salt solution to serve as controls and in these the sex ratio has been 52 per cent. ♀ to 48 per cent. ♂. The work is now being continued, using eggs from a barred, non-barred cross so that sex-linked factors may be used as a check. Additional Leghorn eggs are also being used to increase the data from a statistical point of view.

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THE NATIONAL ACADEMY OF SCIENCES. II

Thermal overflows, thallophytes and rock building: WILLIAM ALBERT SETCHELL. Thermal springs are of wide occurrence over the world, and thermal overflows of water charged with calcareous or with siliceous salts are particularly noteworthy because of the presence of thermal thallophytes and their relation to deposits of sinter, both calcareous and siliceous. The thallophytes exhibit their most conspicuous formations and associations in the warmer portions of the overflows, but there are some noteworthy representatives at about the limit of the thermal and the cooler portions of the overflow. The unicellular thallophytes not forming colonies do not need special mention. Those forming colonial aggregates of some size are not associated with rock building. One colorless filamentous species excretes crystalline sulfur in the hottest portions of calcareous overflows, but no lime, while those inhabiting siliceous waters are devoid of any mineral deposit. The filamentous species of the warmer portions of the overflows containing chlorophyll surround themselves with jellies and the gelatinous masses, firmer or softer, may be associated with the laying down both of lime and of silica, but in varying degree. Certain species seem to have no association of this sort. Some species show slight participation, and one species shows a very decided relation to sinter formation, both calcareous and siliceous. In the cooler portions of the overflows, a single noteworthy species occurs in broad bands or patches of a seal-brown color. In calcareous overflows, lime is laid down in crumbly masses, within the layer of the individuals of this species, while in siliceous waters the sinter separates out as glassy tubes about each filament, but within the firmly gelatinous outer coverings. Since deposition of sinter seems to occur, at least in thermal overflows, only in connection with photosynthetic (*i.e.*, green) thallophytes (or Algae) and since only certain of these are thus associated, there seems possible an active (not passive) relation between certain Algae and rock building, as well as a certain specificity as to the species concerned. The various forms assumed by the jellies of these active aggregates affect and control the external forms as well as the internal structure of the sinters laid down.

Quantum relations in photosynthesis with Chlorella: B. M. DUGGAR, J. F. STAUFFER and FARRINGTON DANIELS. Quantitative measurements have been made on the utilization of carbon dioxide under the action of monochromatic light of measured intensity; likewise, by comparison, of polychromatic light. Light from a mercury arc of high intensity was passed through a monochromator or filter and thence through a stirred suspension of Chlorella. The incident and the transmitted light were measured with a thermopile. The change in oxygen and carbon dioxide of the gas passed through the exposure cell was measured with a special burette. Successive determinations were made in the presence and absence of illumination. When the rate of carbon dioxide assimilation was directly proportional to the light intensity, 0.06 of a molecule of carbon dioxide reacted per quantum of light absorbed. This value of the efficiency of the cell is considerably less than heretofore reported by other investigators.

Some problems in cellular pathology as approached through studies both of crown gall and related pathological growths of plants and of cell-stimulating bacteria: A. J. RIKER (introduced by L. R. Jones). A study of several physiological problems involved in cellular pathology and related to atypical and pathological growth are being approached through the use of easily manipulated plant materals. Examinations have been made of certain physiological changes induced in known substances by cell-stimulating bacteria, including *Phytomonas tumefaciens* (Smith and Town) Bergey *et al.* The ability of single-cell cultures to utilize various sources of carbon and nitrogen has been studied. Quantitative determinations have been made of some of the metabolic products from glucose. Changes in hydrogen-ion concentrations have been found to depend on the composition of the substratum. The plant extracts used were turned alkaline. The oxidation-reduction potentials became more negative in a variety of media. However, crown galls of tomatoes were more positive than contiguous uninfected tissue. Causal relations between either the metabolic products or the physical chemical changes following bacterial action and cell-stimulation are difficult to demonstrate because a large number of factors may induce cell proliferation. Two aids in this direction have been found and are being applied to various working hypotheses. (1) Inoculations with crown-gall bacteria on tomato were followed by galls at 28° but not at 30° C., although host and parasite grew well at both temperatures. (2) From a single-cell parent, sister cultures have been secured, one of which has lost its pathogenicity.

The prolonged activity of momentarily stimulated nerves: G. H. PARKER. According to conventional neurophysiology a nerve when severed from its center and momentarily stimulated is supposed to respond by momentary activity, as is well shown in the single twitch of the attached muscle when a severed motor nerve is subjected to a single electric shock. Such momentary activity does not seem to characterize chromatophoral nerves. When such a nerve in the tail of a catfish is cut, its effectors, the melanophores, spread their pigment and a dark band appears over the area of the tail controlled by the cut nerve. This band may persist for as

much as seven days, during which time it gradually subsides and eventually disappears. This lengthy period is believed to be one of continuous activity of the dispersing nerve-fibers, notwithstanding the fact that the stimulus to excitation was the momentary act of transecting them. By appropriate tests it can be shown that the chromatophoral nerves concerned are not inhibitory, are not degenerate and are open to reactivation. The lengthy period of their activity is not due to mere mechanical stimulation of the nerve-fibers at the cut. It is apparently something inherent in the fibers themselves. These fibers are believed on good ground to be autonomic fibers and hence non-medullated. They are concerned with the dispersion of pigment in the melanophores and hence, to use the conventional classification, they belong to the parasympathetic system. These facts may justify their apparently exceptional action, though it must be kept in mind that among medullated fibers those concerned with pain exhibit long-continued activity and that Adrian has shown recently that there is a certain amount of subsequent discharge in severed mammalian nerves. From what has been stated it appears that the dispersing chromatophoral nerves of the catfish can be activated by transection and that this activation may persist for as much as seven days.

An interpretation of the conflicting views as to the life cycle of the Foraminifera: C. A. KOFOID. The researches of Myers have demonstrated on cytological evidence the continuous life cycle of the Foraminifera, involving an alternation of the asexual generation of agamonts in the microspheric tests terminating in multiple fission forming young gamonts of the sexual generation each in a megalospheric test. The megalospheric or sexual generation closes with maturation and a reduction division, forming haploid gametes. The gamonts or megalospheres are enclosed in a fertilization cyst imprisoning the amoeboid, but not flagellate, gametes; resulting zygotes are released from the cysts and grow into the agamonts of the asexual generation in the microspheric shell. There is in this cycle no trace of the flagellate stage. The flagellate stages reported by previous investigators as gametic zoospores have in the past been questioned, even by Lister, because of lack of cytological evidence of their genetic connection with the nuclei of the foraminiferan. The grounds for doubting the validity of the interpretation of these structures as foraminiferan zoospores are: (1) The finding of a typical life cycle with cytological and observational proof of genetic continuity by Myers; (2) the occurrence of so-called zoospores with one, two or three flagella; (3) the report of occurrence of flagellates arising from both the microspheric and megalospheric tests; (4) the wide occurrence of flagellates as parasites in marine invertebrates both in Protozoa and Metazoa. The hypothesis that these so-called gametic zoospores are in reality flagellate parasites rather than gametes seems all the more probable, though still requiring cytological confirmation. The life cycle proven by Myers' researches gives an adequate biological explanation of the occurrence of microspheric and megalospheric tests and of the phenomenon of associated tests in recent and fossil Foraminifera.

The life history of Patellina corrugata, a Foraminifera: EARL H. MYERS (introduced by C. A. Kofoid). The life cycle of the Foraminifera as proposed by Lister (1895) assumed that flagellate organisms seen emerging from the tests of Foraminifera were gametes. Although Lister was hesitant about accepting these conclusions, they were supported by Schaudinn (1903); Winter (1907) and Hofker (1930). No critical cytological evidence concerning the origin of the nuclei and gametogenesis exists in the literature. The account of the life cycle of *Patellina corrugata* Williamson presented in this paper is based on permanent cytological preparations and photographs of living organisms reared in cultures under continuous laboratory control and prolonged observation *in situ*. In this life cycle there is a regular alternation of generations. The asexual or microspheric generation has its origin in a diploid zygote formed by the union of the two haploid isogametes. The sexual or megalospheric generation arises from the asexual microspheric by multiple fission. Beyond the fact that dimorphism in the Foraminifera is due to an alternation of generations, the life history herein outlined has little in common with the ideas advanced by previous workers. There is no evidence of chromidial origin of nuclei, but all nuclei in the entire life cycle are derived solely by mitosis. The haploid gametes are spherical amoebulae fusing to form diploid zygotes. No cytological evidence of a flagellate stage or of any of its associated kinetic structures, such as a rhizoplast, blepharoplast, parabasal or flagella, were observed. In the life cycle of *Patellina corrugata,* the zygote is formed within a fertilization cyst composed of agglutinated débris that encloses the several megalospheric gamonts which have previously united in syzygy. Kinetic activity of the nuclei of the developing microspheric individual falls into two periods. In the first period two post-zygotic divisions give rise to a four-celled somatella. The microspheric proloculum is formed as a lateral lobe during the resting phase between these first two divisions. Usually one, rarely two, of these nuclei degenerate. After a period of vegetative activity the adult microspheric test, consisting of a primordial test and about ten semi-lunar chambers, becomes enveloped in a protecting multiple fission cyst. In the second period a resumption of the kinetic activities of the microspheric nuclei results in two equational divisions to form a twelve-nucleate somatella. After the escape of the somatella from the microspheric test into the multiple fission cyst, a megalospheric test develops around each of the twelve nuclei. Multiple fission results in twelve megalospheric individuals, each with a single nucleus and a test consisting of a spiral chamber of about one and one-half whorls. These megalospheric gamonts associate in groups of two or more in syzygy and give rise to an enveloping fertilization cyst. Syzygy results in the simultaneous activation of the several individuals. The single nucleus within each megalospheric gamont undergoes two progamic divisions before the cytoplasm and contained nuclei escape into the umbilical depression of the respective tests. Each four-celled somatella then divides to form four mononucleate gametocytes. At no time is there a union of endoplasm or nuclei between the several tests. Plasmotomy and the reduction division of these

blobs results in eight times as many spherical amoeboid gametes as there were gamonts involved. Fertilization is accomplished by the union of two haploid gametes to form a diploid zygote, thus completing the life cycle.

Tone quality: C. E. SEASHORE. The concept of tone quality has been analyzed experimentally as a basis for definition and job analysis for further investigation. Tone quality is found to have two components: first, timbre, which depends on the harmonic constitution of the single wave, its absolute pitch and total intensity; and second, sonance, which depends upon change in timbre in a sequence of waves. A complete analysis or measurement of the quality of any sound in nature or art therefore involves the following items: I. Timbre: harmonic composition, single wave. 1. Number of partials. 2. Distribution of partials: region, smoothness, isolation. 3. Relative intensity. 4. Total intensity. 5. Absolute frequency. II. Sonance: sequence of waves. Items 1–5 as above. Change: periodic, progressive or erratic. Such analyses were exhibited for ten representative orchestral instruments, showing the characteristic quality of each instrument and the change of harmonic constitution with change of total intensity and frequency. Applications are made for the improvement of methods of recording, the preservation of primitive music and principles of phonetics.

Transformations in optics: EDWARD KASNER. In this paper all transformations of lineal elements (x, y, z, y′, z′) of space are determined such that every normal congruence of curves shall be converted into a normal congruence. The infinite group obtained is isomorphic with the group of contact transformations in space. The only transformations in the new group which convert curves into curves are the conformal transformations which form a 10-parameter subgroup. The results are of interest in connection with the optics of general isotropic media. It is shown that the only transformations which convert an involution pair of partial equations into an involution pair are contact transformations. An equivalent problem is the transformation of the class of all integrable Monge equations into itself.

Transmutations by artificially accelerated particles: C. C. LAURITSEN and H. R. CRANE (introduced by R. A. Millikan). A description is given of the equipment in use at the California Institute of Technology for work on nuclear problems. The available data on gamma rays and neutrons produced when some light elements are bombarded with fast particles are presented.

The distribution of energies among the positive electrons ejected from some artificially produced radioactive bodies: CARL D. ANDERSON and SETH NEDDERMEYER (introduced by R. A. Milliken). Analysis of the charged particle radiations given off by the artificial radioactive substances produced by Lauritsen and Crane has shown them to be exclusively positive electrons or positrons. The energy distribution among these positrons has been measured in the cosmic ray cloud chamber energy measuring apparatus of the California Institute of Technology. The spectra are continuous and similar to those of the beta rays from natural radioactive bodies.

Cosmic ray energies at very high altitudes: R. A. MILLIKAN, I. S. BOWEN and VICTOR NEHER. From the records of our self-registering instruments carried in airplanes up to 29,000 feet and in balloons up to 62,000 feet (94 per cent. of the way to the top of the atmosphere) we are able to draw certain definite conclusions as to values of the cosmic ray energies throughout the greater part of our atmosphere. These conclusions are presented and their relation to existing cosmic ray theories discussed.

Sodium rhodanate and anesthesia: WILDER D. BANCROFT and JOHN E. RUTZLER, JR. Experiments on man have shown that sodium rhodanate is antagonistic to morphine, alcohol and amytal. Some people have been unable to confirm our findings that a suitable injection of sodium rhodanate will counteract the effect of amytal with rabbits. The failure of those who have tried to confirm these findings has been due to incorrect evaluation of their results because of the variability among rabbits. Rabbits anesthetized with amytal and subsequently treated with sodium rhodanate are found to recover in a longer or shorter time than the controls, depending upon the dose of sodium rhodanate used. Furthermore, it is found that sodium rhodanate markedly lessens the intoxication that is present during the latter stages of the anesthesia. We have just learned that Professor Wolfgang Pauli used sodium thiocyanate nearly thirty years ago successfully to counteract various physiological disturbances in man. He did not study psychoses, morphinism or alcoholism; but his line of reasoning was the same as ours, and he can be said to have confirmed our results long before we thought of getting them.

The neoplastic traits of a mammalian growth due to a filterable virus—the Shope rabbit papilloma: PEYTON ROUS and J. W. BEARD. Efforts to separate causative agents from neoplasms have been successful only in the case of the tumors of fowls. The authors have experimented to learn whether the skin papilloma (Shope) of "cotton-tail" rabbits, which is due to a filterable virus, is an inflammatory or a neoplastic growth. They find that the verrucous form assumed by the papilloma and the slight inflammation at its base are the consequences of its superficial situation. On transplantation to the interior of the host it manifests the characters of a tumor, behaving often like a malignant one. There it develops solely by a multiplication of the transplanted cells; and this would appear to be true also of the skin papilloma, once it is well started. Within the body the growth is nodular and is frequently unencapsulated; it directly replaces the substance of organs; recurs and is readily disseminated in deep wounds; implants itself upon the peritoneal lining; invades blood-vessels; interferes with function; and, growing progressively, induces cachexia and kills the animal. Thus far, however, it has

not metastasized. The proliferating epithelium shows many division figures but no inclusion bodies suggestive of virus infection. The histology is that of an epidermoid carcinoma. The behavior of the papilloma, when protected from injury or bacterial infection, as after transplantation to the interior of the body, is that of a typical neoplasm; but in the circumstances of its natural occurrence, as reported by Shope, it differs significantly from the latter. It is endemic amongst wild rabbits and is frequently multiple; it is referable to a causative agent which can be readily separated from the proliferating tissue; and a single injury of the epithelium is sufficient to enable this agent to act. The occurrence of the growth evidently is conditioned by but few factors, whereas that of the generality of mammalian tumors would appear to be dependent upon many, or upon very special ones. The supposition that the latter are due to an extraneous cause would entail the assumption that this cause is well-nigh ubiquitous but is so greatly conditioned in its action by various factors that its presence can not readily be demonstrated by either the experimental or the statistical method.

Science and conservation: JOHN C. MERRIAM. To be printed in SCIENCE.

The present status of the values of e, h, and e/m: RAYMOND T. BIRGE. A precision value of the electronic charge *e* may be determined in two different ways. The specific charge *e/m* may be determined in several different ways. But the Planck constant *h* can be determined only in connection with *e* or *e/m*. There are, in addition, a number of types of experiment that yield a f(e, h, e/m). In every case these three constants occur only as factors, so that each function may be written as $(e)^a \cdot (h)^b \cdot (e/m)^c$, in which the exponents a, b, c are integers, positive or negative or zero. One such f(e, h, e/m) is Bohr's formula for the Rydberg constant, for which the experimental value is known to one part in 10^6. This formula is still believed to be correct, and by its use e/m may be eliminated from any other f(e, h, e/m), thus giving a series of f(e, h). Each of these functions can be written in the form $e = a \cdot h^m$, in which *a* is an experimentally determined magnitude, and *m* is found to vary in value from zero to unity. Developing a general idea first suggested by W. N. Bond, we write $e_m \equiv a \cdot h_o^m$, in which h_o is an assumed value of h, and e_m a resulting apparent value of e. This may be transformed, by a Taylor's expansion, to $e_m = e - (e_o \cdot \triangle h/h_o) \cdot m$, in which e_o is an assumed value of e. The plot of e_m against m is thus linear. The intercept gives the true value of e, and from the slope one obtains the true $h = h_o + \triangle h$ (see R. T. Birge, *Phys. Rev.*, 40: 228, 1932). There are at least 14 distinctly different types of experiment, with 9 different corresponding values of m, each of which is capable of giving an accurately determined point on the e_m diagram. Any *two* such points, at different values of m, correspond to a definite value of e and of h. The Rydberg constant formula then gives e/m. If all the experimental data were consistent, the 14 points would lie on some one straight line. Hence the e_m diagram shows at a glance the relative consistency, or lack of consistency, of the experimental data. It is also possible to plot on this diagram, at various values of m, auxiliary scales giving the values of quantities such as the Bohr magneton, the fine-structure constant, etc., directly measured by the several experiments. The e_m diagram is thus transformed into a nomographic chart, from which may be read not only the values of e, h and e/m corresponding to any assumed linear graph, but also the values of these other quantities, such as the Bohr magneton, required in order to make all the data consistent. The chief object of the present paper is to illustrate the remarkable "bird's-eye-view" that this diagram gives of a situation of great intrinsic complexity. In 1929 the writer pointed out an outstanding discrepancy in the various experimental values of e/m. As a result of numerous investigations since then, the discrepancy has disappeared, and three very different methods now yield 1.757×10^7 *em* units. There has, however, now arisen an equally outstanding discrepancy between the wave-lengths (λ_g) of x-rays, measured directly with a grating, and the values (λ_s) deduced from Bragg crystal reflection, assuming a geometrically perfect crystal of calcite, and assuming some value of e ($= e_s$). The Siegbahn system of λ_s corresponds to an assumed $e_s = 4.7740 \times 10^{-10}$ *es* units. The λ_g values require approximately $e_g = 4.805$. The best direct measurement of e (by Millikan) gives 4.768. The author has made extensive recalculations of recent experiments, such as those on refraction of x-rays, diffraction of electrons, etc., introducing the latest theoretical developments, as well as improved auxiliary constants, and each result is shown as a point on an e_m diagram. Two of these points, as well as Eddington's theoretical $1/\alpha = 137$, are fairly consistent with $e_g = 4.805$. One point (σ) requires a value of e much *lower* than 4.768. Two methods (Compton shift and fine structure of hydrogen) do not now give precision results. The remaining points are all fairly consistent with $e = 4.768 \times 10^{-10}$ *es* units and $h = 6.547 \times 10^{-27}$ erg. sec, giving $e/m = 1.7574 \times 10^7$ *em* units, $1/\alpha = 137.41$. Certain alternative assumptions regarding x-ray wave-lengths shift the position of 5 points on the diagram, without, however, improving the consistency, and as long as the uncertainty regarding these wave-lengths remains, the values of e, h, etc., just given can not be said to be at all certain.

(To be concluded)

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