$$E_x = H_x = 0, \quad E_y = H_z = \frac{\partial \Omega}{\partial y} f(t - \frac{x}{c}),$$

$$E_z = - H_y = \frac{\partial \Omega}{\partial z} f(t - \frac{x}{c}),$$

where Ω is a function by y and z whose derivatives are large near some parts of the y-z-plane and small elsewhere. This gives $\nabla . \mathbf{H} = 0$ but $\nabla . \mathbf{E} = (\partial^2\Omega/\partial y^2 + \partial^2\Omega/\partial z^2)\ f\ (t - x/c)$ and thus leads to a charge wherever f does not vanish and Ω fails to satisfy Laplace's equation. The ponderomotive force vanishes. The solution is more general and earlier than Whittaker's, as the latter states. We may notice that the total charge in the pulse is zero if the average value for f on x is zero, as it will be if f is simply harmonic like $\sin(t - x/c)$, or if the plane integral of $\nabla . \nabla \Omega$ vanishes, *i.e.,* if the sum of the boundary integrals of the magnetic force is zero.

Bateman works with the special function $f(t - x/c) = f(u) = (\sin 2\pi\nu u)u$ which gives as the energy of the pulse $2\pi^2\ cW\nu$ where W is the energy in the plane of y and z, *i.e.,* $W = \int\int (\nabla\Omega)^2\ dxdy$. With $2\pi^2 cW = h$ we should get for the universal constant $W = 1.1 \times 10^{-38}$ with dimensions mass times length. If we take out the mass of the electron we have a universal constant 1.25×10^{-11} with dimensions of length, and dividing by c we have 4×10^{-22} as a universal constant of time—these correspond to a wave length of a little more than one thousandth of an Angstrom, which is about one twentieth of the wave length that on the quantum theory would be emitted if an electron at rest blew up and dissipated its energy into radiation. Presumably, however, we are not ready for such numerical speculations, fascinating and modish as they are. Another interesting point about this example is that on reflection by a plane mirror moving with velocity u we find the quantum reappearing with the same type of f but with its frequency changed as required by Doppler's principle. Now Doppler's principle is derivable from very general considerations on waves and pretty as the above demonstration is, it would be prettier to reverse it and find what restriction the principle puts on types of function f.

I have not ventured into de Broglie's light-molecules and his statistical investigations with them, nor mentioned the apparent necessity that quanta be of two kinds, right- and left-handed. I have not gone into the work of Born which he has but so recently discussed at length in his lectures at M. I. T., or the propositions of L. V. King in a pamphlet that I have not seen, or even of Barla's phenomena in X-rays, which seems to be contesting the explanation of the Compton effect. To cover all the recent speculations on the nature of light would be fairly well to cover the interesting and disputed parts of modern physics. That can not be done in an hour. Some years ago A. G. Webster in commenting at the American Academy on the difficulties we have been discussing said that the modern physicist had a perfectly good coat and an equally good pair of trousers but was completely naked between the two. It sometimes seems as though the still more recent discoveries and disputations had tended dangerously to fray out the nether part of the coat and the upper portion of the trousers. We shall sometime have a beautiful whole new suit, possibly with spats and cravat and patent leathers and a plug hat, but those will be the evil days when the grinders cease because they are few and those that look out of the windows be darkened. Let us enjoy our present gamin life.

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THE CONCEPTION OF A SPECIES[1]

IN the light of recent experiments and researches in genetics, cytology and taxonomy it is now possible to present a more precise conception of a species.

A species is a group of individuals of common descent with certain constant characters in common which are represented in the nucleus of each cell by constant and characteristic sets of chromosomes.

Since the discovery of Mendel's law, genetics, with its experimental analyses of hereditary units, has thrown considerable light on the nature of variation in plants and animals. It is now clear that hereditary variations are due to discontinuous mutations in the chromosomes, but it is equally certain that the most minute variations perceptible may be inherited, as demonstrated in the eye-colors of *Drosophila* and as I found in the minor flower-shades of the scarlet *Antirrhinum.* Genetics has provided us with a fairly complete understanding of the nature and inheritance of the minor variations of individuals, varieties and sub-species upon which Darwin rightly laid so much stress, and to which many modern systematists have given specific rank. Concerning the major variations that constitute species and genera in the broad Linnean sense little light can be expected from genetics alone, owing to the barriers of sterility between the larger groups.

Recently, cytology, with its modern refinements of technique, has made remarkable progress in the analyses of chromosome complexes. So far as my records go, at least 2,845 species of plants and animals, representing 1,326 genera, 417 families, 181

[1] Paper read at a joint discussion between Sections C, D and K, at the British Association, Oxford meeting, August 10, 1926.

orders, 77 classes and 33 Phyla have been examined. The chromosome numbers found in these species vary from one pair in the Nematode Worms *Gordius* and *Ascaris* to more than one hundred pairs in the Decapod *Cambarus,* while in plants the numbers range from two pairs in the Fungi *Eumycetes* to more than one hundred pairs in *Equisetum* and the ferns *Ophioglossum* and *Ceratopteris.* In all recent cases, where large numbers have been examined by several observers, it has been found that the number of chromosomes or chromosome sets is constant and characteristic for each species. In some genera the chromosome numbers of the species so far examined are identical. In other genera the chromosome numbers are polyploid, being in regular multiples of a basal number: notwithstanding the comparatively few cases where many species of a genus have been examined, fifty-four polyploid genera belonging to seven phyla have been found in plants, while in animals, where much less has been done, twenty-five polyploid genera belonging to ten phyla have been recorded. In other genera the chromosome numbers may be either in two or more polyploid series or they may be irregular. It is important, however, to emphasize the fact that visibly identical chromosome complexes may be entirely different in their genetic constitution, they may have similar genes in different combinations and arrangements or they may have entirely different genes. For this reason chromosome numbers are only of secondary importance, and cytology alone can not be expected to provide a conception of a species. It is only by an intimate combination of the experimental methods of genetics with the cytological analyses of the chromosome complexes of various species and genera that important results have come.

After the discovery of Mendel's work and its extension to various species of plants and animals by Bateson and others, the most important advance was made by Morgan and his colleagues, who have been able experimentally to locate the relative positions of the genes of the Mendelian characters of *Drosophila* in each of the four chromosomes and to establish a linkage system of these characters within each chromosome. This valuable work has now been amply confirmed in many genera of plants and animals and is being rapidly extended. These experiments by combining cytology with genetics have broken new ground and have demonstrated the chromosome mechanism by which the minor variations of a species are inherited.

The next step is to discover the chromosome mechanism which regulates the inheritance and evolution of the major variations that constitute species and genera, and many investigators are now working at this problem. This brings in taxonomy, the oldest and most important of the biological sciences, for in any conception of species the systematist must have the final word, since it is he who makes use of the results obtained by other biological specialists in order to build up his classifications, distributions and phylogenies. My own work has been chiefly concerned with an intensive study of the polymorphic and polyploid genus *Rosa.* The species and sub-species of this genus have been exhaustively analyzed taxonomically and 424 individuals of these (representing all the known species) have so far been examined cytologically, which, added to the 332 individuals previously examined by Täckholm, Blackburn and Harrison and Penland, makes a total of 756 individuals in which the chromosome complexes have been analyzed. A large number of genetic crosses have been made between the various species and a number of F_1 plants raised, which, though sexually sterile, have provided valuable material for taxonomic and cytological analyses. The experimental results of these investigations show:

(1) That the specific characters of *Rosa* are represented in sets of seven chromosomes called septets.

(2) That there are five fundamental species of *Rosa,* each species carrying in its gametes one distinct genetical septet of chromosomes, representing at least fifty specific characters.

(3) That the regular polyploid species of *Rosa* are made up of the various paired combinations of the five differential genetical septets making twenty-six species possible. Eighteen of these have been found and have been tested taxonomically, cytologically and genetically, leaving eight to be discovered, if they exist, one of which has already been made genetically.

(4) That the irregular polyploid species of *Rosa,* peculiar to Europe and Western Asia, are made up of various paired and unpaired combinations of the five differential genetical septets, making 180 species possible, many of which apparently do not exist.

Thus in *Rosa* 211 species are possible, each differing from another in the presence or absence of genetical septets of chromosomes and characters. Each species is therefore a discontinuous taxonomic unit subject to experimental verification by three distinct methods, taxonomic, cytological and genetical. Genetically each of these species is homozygous in its specific characters and either homozygous or heterozygous in its sub-specific, varietal and minor characters, while each species is taxonomically equivalent to a Linnean species.

In accordance with this conception, a species is a real entity, corresponding to the intuitions of the Old Systematists, though they were unable to demonstrate it experimentally.

The utility of such a conception of species in classification and in the problems of distribution, speciation and phylogeny is evident, for it is clear that the chromosome complex is the vital mechanism of evolution, and there are welcome signs at this meeting that the physiologists and biochemists are coming to our aid in solving the pressing problem of the modes of action of the chromosomes in development.

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INTERNATIONAL CRITICAL TABLES

ONE of the major projects of the National Research Council has been the preparation and publication of International Critical Tables of Numerical Data in Physics, Chemistry and Technology, undertaken at the request of the International Union of Pure and Applied Chemistry and the International Research Council. The work of critical compilation began in 1922, and the first of the projected five large volumes was published last year. The responsibility for the editorial work has rested on Dr. E. W. Washburn, editor-in-chief; Dr. Clarence J. West, associate editor for chemistry; Dr. N. Ernest Dorsey, associate editor for physics; and Dr. F. R. Bichowsky and Dr. Alfons Klemenc, assistant editors. These responsible editors were assisted by an advisory editorial board composed of seven eminent chemists and physicists, and by ten corresponding editors and about 300 cooperating experts. The data used are derived from material in eighteen languages.

Nearly $200,000 has been expended on the compilation. This money has come as gifts from 244 firms and individuals and two major foundations (Carnegie Corporation and International Education Board). The gifts from these foundations, amounting to $70,000, were made for the special purpose of enabling the published tables to be sold at a price not prohibitive to individual buyers. Publication was undertaken by the McGraw-Hill Book Company, Inc., the well-known publishers of scientific books, under a special arrangement regarding selling price.

The regular price for a set of five volumes was fixed at $60, but a prepublication price of $35 a set was made to all subscribers ordering sets before the actual publication of Volume I.

The more optimistic among us estimated that we should have prepublication subscribers to the number of 1,000 to 1,500. The actual result is that 6,638 sets have been ordered at the pre-publication price of $35, and several hundred sets at the post-publication price of $60 a set. The distribution of these orders presents some interesting features.

Of the total of 6,638 sets ordered in advance of publication, 4,694 sets were ordered by individuals, 531 by libraries, 450 by educational institutions and 973 by industrial concerns.

As regards the geographical distribution of the orders a gratifying wideness in this distribution is apparent on going over the lists. The United States has ordered 4,867 sets, and foreign countries 1,771 sets. Fifty-three countries and colonies are represented in the foreign list with Great Britain and Ireland leading with 379 sets ordered, Germany next with 224 and Japan third with 146. France has ordered but 58 sets which are not as many as those ordered from Holland (91), Sweden (72) and Italy (67). Little Belgium has ordered 50 sets. Darkest Russia has ordered 27 sets, and benighted China 43 sets.

The total list of foreign countries, together with the figures of sets ordered follows: Africa, 20; Argentina, 19; Australia, 20; Austria, 37; Belgium, 50; Brazil, 5; Canada, 151; Ceylon, 1; Chile, 9; China, 43; Colombia, 2; Cuba, 10; Czechoslovakia, 37; Denmark, 31; Dutch East Indies, 17; Egypt, 1; Estonia, 4; Finland, 11; France, 58; Germany, 224; Guatemala, 1; Great Britain and Ireland, 379; Haiti, 1; Hawaii, 9; Holland, 91; Hungary, 9; Iceland, 1; India, 29; Italy, 67; Japan, 146; Jugoslavia, 4; Latvia, 3; Luxembourg, 1; Mexico, 17; New Zealand, 2; Norway, 38; Palestine, 2; Peru, 7; Philippines, 10; Poland, 12; Porto Rico, 7; Portugal, 1; Rumania, 8; Samoa, 1; Siam, 2; Soviet Russia, 27; Spain, 18; Straits Settlements, 3; Sweden, 72; Switzerland, 49; Syria, 2; Tasmania, 1; Trinidad, 1.

VERNON KELLOGG

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SCIENTIFIC EVENTS

EXCURSION OF THE INTERNATIONAL SOIL SCIENCE CONGRESS

THE national committee, which is planning for the work of the International Soil Science Congress, which is to meet in Washington on June 13, is arranging for an excursion through the United States to follow immediately after the close of the meeting on June 22.

The itinerary is now being worked out. It is planned to have the excursion go south from Washington to central North Carolina, thence across the mountains into Tennessee, southeast to Georgia, thence to Alabama and through Tennessee to southeastern Missouri, across that state to Kansas, thence either through Colorado, Utah and Nevada to California, or through Arizona and New Mexico to California, then north through Oregon and Washington to British Columbia,