by the Photographs Committee, of which, however, only a small selection could be shown, those exhibited by the Scottish Geological Survey, and the specimen slides and maps to illustrate papers and discussions, kindly lent by Prof. Sollas, Messrs. Teall, Topley, Johnston Lavis, Gregory, and many others. This exhibition, if it can be continued with increased facilities at subsequent meetings, promises to become one of the most important features of the section's meeting

EVOLUTION AND CLASSIFICATION.[1]

AS we have gathered up the scattered masses of botanical knowledge, laboriously wrought out by many isolated workers, and attempted to fit them together into a consistent whole, which should outline the structure of the temple Botany, we have found that the workmen have not always followed the same architectural plan, and have often used different units of measurement. With the increasing specialisation so noticeable year by year there is a corresponding lack of coordination of work. To this lack of coordination, this want of unity of measurement, this misunderstanding of plan, we can no longer close our eyes. and I therefore feel free to invite your attention to the following somewhat summary discussion of the causes of the present unsatisfactory condition, in the hope that we may thereby be enabled to see how we may make some improvement.

All botanical knowledge finally culminates in some kind of classification. The facts of histology, morphology, and physiology are of great biological importance, but the greatest of all biological facts is that the world is peopled with living things. We may group and arrange in orderly sequence the histological facts of the science; we may do likewise with the facts which the morphologist has discovered; we may make a classification of all the known physiological facts; but beyond and above these lies the greatest grouping of all—the grouping in orderly sequence of the organisms themselves whose histology, morphology, and physiology we have studied.

It is now a full third of a century since a great light was first turned upon all biological problems by the formulation of the doctrine of evolution by the master-mind of Darwin. In its light many puzzles have been solved, and many facts hitherto inexplicable have been made plain. We now know what relationship means, and we have given a fuller meaning to the natural system of classification. From the new point of view a natural classification is not merely an orderly arrangement of similar organisms. It is an expression of genetic relationship. Furthermore, in the light of evolution we now see the meaning of many reduced structures whose significance was formerly not at all—or but vaguely—understood. We have become familiar with the fact that degradation is a prominent factor in the vegetable kingdom. Evolution has by no means always involved an advance in structural complexity. Often this catagenesis is a result of parasitism or saprophytism, as is so well illustrated in the "fungi," where the degradation has gone so far that their relationship has to a great degree been obscured.

But there are also many cases of a catagenesis not due to a dependent habit in which we have evidence of a simplification from a more complex structure. Thus in the willows and poplars, where we have a raceme of very simple flowers, each consisting of a single ovary, or one to many stamens, it is readily seen that this simplicity is not primitive. The ovaries are not single carpels, but are composed of two or three united. The flower of the willow is simple by a degeneration from a higher type—probably a tricarpellary or pentacarpellary type—by the loss of its floral envelopes and stamens or pistils.

Every naturalist should be as familiar with these illustrations of evolution by simplification as he is with those of evolution by complication. In the growth of the great tree of life, while the development has been most largely in an upward direction, so that the great body of the tree has risen far above its point of beginning, there are yet multitudes of twigs and branchlets which droop downward.

I need not now, before a body of scientific men, speak of evolution as an hypothesis; for we know it as a great biological fact, about whose existence there is no shadow of doubt. A natural classification will conform strictly to the lines of evolution, it will be in fact a clear exposition of the successive steps in its progress. In such a classification the primitive forms will precede the derived ones, and the relation of the latter will be positively indicated. Moreover, in such a system there will be no confusion between the primitively simple forms and those which are so by derivation.

An examination of our common systems shows them sadly deficient in the essentials of a scientific classification. This is particularly true of the treatment of the flowering plants at the hands of English and American botanists. Nothing could show better the conservatism of botanists than the fact that for a third of a century after the general acceptance of the doctrine of evolution they are still using so crude an arrangement of the group of plants with which they are most familiar.

I may assume that it is well known to nearly all of us that the prevailing arrangement of the Dicotyledons does not represent the later views of any of the systematists. The fact is that the systematic disposition of the higher plants is at present a make-shift, maintained by conservatism, and a reverence for the time-honoured work of the fathers. It is unscientific to let our practice drag behind the present state of our knowledge: it is far more so for us to cling to the opinions of our fathers, through mere reverence, long after we know them to be untenable. It is not to the credit of our science that for a second time she has persistently held to a system through such considerations. For thirty or forty years after a natural system had been constructed by Jussieu, botanists as a body still adhere to the artificial system of Linne. Now, sixty years later, we find ourselves faced with a problem similar to that which Lindley, Torrey, Beck, and Gray met. History repeats itself with such exactness that, with the change of a word here and there, the arguments *pro* and *con* then used may be used to day. The system of Jussieu and DeCandolle is now as much a clog and a hindrance to the systematic botany of the higher plants as was that of Linne sixty years ago, and now as then it is the spirit of conservatism and of veneration for time-honoured usage which maintains the incubus.

Manifestly a system of classification which conforms to and is based upon the doctrine of evolution must begin with those forms which are primitive, or which as nearly as may be represent primitive forms. Since the flower is a shoot in which the phyllomes are modified for reproductive purposes, that flower in which the phyllomes are least modified must be regarded as primitive, while that in which there is most modification must be regarded as departing most widely from the primitive type. The simple pistil, developed from a single phyllome, is primitive and lower, the compound pistil is derived and higher. The several seeded compound ovary must be lower, and the compound ovary with but one seed must be higher. Separate stamens are primitive, united stamens, whether the union be with one another or with other structures, must be derived and consequently higher. So, too, when all parts of the flower are separate it is a primitive condition, and when they are united it is a derived structure.

Applying these principles to the flowering plants it becomes evident that in the Dicotyledons either the Apetalæ or the Polypetalæ must furnish our starting point. The Gamopetalæ are universally admitted to be higher than the groups just mentioned, and certainly do not contain the sought for primitive types. Even a hasty examination of the thirty-six apetalous families shows that they are, at least to a very large extent, derived from the Polypetalæ by the abortion of some parts and the entire omission of others. It will not be difficult to determine that the Ranales must take rank below all other Polypetalæ, in the sense of representing more nearly than any other group the primitive Dicotyledons.

The attempt to make a natural system by linking family to family in a long undulating chain, by concatenation, is unscientific because it absolutely fails to conform to the law of evolution. We must abandon the old classification and attempt one which in the light of evolution is rational. Let us not cling to the old because it is inconvenient to change, let us not cling to it through a mistaken reverence for the practice of the fathers, let us not cling to it as long as a flaw may be found in a new system. Science is ever abandoning the old when the old is no longer the true; it tears down the work of years when that work no longer represents the truth; and it dares to reach

[1] Abstract of Annual Address before Section G (Botany) of the American Association for the Advancement of Science. By C. E. Bessey, President of the Section.

out and frame a rational system even though some parts of it for a time rest upon hypothetical grounds.

A REVISED ARRANGEMENT OF THE BENTHAMIAN "SERIES" OF FLOWERING PLANTS.

Monocotyledons.

Apocarpæ.
Coronarieæ.
Nudifloræ.
Calycinæ.
Glumaceæ.
Hydrales. (Hydrocharideæ).
Epigynæ.
Microspermæ.

Dicotyledons.

Polypetalæ.

Thalamifloræ (including the apetalous Curvembryeæ, Micrembryeæ, and "Ordines Anomali," and the Euphorbiaceæ and Urticaceæ, &c., of the Unisexuales).
Discifloræ (including the apetalous Daphnales and the Juglandaceæ and Cupuliferæ, &c., of the Unisexuales).
Calycifloræ (including the apetalous Aristolochiaceæ and Cytinaceæ).

Gamopetalæ.

Heteromeræ.
Bicarpellatæ.
Inferæ.

SCIENTIFIC SERIALS.

American Journal of Science, September. — Fireball of January 13, by H. A. Newton (see p. 524).—On a photometric method which is independent of colour, by Ogden N. Rood. This is not based, like most previous methods, upon the comparison of the luminosities of two adjacent surfaces, but upon the shock that is produced upon the retina by a change of intensity of light. If one-half of a rotating disc reflects less light than the other by 1-50th of the whole amount, with appropriate rates of rotation a faint flickering will be noticed. This flickering disappears if the two halves have the same degree of brightness, whatever may be their colours.—On the oscillations of lightning discharges and of the Aurora Borealis, by John Trowbridge. Photographs were obtained of sparks having both great electromotive force and great quantity, produced by an alternating machine giving from 300 to 400 alternations per second, with the aid of a step-up transformer and an oil condenser. The oscillations were investigated by Feddersen's rotating mirror method. The sparks were about 2 cm. long, and the interval between two successive oscillations was one hundred-thousandth of a second. On each of the photographs reproduced some ten or twelve oscillations can be counted. The discharge is seen to follow exactly the same path three times in succession. After that it assumes the character of a brush discharge. By intercalating a non-inductive water resistance and a vacuum tube between the terminals of a suitable transformer it is possible to imitate exactly the phenomena observed when a vacuum tube is held in one hand while the other hand grasps the terminal of the transformer. In observiug the striæ and waving columnar form of the light excited in this manner in tubes filled with rarefied gases, one is led to believe that the stratified form of the Aurora Borealis is produced in a similar manner.—On the estimation of chlorates and nitrates, and of nitrites and nitrates in one operation, by Charlotte F. Roberts. By means of the apparatus for the estimation of nitrates previously described, chlorates and nitrates together may be estimated. They are treated with manganous chloride, and the resulting gases are passed through potassium iodide and then into a Hempel's burette. The amount of nitric oxide, gives the amount of nitrate present, and the chlorate is estimated by deducting from the total chlorine liberated that due to the reduction of the nitrate.

SOCIETIES AND ACADEMIES.

LONDON.

Chemical Society, June 15.—Dr. Armstrong, President, in the chair.—The following papers were read :—Contributions to our knowledge of the aconite alkaloids. Part vi. Conversion of aconitine into isaconitine, by W. R. Dunstan and F.H. Carr. On heating the hydrobromide of the highly poisonous aconitine it is converted into the corresponding salt of its non-poisonous isomeride, isaconitine.—Part vii. Some modifications of aconitine aurichloride, by W. R. Dunstan and H. A. D. Jowett. Aconitine aurichloride may be obtained in three different physically isomeric modifications, melting at 135·5°, 152°, and 176° respectively.—Note on the stereoisomerism of nitrogen compounds, by S. U. Pickering.—A study of the properties of some strong solutions, by S. U. Pickering. The depressions of the freezing points of water, acetic acid, and benzene, by a number of organic non-electrolytes, indicate in all cases the formation of compounds of the solvent with the dissolved substance.—Studies on citrazinic acid, by W. J. Sell and T. W. Easterfield. The authors propose provisional formulæ for citrazinic acid and a number of allied compounds as the result of their work on the subject.—The essential oil of hops. Preliminary notice, by A. C. Chapman. A dextro-rotatory sesquiterpene $C_{15}H_{24}$, is obtained by the steam distillation of hops.—The sulphides and polysulphides of ammonium, by W. P. Bloxam. The author has obtained a number of crystalline double ammonium sulphides of the general formula $(NH_4)_2S$, $xNH_4 \cdot SH$.—Sarcolactic acid obtained by fermentation of inactive lactic acid, by P. Frankland and J. MacGregor.—Hexanitroanilide, by A. G. Perkin.—The constituents of the Indian dye-stuff kamala, I., by A. G. Perkin. On extraction with ether, kamala yields rottlerin, $C_{11}H_{10}O_3$, isorottlerin, two resins $C_{12}H_{12}O_3$ and $C_{13}H_{12}O_4$ and a small proportion of a yellow colouring matter.—A quantitative method of separating iodine from chlorine and bromine, by D. S. Macnair. The method is based on the fact that, when treated with chromic acid mixture, silver iodide is converted into the iodate whilst silver chloride and bromide are converted into the sulphates.—Note on a form of burette for rapid titration, by L. Garbutt.—The use of sodium peroxide as an analytical agent, by J. Clark. By heating powdered minerals with sodium peroxide, the arsenic and sulphur may be rendered soluble.—Stibiotantalite, a new mineral, by G. A. Goyder.—The colouring matter of *Drosera Whittakeri*, II., by E. Rennie. The author has extended his previously published work on this subject.—Preparation of mono-, di-, and tri-benzylamine, by A. T. Mason. Mono-, di-, and tri-benzylamine respectively may be obtained as the chief products of the interaction of benzyl chloride and ammonia, by varying the quantity of the latter.—Piazine (pyrazine) derivatives, II., by A. T. Mason.—Piazine derivatives, III., by A. T. Mason and L. A. Dryfoos. In these two papers the authors describe a number of new substituted piazines and their dihydrides.—Condensation products from ethylenediamine and derivatives of acetoacetic acid, IV., by A. T. Mason and L. A. Dryfoos.—Studies of the oxidation products of turpentine, by S. B. Schryver. The author assigns to terpenylic acid the formula

$$\begin{array}{r} CH_2 \cdot CO \\ \cdot \quad\quad \\ COOH \cdot CH_2 \cdot CH \cdot CMe_2 \end{array} \!\!\! > O$$

—Addendum to note on the nature of depolarisers, by H. E. Armstrong.—The molecular complexity of liquids, by W. Ramsay and J. Shields. The authors deduce the molecular weights of liquids from their surface tensions.—The preparation of active amyl alcohol and active valeric acid from fusel oil, by W. A. C. Rogers. By repeatedly heating fusel oil with fuming hydrochloric acid, pure laevo-rotatory amyl alcohol ($[\alpha]_D = -5 \cdot 2°$) is obtained ; by oxidising the alcohol, active valeric acid may then be prepared.—On the occasion of the Rothamstead jubilee, July 29 last, an address was presented to Sir J. Lawes and Dr. Gilbert by the President and Council of the Chemical Society.

PARIS.

Academy of Sciences, September 18.—M. de Lacaze-Duthiers in the chair.—On the teeth of hyperboloidal gearing, by M. H. Resal.—The shooting stars of the month of August, 1893, observed in Italy, by P. François Denza. Reports received from members of the Meteorological Association in all parts of Italy show that the August showers were observed under comparatively favourable conditions. The number of meteorites observed grew progessively from the first to the eleventh of the month, and the phenomenon exhibited on the latter date a greater brilliancy than usual. The maximum took place earlier than in previous years, and the greater density of