such assurance until he stipulates for so many pounds of this and that fertilizing element, nitrogen or phosphoric acid, as the case may be, in a well-defined state of solubility or availability, instead of buying so many tons of so-called ground bone or superphosphate, it may be on an old analysis, or without analysis at all."

Quite a good idea of the recent progress and present status of investigation in agricultural chemistry may be derived from the transactions of the "Section for Agricultural Chemistry" of the meeting of the German *Naturforscher und Aerzte*, held at Wiesbaden in September, 1873. Nearly forty persons were present, among whom were a number of the directors and chemists of the German experiment stations. The proceedings consisted chiefly of accounts of new investigations in animal and vegetable chemistry and in physiology.

Dr. Von Wolff reported a series of experiments on the digestive capacity of swine for various fodder materials. Cock-chafers (*Maikæfer*), which are sometimes collected in large quantities in Germany, were found to be quite nutritious, forty-four per cent. of the albuminoids and ten and a half per cent. of the fat being digested by the swine. The digestibility of barley, maize, beans, pease, cocoa-nut cakes, was also tested. The high digestive capacity of swine for carbo-hydrates was strikingly demonstrated. The opinion which has been maintained that the fats of the animal body are made from the albuminoids of the food alone was controverted by some of these experiments in which the albuminoids of the food were insufficient to cover the increase of fat in the bodies of the swine, so that the carbo-hydrates appear also to have taken part in the formation of the fat.

Dr. Von Wolff reported also some experiments on the digestive capacity of sheep for hay when fed alone, and with turnips. Previous experiments have shown that when to "crude fodder materials," as hay, materials rich in carbo-hydrates but poor in albuminoids, as potatoes, meal, or starch, are added, the digestion of the crude fodder, and particularly of its albuminoids, is thereby decreased. In this case the decrease in digestion of the albuminoids of the hay when turnips were added was considerably less than had been found to be the case with potatoes or starch.

Professor Mayer, of the University of Heidelberg, gave accounts of experiments on the absorptive power of leaves and other superterraneous parts of plants for ammonia. Various plants were found capable of absorbing carbonate of ammonia in the gaseous form and in solution. No special facility on the part of leguminous plants for absorbing combined atmospheric nitrogen appeared from these experiments.

Dr. Fleischen, of the experiment station at Weende, reported a new respiration experiment with sheep, in continuation of and with similar results to those which have been going on for some years past at his station.

Other investigations by Wolff on the influence of different amounts of phosphoric acid upon the development of oat plants grown in aqueous solutions, and by Weiske and Wildt on the excretion of hippuric acid, our space will not allow us to describe.

Accounts lately received of the transactions of the first meeting of the directors of the Italian experiment stations, held at Rome in January, 1873, show that a considerable amount of valuable work has already been done, and that the prospect for the success of these institutions, lately established in Italy, is very encouraging. No less than twelve stations were represented at the meeting.

In the department of *Engineering* we may chronicle the proposition to build another international bridge across the Niagara River at Grand Island. Charters for this purpose have already been granted by the Legislatures of Canada and New York. Another project of considerable importance is that of a company to bridge the Mississippi at Carondelet, which meets, however, with much opposition. A board of engineers has been sitting in St. Louis during the past month to consider the plans and location of the bridge, acting under instructions from the Secretary of War.

Work on the East River Bridge continues. The key-stones of the arches in the Brooklyn tower were raised to their places August 8. They weigh eleven tons each. This tower is now 225 feet above high tide, and will probably be finished by November. The New York tower is now 148 feet above high tide, and it is expected will be carried above the spring of the arches before cold weather. The Brooklyn anchorage is now forty feet up, but that on the New York side is not yet begun. The Brooklyn City Council has voted an additional $2,000,000 to the enterprise.

From the Hoosac Tunnel we have the report that much additional arching will be required to make transit perfectly safe, and the work is being executed by the Messrs. Shanly, who completed the excavation of the tunnel. Apropos of the much-discussed Channel Tunnel, the *Engineer* records the statement that the Great Northern Railway of France has volunteered to contribute its share of £80,000, provided the British railway lines contribute their portion, for the purpose of meeting the estimated cost of running preparatory driftways to determine the character of the bed of the Channel, and thus set at rest the question of the ultimate practicability of the project.

The recently launched iron steam-ship *City of Peking* has made her trial trip with great satisfaction. Mr. John Roach, her constructor, has received a contract to construct three additional steam-ships for the same line.

The Henderson hydraulic brake, which has of late received much attention, was given an experimental trial some weeks ago on the West Chester and Philadelphia Railroad. The train

consisted of five passenger cars and one baggage car, attached to a powerful locomotive, which were run about ten miles up the road, making a number of stops to test the efficiency of the brake. Three stops were made with the following results: 1st. Grade descending 15 feet to the mile; speed, 35 miles per hour; train stopped in distance of 630 feet, and in 20¼ seconds time; boiler pressure, 105 pounds. 2d. Grade as above; speed, 32 miles; stopped in 540 feet; boiler pressure, 115 pounds. 3d. Level; speed, 35 miles; stopped in 840 feet, in 28½ seconds; pressure, 105 pounds. These results will compare favorably with those obtained by the most approved forms of power brakes. The construction of the Henderson brake, to which allusion has already been made in these columns, is extremely simple, a fact which constitutes one of its principal merits.

The last month was signalized by the meeting of the American Association for the Advancement of Science, at Hartford. The number of papers presented was quite large. The only one, however, which falls within the scope of this department is that of Professor T. Sterry Hunt on a new wet process of copper extraction. The process, which is too long to describe in detail, involves the employment of protochloride of iron, which converts the oxide of copper into a soluble chloride. From this solution the copper is precipitated by metallic iron. The speaker affirmed that in this process the injurious elements of the ores, such as arsenic, antimony, and tin, remain undissolved, and the metallic copper obtained is so pure that it can be made into fine copper by a single fusion.

The Chief of the Bureau of Statistics furnishes the following statement of the principal exports from Great Britain to the United States during the seven months ending July 31, 1874, as compared with the corresponding period of 1873:

Articles.	1873.	1874.
Copper (unmanufactured)....cwt.	43,804	724
Copper (manufactured).....cwt.	1,286	707
Hardware and cutlery.....£	479,895	364,334
Iron and steel (bar, bolt, etc.).tons.	21,095	2,397
Iron (railroad of all kinds)...tons.	134,393	72,631
Iron (hoop, sheet, boiler) ....tons.	13,834	3,396
Tin plates.....tons.	58,462	53,405
Old iron.....tons.	27,400	5,259
Steel.....tons.	12,624	7,603
Lead (pig, etc.).....tons.	2,287	1,455
Machinery.....£	348,904	135,791

The comparison is instructive, as showing a heavy decrease in every item given.

From reports recently made to the government Land-office the following statistics indicate the extent and distribution of the Rocky Mountain coal-field:

Locality.	Area.	Coal Area.
	Square Miles.	Square Miles.
Texas	237,000	30,000
Indian Territory	69,000	40,000
New Mexico	122,000	20,000
Kansas	80,000	80,000
Missouri	67,000	24,000
Nebraska	84,000	84,000
Iowa	55,000	24,000
Wyoming	68,000	20,000
Colorado	102,000	20,000
Montana	148,000	74,000
Dakota	150,000	100,000
Total	1,182,000	516,000
Approximate coal area of British Amer..		737,000
		1,253,000

SEVEN ASTRONOMERS ROYAL.

In connection with the valuable astronomical papers published in this Magazine during the present year—a year of unusual significance in this department of science—the following summary, copied from a recent number of the *Edinburgh Review*, and showing the work accomplished by the astronomers of the Royal Observatory at Greenwich since 1674, will be of great interest to our readers. The record has special reference to lunar observations.

The Royal Observatory at Greenwich was built in the reign of Charles II., "for the rectifying the tables of the motions of the heavens, and the places of the fixed stars, so as to find out the longitudes of places for the perfecting the art of navigation." Flamsteed, a contemporary of Newton, was appointed the first "Astronomical Observer" of the king, or "Astronomer Royal," in 1674, and the work of the observatory was commenced in 1676. The earliest mural circle, or large circle attached to the face of a wall, with a graduated scale, for exact observations in the meridian, was constructed by Flamsteed at his own expense in 1689; and with this exact instrument the systematic study of the moon's movements was initiated, two years after the publication of the *Principia*, which contained the final development of Newton's great theory. In 1694 Flamsteed supplied Newton with a series of observed places of the moon for use in his calculations. A notable illustration is afforded of the appreciation which was given to astronomical science at this time in the fact that the first mural circle in the observatory was constructed at Flamsteed's own expense; that Flamsteed's salary for his public service was £100 per annum, with a deduction of £10 per annum for a tax, and was coupled with the condition that he should instruct two of the Christ-church schoolboys in nautical astronomy, and that the salary of an indispensable assistant was also paid by him. Flamsteed died on the last day of the year 1719, being at that time sixty-four years of age. His observations were printed five years after his death, under the title, *Historia Cœlestis Britannica*, and the second volume of this work contained places of the moon computed from observation.

Flamsteed was succeeded in the Royal Observatory by Edmund Halley, who was also a contemporary of Newton, and who began his work at the observatory when he was sixty-four years old. It is probable that he was induced to enter upon so laborious an office at such an advanced period of his life on account of the great advantage the position afforded him for prosecuting certain researches into the moon's movements upon which he was already engaged. He constructed a new transit instrument and a mural quadrant, and pursued his investigations with these. About ten years after his accession at Greenwich the reflecting quadrant—the mechanical contrivance which rendered lunar observations at sea for the determination of the longitude possible—was discovered independently by Hadley in England and by Godfrey in America. Tables of the comparison of observed and computed places of the moon from 1722 to 1739 were constructed by Halley, and these were subsequently printed. Edmund Halley died in 1742.

The third Astronomer Royal was James Bradley, whose name is inscribed in the annals of science in imperishable characters on account of his being the inventor of the zenith sector, and the discoverer of the aberration of light, and of the nutation of the earth's axis. He administered the affairs of the Royal Observatory from 1742 to 1761, and the era of what is termed the "exact observations" of Greenwich is generally considered to date from about this time, or, more exactly, from 1750. His observations were printed after his death by the University of Oxford.

During the rule of Bradley at the Royal Observatory the French astronomer Lacaille determined the horizontal parallax of the moon, or, in other words, its distance from the earth, with much greater precision than had been found possible previously; and Mayer, of Göttingen, also completed a series of lunar tables, based on observations of eclipses and of occultations of fixed stars by the moon, which were found to give the proper places of the moon within a minute and a half of celestial longitude. These tables took into account fifteen distinct forms of irregularity. Bradley compared the actual corresponding places of the moon with the forecasts of these tables, and reported in regard to them that they unquestionably rendered it possible for sailors to find their position in the open sea, by observing the distance of the moon from certain standard fixed stars, within one degree of longitude, and that they therefore virtually fulfilled the object for which a public reward had been offered. Mayer's wife, in consequence, after his death received the sum of £3000 from the British government in recognition of the important service thus rendered to the science of navigation. Mayer's tables were extended and otherwise improved twelve years afterward by Mason, and the possible errors in observing and calculating longitude at sea were pronounced to be then further diminished very nearly one-third.

In the last year of Bradley's life, John Harrison, a Yorkshire carpenter and mechanic, rendered the construction of the chronometer so perfect that it became possible for the sailor to carry Greenwich time with him through long voyages, so that thenceforth he could make the chronometer serve the same purpose as observing the distance between the moon and a star. In 1761 Harrison sent a chronometer to Jamaica which went wrong only five seconds and a tenth during the voyage, and this it was found would not have involved an error in longitude for the ship's place of more than two miles. The sum of £20,000 was awarded to Harrison by an act of Parliament for this improvement of the marine chronometer. The observation of lunar distances at sea became of only secondary importance after this. But it was still held of great consequence, on account of its supplying the means of checking and verifying the performance of the chronometers, and of replacing them altogether in case of accident.

In the year in which Harrison perfected the construction of the marine chronometer, Dr. Bliss succeeded Bradley as Astronomer Royal. But he died within four years, and so left no material contribution to the efficiency of the observatory. Neville Maskelyne followed him in 1765, and continued his distinguished services as Astronomer Royal for the long term of forty-six years. He had been so fortunate as to have been previously engaged in observing the transit of Venus at St. Helena in 1761, and co-operated in the subsequent observation of this phenomenon eight years afterward, on the historical occasion when Cook was sent to Otaheite. Maskelyne introduced at the Royal Observatory the method of noting the transits of celestial bodies over a system of five vertical wires placed in the field of the telescope, and first ventured upon the refinement of reckoning the meridian passage of a star within tenths of seconds. The distinguished honor also belongs to him of having commenced the publication of the *Nautical Almanac*, which first appeared two years after his appointment as Astronomer Royal. He was engaged with the preparation of a fine mural circle for the observatory when his useful life was brought to a close, at the advanced age of seventy-nine years.

During the reign of Maskelyne at the Royal Observatory the French mathematicians Laplace and Lagrange had been making important progress in investigating theoretically the moon's movements. A slight continued acceleration of the moon's rate of traveling, and a gradual shifting of the points where the planes of the orbits of the moon and of the earth cross each other, and of the situation of the moon's farthest departure from the earth in each turn of its revolution, were traced to a gradual diminution in the eccentricity of the earth's orbit. The disturbing influence of the equatorial bulging of the earth, and of the varying distance of the sun, had also been detected. In consequence of these rapid and important advances in theoretical knowledge the French Academy of Sciences thought it well to offer a prize for new tables of the moon in which all these discoveries should be taken into account. Tables were published in answer to this appeal in 1802, by Tobias Burg, of Vienna, and these were still further developed, as it was then thought, in 1811, by the astronomer Burckhardt, who discussed no less than four hundred observations of the moon for this purpose. The extended tables of Burckhardt were thenceforth adopted in the preparation of the *Nautical Almanac*, under the impression that they were the best then available; but it unfortunately happened that a complicated and involved form of expression had been used in them, which served to conceal for a long time certain inherent imperfections. It was only in subsequent years that it was discovered these tables allowed errors in the moon's calculated place as large as half a minute of longitude.

John Pond succeeded Maskelyne at the Royal Observatory, and he had the satisfaction of adding a large transit instrument to the equipment of the place. He gave great attention to establishing the positions of standard fixed stars that could be used as the graduations of the heavens from which the moon's movements had to be measured. The great improvement, however, which he introduced into observational astronomy, and which enabled him to accomplish his object of getting more exact observations of the fixed stars, was the very beautiful method of observing the image of the star reflected from the still surface of mercury at the same instant that the star was seen through the telescope. The half of the angular measure that was included between the lines of sight in which the two observations were made of necessity gave the height

of the star above the horizon. In this way all levels and plumb-lines for getting the bearing of the horizon were summarily dispensed with. The observation found its own horizon by the simple expedient of establishing reflection from an absolutely horizontal surface. This method of getting observations above the horizon is of the most exquisite perfection of delicacy and exactness, and is so entirely satisfactory that it is still in use in observing altitudes and polar distances with the great meridian instruments at Greenwich.

The seventh individual in the series of distinguished men, which completes the list of the Astronomers Royal of Great Britain, is Sir George Biddell Airy, who succeeded Pond in 1835, and still happily fills the place of "astronomical observer" at the great national observatory. It would not be an easy task to enumerate all the good services that this energetic veteran has rendered in his long term of thirty-nine years' service. But some of these must be named on account of the direct bearing they have upon the perturbational history of the moon and the perfection of the tables of the moon's movements. While Mr. Airy was yet directing the operations of the observatory of the University of Cambridge he introduced the admirable and most important practice of having all current observations at once reduced, with the necessary refinements of correction, and printed side by side with the corresponding terms of the tables that presumably represent them, so that each particular failure in the table might be apparent at a glance. Before this period all the moon observations had been taken by meridian instruments; that is to say, the place of the moon was noted on the instant that it crossed the meridian, by measuring its height in declination above some standard fixed star, and its distance in right ascension from the same star counted in seconds of time that elapsed between the consecutive meridian passages of the moon and star. This method of observing is very exact, but it of necessity limits very materially the number of moon observations that can be made. As soon, therefore, as the present Astronomer Royal had fairly entered upon his career of public service, he set himself to add to the equipment of the observatory an instrument by which good observations of the moon could be taken *out of the meridian*. The instrument which he constructed for this purpose was the fine altazimuth, that is still in use, and that answers the end for which it was contrived admirably. With it the position of the moon is compared with that of standard fixed stars when it is still far from the meridian on either side, and, what is of still greater importance, the moon is also observed in a part of its orbit in which no observation at all can be taken upon the meridian, and in which part, therefore, there was previously no means of checking off its irregularities of pace. By this expedient of extra-meridional observation the number of satisfactory observations of the moon has been trebled. In the year 1848 Mr. Airy printed the reduced and corrected observations of eight thousand places of the moon that had been made at the Royal Observatory between 1750 and 1830, and which had, up to that time, been of no practical avail, on account of not having had these essential reductions and corrections applied. Other notable improvements in instrumental work that have been effected by the present Astronomer Royal are the adoption of a plan, which he himself devised, of taking the observation of both the direct and reflected images of a star upon the meridian by the same instrument, instead of employing two instruments for the purpose, as was previously done; and the fusion of the two great meridian instruments, namely, the transit and the mural circle, into one, so that both declinations and right ascensions can be read off at one observation, instead of requiring two instruments and two observers. The transit circle which has thus been introduced at Greenwich has now superseded the double-instrument system at all the best observatories.

The near approach to perfection which the lunar theory and the tables of the moon have made has mainly resulted from two centuries of unintermittent work at the national observatory, which commenced with Flamsteed, and which, happily, has not yet ended with Airy. It is, at the present time, just two full centuries since the warrant was issued by the second Charles for the appointment of an "astronomical observer" to look after the scientific interests of navigation, and it is certainly a notable circumstance that through this long stretch of two hundred years there have been only seven Astronomers Royal. If the one exceptionally short-lived Astronomer Royal be withdrawn from the list, the official lives of the remaining six make up the term of one hundred and ninety-six years, and this gives very nearly thirty-three years for the official life of each individual of the series—a very fair allowance indeed, considering the work that is accomplished in the time.

THE SPECIES OF AMERICAN SQUIRRELS.

Mr. J. A. Allen, well known as one of the most accomplished and thorough of American zoologists, has lately published a synopsis of the general results obtained by him from an investigation of the American *Sciuridæ*, or mammals belonging to the squirrel group, including the squirrels proper, the flying-squirrels, ground-squirrels, marmots, etc. As the result of his inquiries, based upon the immense amount and variety of material in the National Museum at Washington, he has occasion to reduce the number of species still lower than that allowed by Professor Baird in his monographs of the same forms, finding that many of those which have hitherto been considered as species are in reality merely climatic or geographical races, several of which are referable to a common type.

A striking generalization obtained in his investigations has reference to the increasing intensity of color of the species in proceeding from the north southward, this being very evident in the fox-squirrel of the Mississippi Basin, the belly of which in the northern part of its range is almost white, while in specimens from Lower Louisiana it is reddish-fulvous, or a deep orange. Equally decided differences exist in specimens of the same species as they proceed from east to west.

Mr. Allen now considers that we have at least five more or less well marked areas characterized by certain peculiarities of color variation in mammals and birds, as well as by a close relation between the areas, the prevalent tendencies of change of color, and the amount of aqueous pre-

cipitation. The first of these regions is that of the Atlantic slope, which includes not only the country east of the Alleghanies, but a large part of the British possessions, extending westward as far as Fort Simpson, and northward and westward to Alaska, including, apparently, all that territory north of the Alaskan Mountains and having an annual rain-fall of about thirty-five to forty-five inches. This region, in view of its great extent, he selects as representing the average or normal type of color, the variation in other regions being in the direction of intensity.

The second region embraces the Mississippi Valley, or more properly the Mississippi Basin, and is termed the *Mississippi Region.* Here the annual rain-fall reaches forty-five to fifty-five inches, and sometimes more. In this region the tendency is to an increase of fulvous and rufous tints, these reaching their maximum in the limited area of greatest humidity, although a general increase of color is more or less characteristic of the region.

The central portion of the Rocky Mountains forms the third region, to be called the *Colorado Region*, as including the greater part of that Territory within its limits. Here the general tendency is to an increase of intensity of colors, as compared with the region west of it, with a development of rufous and fulvous tints. The humidity here is less than that in either of the other regions named, the rain-fall being only from twenty-four to thirty inches.

The fourth area Mr. Allen calls the *Campestrian Region*, and includes the arid plains and deserts of the continent, containing not only the "great plains," so called, but the plains of Utah, Nevada, Western Colorado, New Mexico, Arizona, and southwest to Lower California. Here the rain-fall ranges from three inches to twenty, being below fifteen generally. Here a general paleness of color is the distinctive feature.

The fifth region, called the *Columbian Region*, begins on the Pacific coast at about the fortieth parallel, and embraces a comparatively narrow belt to Sitka. Its peculiarities are most strongly developed west of the Cascade Range north of 45°, and prevail eastward nearly to the main chain of the Rocky Mountains. The average rain-fall is from fifty-five to sixty-five inches. The prevalent tendency in color is to dusky and fuscous rather than rufous tints.

Other subdivisions of a similar character Mr. Allen thinks may be desirable, and may need to be made hereafter, especially for the southern half of Florida, which is characterized by excessive humidity and a subtropical intensity of color; and it may be necessary to recognize as a distinct district the almost rainless portions of the *Campestrian Region.*

Mr. Allen in this communication refers again to the relation between color and humidity previously enunciated by him, remarking that the best mode of expressing it is to say that a decrease of humidity is accompanied by the decrease of intensity of color, this evidently resulting from exposure to the bleaching effect of intense sunlight and a dry, often intensely heated, atmosphere. He refers to the condition of *melanism* as a race characteristic in mammals, and confirms the generalization of Professor Baird that but few mammals possess this in a specific form, and that where it occurs in such groups as the squirrels, the wolves, foxes, cats, etc., the individual must be considered as a melanistic form of some race the normal color of which is different, generally fulvous or rufous.

Mr. Allen's paper embraces a list of the species of North American *Sciuridæ* which he considers permanent, and among the true squirrels he allows but five that are permanent where Audubon gives twenty-four. He, however, recognizes in addition seven geographical varieties, making the whole number of permanently distinct forms twelve. Of flying-squirrels he allows but *one species;* of the genus *Tamias*, or the ground-squirrels, he gives *three;* of the *Spermophilus*, *eleven;* of the prairie-dogs, *two;* and of the true marmots, *three*—making twenty species in all.

THE ATMOSPHERE OF JUPITER.

Dr. Lohse has investigated the velocity of the rotation of the cloud layers of Jupiter at different degrees of latitude on that planet. He finds that, in general, in the middle latitudes of Jupiter, there is a greater stability in the upper strata of the atmosphere than in the neighborhood of the equator, where the velocity of the rotating masses is increased by wind. He sees in this fact a probability that trade-winds prevail there as upon our earth.

THE THEORY OF ERRORS OF OBSERVATION.

Mr. C. S. Peirce, in an interesting article on the laws of errors of observation, and the nature of the so-called personal equation, gives the results of some experiments made upon an entirely untrained observer, a young man about eighteen years of age, who had had no previous experience whatever in observations. He was required to answer a signal consisting of a sharp sound like a rap, his answer being made by tapping upon a telegraph operator's key nicely adjusted. Both the original rap and the observer's tap were recorded by means of a delicate chromoscope, and five hundred observations were made on every week-day during a month. It was found that on the first day the observations were scattered through a very large range of error, the difference in time between the records of the event and of the observation varying in fact between the extreme values from 0.16 to 0.98 of a second. The personal equation proper on the second day was between 0.2 and 0.3 of a second, and from that time it steadily decreased until it amounted only to one-seventh of a second; it then gradually increased until the twelfth day, when it amounted to 0.22 of a second. While this variation in personal equation occurred, the range of errors or discordances was constantly decreasing, until on the twenty-fourth day the probable error of the result does not exceed one-eightieth of a second. This is considered to clearly demonstrate the value of such practice in training the nerves for observation; and he recommends that transit observers be kept in constant training by means of similar observation of an artificial event, which can be repeated with ease and rapidity, it not being essential, he thinks, that those observations should very closely imitate the transit of a star over the wires of a telescope, inasmuch as it is the general condition of the nerves which it is important to keep in training more than any thing peculiar to this or that kind of observation.