(7) The progress of secular extinction of species and other divisions of the animal and vegetable kingdoms, including the types which specially characterise the various stages and sub-stages of the geological scale, was accelerated by adverse changes of environing conditions, and were retarded by a continuance of congenial conditions. The final consummation of the extinction of the types was naturally often, and perhaps usually, caused by catastrophic changes of conditions which occurred within the limited areas to which they were reduced by approaching secular extinction.

(8) The geographical distribution of species within the time-limits of the stages and sub-stages of the geological scale, and consequently that of the distinguishing types which the species constitute, has been effected by natural means. Such means included not only locomotory and mechanical dispersion within those time-limits from one original centre which was then the terminus of an evolutional line, but, at least in the same cases, survival in various regions by separate evolutional lines from the faunas of preceding stages and sub-stages was also included.

(9) The animal and vegetable life of each stage of the geological scale was in the aggregate different as to its forms from that of all others, and each stage and sub-stage was further specially characterised by certain generic, and also more general, types or peculiar groups of species. These types, however, were not necessarily confined within absolute time-limits.

(10) Although movements and displacements of the earth's crust have from time to time occurred over large portions of its surface, arresting sedimentation or changing its character and causing great destruction of life, there has never been a universal catastrophe of that kind. On the contrary, during all the time that disastrous conditions prevailed in any given area, conditions congenial to the existence and perpetuity of life prevailed in other and greater areas.

The second of the two sets of propositions show that certain of the views held by the early geologists, notably those which assumed the universally sharp definition of all the divisions of the geological scale, were radically wrong. Still, it is evident to every one who is familiar with modern geological literature that those views have continued to exert an adverse influence upon the biological branch of geological investigation long after they have been formally rejected, even by those who continued to be influenced by them. The early geologists adopted methods of investigation which were consistent with their biological views, but it has been shown that from the present standpoint of biology certain of those views were so fundamentally wrong that the methods which were based upon them are quite out of place in modern investigation. Still, those methods of our energetic predecessors have come down to the present time with such force and with such evidence of the general correctness of the scale which they had established by them, that it has been difficult for their successors to adopt the modification of methods which has been necessitated by the great subsequent revolution in biological thought and methods of investigation.

The facts which have been stated show that, while the scale which the early geologists established is a wonderful production of human reasoning and the best possible general standard which can be adopted before a comparatively full investigation of the geology of the whole earth has been made, it is not, and cannot be except in a general way, of universal applicability. That is, while the respective stages and sub-stages of the scale are recognisable only by means of their characteristic fossil remains, it has been shown that any of those characteristic forms are so liable to range from one stage or sub-stage to another, that it is impossible to sharply define the limits of stages, and often impossible to distinguish sub-stages in one part of the world as they are known in another part.

(*To be continued.*)

SCIENTIFIC SERIALS.

Bulletin de l'Académie des Sciences de St. Pétersbourg, V^e^ série, t. ii. No. 2, February 1895.—We notice in the proceedings of the meetings, that the full account of Baron Toll's observations in the New Siberia Islands will soon be published by the Academy. In the meantime the explorer has visited Switzerland in order to study glacier ice, and has found there further proofs, supported by A. Forel, in favour of the masses of ice which he has found in New Siberia (buried under clays containing fossil stems of *Alnus fruticosa* fifteen feet long), really being remains of the ice-sheet which covered the islands during the glacial period.—The yearly report of the Academy, which contains, among other matters, the obituaries of L. Schrenck, A. Middendorff, I. Schmalhausen, and P. Tschebycheff, whom the Academy has lost during the last year.—The positions of 140 stars of the star cluster 20 Vulpeculæ, according to measurements taken from photographic plates, by A. Donner and O. Backlund (in German). The measurements were taken on two plates, one of which had been exposed for twenty minutes only, and the other for one hour, and the accord between the two is most satisfactory, the average difference being 0·00s. in right ascension, and 0″·02 in declination, while the difference between the measurements on the photographic plates, and the direct measurements of Schultz, attains on the average −0·040s. in R.A. and −0″·55 in D.—On the differential equation $dy/dx = 1 + R(x)/y$, by N. Sonin.—On a new entoptric phenomenon, by S. Chirieff.—Note on the last mathematic conversation with P. L. Tschebycheff, about his rule for finding the approximate length of a cord, and the means of extending the method to curves of double flexure (all three in Russian).—The ephemeride of the planet (108) Hecuba, by A. Kondratieff.

Vol. ii. No. 3, March 1895.—Yearly reports of the Philological Section of the Academy, and of the committees: for the Baer premium, which was awarded this year to the Tomsk Professor Dogel, for his researches into the histology of the nervous system, and to Prof. Danilevsky for researches into the comparative study of parasites in blood, and the Lomonosov premium, which was awarded to A. Kaminsky for his work on the yearly march and geographical distribution of moisture in the Russian empire in 1871–90.—On the Perseids observed in Russia in 1894 (in French), by Th. Bredikhine. The observations were made by several observers at Odessa and at Kieff. It must be remarked that the observers have had difficulty in observing the meteors, the course of which made a sharp angle with the direction of the vertical line; and this circumstance is probably not without some influence upon the determination of the radiant point. The meteors observed on July 24, 26, and 27, seem to belong to a meteoric stream other than the Perseids. Combining the results of this year's observations (which are given in full in thirteen tables) with the observations of the preceding year, and calculating the elements for each of the radiants, the author sees in them a confirmation of the theoretical results he arrived at in his paper on the Perseids of 1893; the values of the inclination (i) of the centres of radiation—with the exception of the three first, which are somewhat uncertain—are all below the value of i for the comet of 1866. The average value of i before the epoch (August 10·5) is 60°, while after that time it is only 56°; but this decrease cannot be considered as quite real, on account of the said uncertainty in i for July 24–27. An inspection of the charts shows that a condensation of the radiation is taking place towards the epoch which falls on the night of the 10th to the 11th, as seen from the observations made in Italy by P. Denza. The arithmetical average of the coordinates of the three chief radiants of August 10 are $\alpha = 48° 48'$, and $\delta = 56° 30'$, we have: $l = 63° 32'$, $b = 36° 51'$, $i = 64°·8$, $s = 72°·8$, and $V = +34°·4$. The value of i corresponds to the radiant of the comet of 1866. Considerable variations appear in the elements Ω and π; the perihelium is displaced in the direction of the orbital motion of the meteors. In a subsequent memoir the author proposes to take up the theory of the subject, and to evaluate the secular variations of the generating orbit of the comet, and of some of its derived orbits.—On the best means of representing a surface of revolution on a plane, a mathematical treatment of the subject, in Russian, by A. A. Markoff.—On the limit values of integrals, by the same.—List of the works of P. L. Tschebycheff.—On the methods for correctly determining the absolute inclination by means of the induction inclinator, and the degree of exactitude lately obtained with this instrument at the Pavlovsk Observatory, by H. Wild (in French).—The non-periodical variations in the quantity of precipitation at St. Petersburg, by E. Heintz (in Russian, summary in French).—Ephemeride of the planet (209) Didon, by Mme. Eugénie Maximoff.—Determination of the magnitudes of the stars in the star cluster 20 Vulpeculæ, by Mme. Marie Shilow. The diameters were measured by the micrometer, and the corresponding magnitudes were calculated by means of Charlier's formula.—On one sum, a mathematical note (in Russian), by I. Ivanoff.

THE numbers of the *Journal of Botany* for May to July contain, besides mere technical papers, one on the genu

Argemone, by Dr. D. Prain, a description of a new species of *Bryopsis*, and of a peculiar mode of growth in another species, by Miss E. S. Barton; an account of fossil plant-remains in peat, by Mr. A. Gepp; and a description of a large number of new species of Orchidaceæ, by Mr. A. B. Rendle, from the plants brought by Mr. Scott Elliot from Tropical Africa.

SOCIETIES AND ACADEMIES.

LONDON.

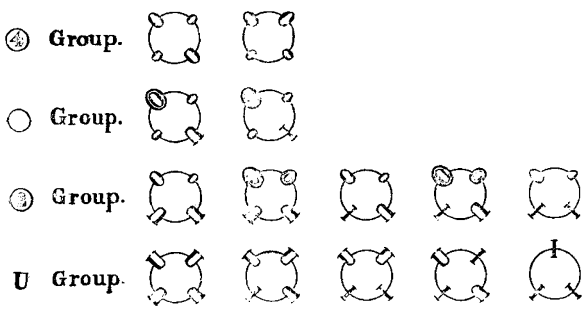
Royal Society, May 16.—"The Complete System of the Periods of a Hollow Vortex Ring." By H. C. Pocklington.

May 30.—"The Kinematics of Machines." By Prof. T. A. Hearson.

In this paper it is shown that all machine movements, however complex, are derived from the association together of some of a comparatively limited number of kinds of simple motions, which take place between consecutive directly connected pieces.

Certain geometrical laws are enunciated, from which are derived the conditions necessary for the association of those motions together in one machine. It is shown that those laws preclude the existence of certain combinations of motions. By attaching to each kind of motion a suggestive symbol a method of expressing the constitution of a machine movement by a simple formula is proposed, whereby similarities and differences between machines may be exhibited at a glance.

The author commences by considering a mechanism, consisting of four bars united in one continuous linkage by four pins which have parallel axes. By imagining the length of the links to undergo variation from zero to infinity, it is shown that this mechanism is representative of all the simple plane mechanisms, and, by imagining other variations to occur, it is shown to be representative of still further classes of mechanisms, in which the parts do not move in or parallel to one plane. In this the relative motions of consecutive pieces are either turning, when one piece revolves completely around relatively to the other, the representative symbol being the letter O, or swinging, when one piece turns through a limited angle relatively to the adjoining one, represented by the letter U.



The first law enunciated, which governs the association of the O and U motions, is founded on the geometrical fact that the sum of the four angles of the quadrilateral is constant. After a complete revolution the angle between the bars is considered to have been increased or diminished by 2π.

From this it is impossible for only one motion to be turning and the other three swinging, otherwise the sum of the four angles would increase or decrease by 2π each revolution.

The second law, which governs the association of the motions, has to do with the proportions between the length of the links necessary to permit of complete turning. This is founded on the fact that one side of a triangle cannot be greater than the sum of the other two. From these two laws together it is shown that it is impossible to have two Os alternating with two Us.

Next it is pointed out how the U motion may be provided for by constructing a circular slotway in one piece, and shaping the other piece to fit the slotway, so that by imagining the radius of curvature of the slotway to be indefinitely increased a relative movement of reciprocating sliding motion, represented by the symbolical letter I, will be substituted for the swinging motion U. A slide being conceived to be a swing through a zero angle about an infinitely distant centre, the previously mentioned laws will apply to associations containing I motions, and it will follow that a combination of three slides and one swing is precluded by the first law.

By the application of the governing laws 14 distinct combinations are found to be possible, and only 14. They are exhibited by the following formulæ, in which a large O associated with a small o signifies that in one case adjacent links turn relatively to one another so as to continuously increase the angle between them, and in the other to continuously diminish the angle. The double ◎ signifies that two complete revolutions accompany one complete to-and-fro swing or slide.

Applying Reuleaux's principle of "Inversion" it will be seen that 32, and only 32, distinct machine movements can be derived from the above 14 mechanisms. Those from the same mechanism are distinguished from one another in the formula by using a thick line for the frame link. For example,


signifies a machine movement like that employed in the crank-and-connecting-rod engine.


is exemplified in the oscillating engine much used in paddle-wheel steamers.


is found in Stannah's pendulum pump, and


quadrupled is the movement adopted by Rigg in the design of his high speed engine.

The author next discusses the relation of cams and spur-wheel mechanisms to the foregoing kinematic chains, showing that they are the result of the suppression of one of the previous four links and the amalgamation of the two adjoining simple motions into one more complex. A comparison is also made with belt gearing, and expressive formulæ suggested.

The author then passes to the consideration of machines the parts of which do not move parallel to one plane.

The first 13 of the previously mentioned mechanisms have their counterpart in mechanisms the parts of which move parallel to the surface of a sphere. Hooke's joint is the best known example. The 14th consisting of 3 slides cannot be adapted to a sphere but it can to a cylinder, and from it are derived 4 possible screw mechanisms.

The remaining mechanisms consist of those in which the axes of the turning and swinging motions neither meet nor are parallel. They include the motion which occurs at a ball-and-socket joint. The method of classification according to the proposed scheme is summarised as follows:—

All simple machine movements may be ranged in four divisions, viz.:—

(1) Consisting of plane mechanisms, in which the pieces move in or parallel to the surface of a plane.

(2) Spherical mechanisms, in which the pieces move in or parallel to the surface of a sphere.

(3) Cylindrical mechanisms, in which the pieces move in or parallel to the surface of a cylinder.

(4) The remainder, to which the name conoidical mechanisms is given, in which the axes of the swinging and turning motions neither meet nor are parallel.

The mechanisms in each of these divisions are classed in two subdivisions.

Subdivision S, with surface contact of consecutive links.

Subdivision P, with point contact of consecutive links.

The mechanisms in each of the eight subdivisions are still further subdivided into combinations. The combinations of 1_s, 2_s, and 3_s, are exhaustively enumerated, and it is suggested that an extension of the methods of applying the geometrical laws would lead to the preparation of an exhaustive list of the possible combinations in the other subdivisions. The combinations are still further subdivided into inversions according to Reuleaux's principle of the inversion of a machine.

Lastly, the author proceeds to show how the foregoing considerations assist in the analysis of compound mechanisms. It is assumed that practically all compound mechanisms contain a continuous mechanism A, of not more than four links, from which definiteness of relative motion of all the other links is derived. Any two links of A in their exact length, or longer or shorter, may be adopted to form with two new links a second mechanism B, and any two of A or B, or one of A and one of B, may be adopted to form with two still further added links a third mechanism C, and so on. In this way a definiteness of relative motion of many links in a compound mechanism is derived. The notation lends itself to a clear exhibition of the