latter year he enlisted in the American army and served in France as zone major for the duration of the war.

After receiving his discharge from service, Chapin returned to Columbia for his doctorate and, escaping the lure of Drosophila, was given his Ph.D. for a thesis on his African bird studies, the only degree in ornithology that the university has granted.

There followed additional years of study before the publication of the book (the first of three volumes) for which Chapin is now honored.

The work of a man exceptionally qualified by desire, natural gifts and experience gained in nature, the museum and the classroom, it records in detail observations on habits and distribution, the result of prolonged field-work; it discusses questions of taxonomy and of nomenclature from the standpoint of the skilled systematist who has access to many specimens and is familiar with the literature of his subject, and it treats with the authority of the trained biologist those problems which arise in attempting to explain the relation of an animal to its environment.

Here, Mr. President, is an outline of the facts and factors which have induced the members of your committee to recommend the award of the Elliot Medal to James Paul Chapin.

FRANK M. CHAPMAN

AMERICAN MUSEUM
OF NATURAL HISTORY

PRESENTATION OF THE PUBLIC WELFARE MEDAL TO AUGUST VOLLMER

IT is a commonplace to-day to remark on the disparity between our knowledge and control of the physical forces of nature, and our knowledge and control of social forces.

Three centuries of scientific effort have won basic understandings of physical behavior, and have replaced superstition and appeal to authority by rational viewpoints. But it is vastly more difficult to make progress in the understanding of social forces, and the solution of social problems. Here prejudice is more deeply intrenched; selfishness and provincialism more completely determinant of mental attitude.

However great these difficulties may be, we have faith that surely, even if very slowly, knowledge and mastery are to be gained through the method that we term scientific.

To-night we honor a man whose service has been given to a social problem of critical importance in that difficult field, and who is applying to that problem the spirit and the technique of science.

Crime is a disease of society and August Vollmer a clinician who has stimulated the application to the problems of criminology and police administration of all that can be gathered from the realms of exact knowledge. His achievements have been noteworthy and of wide influence. They constitute, using the language of the purpose of the award of the Marcellus Hartley Medal, "eminent service to the public, performed without a view to great monetary gain, and by methods which are truly scientific."

Vollmer's work began and continued for many years in the police department of Berkeley, where, with but limited resources, pioneering demonstrations of scientific techniques were made. After a few years at Chicago, he returned to Berkeley, where now, as professor of police administration, he is engaged in the effort to bring the university's resources to the improvement of the administration of criminal justice.

By these years of effort, Vollmer has shown the way to the elimination of graft and spoils in police administration, has elevated the standards of personnel, and inspired his co-workers with pride in and ambition for their profession. He has stimulated the search of all fields of science to bring them to bear on the problems of crime detection and prevention. It is not too much to say that he has been instrumental in the veritable remoulding of a profession.

Such results bear testimony to Vollmer's qualities. He brought to his work persistence, intelligence and human sympathy without sentimentality. His unselfishness and modesty have been important factors in the acceptance of his demonstrations, and of his wide-spread influence.

These achievements in the difficult and once unpromising field of police administration have far-reaching results. Respect for law and order grows with the efficiency and character of their formal guardians, and every successful performance of a difficult function stimulates the faith and confidence of a people in its government.

MAX MASON

ROCKEFELLER FOUNDATION

ABSTRACTS OF PAPERS PRESENTED AT THE WASHINGTON MEETING OF THE NATIONAL ACADEMY OF SCIENCES

Lability of the basal metabolism of the dairy cow: FRANCIS G. BENEDICT AND ERNEST G. RITZMAN. The basal metabolism of five Holstein (ca. 600 kg.) and four Jersey (ca. 300 kg.) cows, ranging in age from 3 to 15 years, was measured in 24-hour periods on the fourth and fifth days after the withdrawal of food. At this

stage of fasting the respiratory quotients approached that of fat and the methane production was very low. Before their fasts the cows were fed for at least three weeks on maintenance or somewhat better than maintenance rations, consisting of roughages alone, concentrates alone or green grass (pasture). At no time were they undernourished. The roughages included six different hays, of varying protein content and of early and late cuttings. The concentrates given were either cornmeal alone or linseed meal supplemented by wheat bran. The cows were at all times kept at a controlled environmental temperature of about 20° C. In the majority of instances they were dry, in a few cases pregnant or lactating. The experimental series with any one animal extended from two months to one, two or (with two cows) three and one-half years. None of the cows underwent a change in body weight greater than 15 per cent., except in one instance, when the weight increased 28 per cent. within a year's time. The basal heat production per 500 kilograms of body weight, expressed on the basis of lying per 24 hours, varied from 10 per cent. with a dry cow (measured only twice) to 90 per cent. with two dry cows measured repeatedly over a period of several years. In eight instances with four cows (non-lactating) a marked change in fasting metabolism (either a decrease or an increase), amounting to from 30 to 85 per cent., occurred within two months, when there was no pronounced change in body weight and the animals could not possibly have altered appreciably in body composition. The greatest changes in metabolism occurred during lactation and especially with the change from hay to pasture feeding or *vice versa*. In view of the clearly demonstrated lability of the basal metabolism of these dairy cows the concept of constancy in basal metabolism of animals, which has prevailed among physiologists in general for so many years, must of necessity be revised and the possibility should be recognized that great changes in the endogenous metabolism may take place even within a relatively short time without concurrent changes in body weight.

Heat losses from the human body: EUGENE F. DU BOIS and JAMES D. HARDY. An analysis of the modes of losing heat from the body surface is important in understanding the mechanism for control of body temperature and the production of fever. Experiments carried on for the past twenty years by the Russell Sage Institute of Pathology with its calorimeter have eliminated much uncertainty as to the relation of the heat produced in the body to that eliminated from its surface and have carried the analysis of heat losses to the stage where it is known that under the standard experimental conditions about 24 per cent. of the heat lost is by means of vaporization of moisture. The development of an accurate instrument for the measurement of radiation permits us to estimate the amounts of heat lost through all channels. The proportions of heat lost by radiation, conduction and convection and vaporization are found to depend upon many factors. The physical factors include temperature of the air, of the walls of the chamber, humidity, air velocity, clothing and surface area exposed. Physiological factors include total heat production, vasomotor control and state of health. Measurements on a group of lightly clothed subjects while lying quietly in the calorimeter for periods of three hours show heat loss distributions as follows: Radiation 60 per cent., vaporization 25 per cent., convection 15 per cent. These proportions hold fairly well for clothed or unclothed subjects if the environmental temperature be kept between 77° F. (25° C.) and 81° F. (27° C.). Out of this range the effect of clothing is quite marked. Without clothes shivering usually occurs after several hours exposure to an environmental temperature below 75° F. and visible sweating at temperature above 82° F. The quantitative study of convection has explained several paradoxes and has thrown light on Rubner's law of surface area.

Some remarkable ciliate Protozoa from the caecum of the Indian elephant: C. A. KOFOID. The caecum of the Indian elephant contains two very remarkable new genera of commensal ciliate Protozoa named Polydinium and Elephantophilus. These new genera represent the highest level of evolution as yet discovered in the family Ophryoscolecidae, which includes many commensal species in the stomach of ruminants and in the caecum of other herbivorous mammals. *Elephantophilus zeta* has a Z-shaped macronucleus which, at division, reverts to the primitive club-shaped form found in *Polydinium mysoreum* and generally throughout the Ophryoscolecidae. Both of these new genera have multiple spirally curved ciliary zones arranged in a secondary bilateral grouping instead of a single dorsal zone found elsewhere in some other genera of the family. There are five such zones in Polydinium and six in Elephantophilus. Prior to binary fission new ciliary zones are interpolated between the old. Multiple contractile vacuoles are distributed along these zones of motor activity in both genera. Prior to fission, new vacuoles arise along the new interpolated zones. These metameric structures and their adjacent excretory vacuoles provide a powerful spiral mechanism for boring locomotion through the comminuted vegetable contents of the caecum, among which they ceaselessly move and on whose cellulose fragments and other Protozoa and bacteria they feed. The evolution of structural complexity in the commensal protozoan fauna of herbivorous mammals has advanced along with that of their hosts.

Diabetes in relation with anterior hypophysis: W. G. MACCALLUM. Much experimental work bears upon the governing relation of the anterior hypophysis in the control of carbohydrate metabolism. Certain authors maintain the existence of a secretion neutralizing insulin, while others attempt to show that the hypophysis stimulates an outpouring of blood sugar by way of the adrenal medulla so that the essential is a balance between the activity of the islands of Langerhans and the adrenal medulla. A chart representing these relations is illus-

trated by the description of a case in which recovery from diabetes resulted from the establishment of a balance by the later atrophy of part of the anterior hypophysis.

Maternal influence upon longevity and upon the incidence of leukemia in mice: E. C. MACDOWELL (introduced by A. F. Blakeslee). In reciprocal matings between two highly inbred contrasting strains of mice, the average length of life in the first hybrid generation (683 *vs.* 545 days) differs by 138 ± 11.5 days, which is 12 times the probable error. The data behind these averages form frequency polygons of closely similar shape but with distinctly different ranges and with modes differing by three 50-day classes. Each sex of offspring alone gives similar results; no consistent sex difference in age is demonstrable. In one type of the cross 6 fathers and 17 mothers produced 166 young; in the reciprocal cross 11 fathers and 21 mothers produced 140 young. These two sets of F_1 hybrids also differ significantly in the incidence of spontaneous leukemia, as recently reported. The incidence of leukemia and length of life are inversely related; both vary toward the mothers' strain. While the incidence of leukemia in both directions of the cross lies between the parent strains, the age in both cases averages about 100 days above the mothers' strain; leukemic mice from the reciprocal matings differ as much in length of life as the non-leukemic mice. These results speak against a causal relationship between the two sets of observations. Reciprocal matings in a back cross give similar general results. Both length of life and incidence of leukemia differ significantly according as they are brought in from the grandmother by the father or the mother. Comparisons between the two hybrid generations showing groups with the same age and markedly different incidence of leukemia give further evidence of the physiological independence of these traits and indicate differences in the mode of transmission. Through the male line the incidence of leukemia in two hybrid generations shows a correlation with the total heredity from the leukemic strain; transmission through females raises this incidence. Longevity is also modified by maternal influence combined with marked heterosis and slight change in the corresponding matings in the back cross.

Oxygen consumption during Yogic breathing exercises: WALTER R. MILES and K. T. BEHANAN. Traditionally in the cult of Yoga special breathing routines have been used as a preliminary for mental concentration. The exercise types in question range from those composed chiefly of extremely rapid shallow breathing (two respirations per second) to those involving extremely deep and slow ventilation (one respiration per minute). Some of the learned breathing patterns are characteristically continued for 20 to 30 minutes preceding concentration. The present paper reports repeated metabolism experiments with three common Yogic patterns as practiced by a Hindu male (K. T. B.) of 31 years following a two-year period in the regimen of the Yoga cult. Each breathing pattern is found to produce a considerable rise in metabolic rate during the time (10 to 30 minutes) of the exercise. The effect on subsequent normal breathing appears to be transitory in two of the three types studied. In the case of the Bastrika pattern where shallow and deep breathing are alternated within each minute the after effect is more definitely prolonged and is in the direction of a reduced metabolism. A very slight increase in oxygen consumption is found in the experiments on mental concentration after normal quiet periods. The study suggests that artificial breathing patterns, if they influence mental concentration, do so probably more in psychological than in physiological terms.

Isolation from pancreas of a substance which inhibits trypsin digestion and its effect on the activation of trypsin: JOHN H. NORTHROP and M. KUNITZ. It has been known for nearly 100 years that the secretion from the pancreas possesses the property of digesting protein (meat). It has also been known that the secretion is inactive when it leaves the pancreas but becomes active upon entering the small intestine. The agent (enzyme) responsible for this digestive power was named "trypsin" by Kühne, but the chemical nature of this agent and the mechanism whereby it was activated have always been uncertain and controversial. The writers have isolated from fresh pancreas the active and inactive form of two proteolytic enzymes, trypsin and chymo-trypsin, and the activation of these pure compounds has been studied. In addition, the writers have recently isolated a crystalline material which is a compound of the enzyme, trypsin and another substance (inhibitor) of histone-like character which inactivates trypsin. It was found possible to split the compound into trypsin and inhibitor, and both components were then obtained in crystalline form. By combining the two components again the original compound may be synthesized and crystallized. Crude inactive trypsin solutions containing a trace of active enzyme become active when allowed to stand in neutral concentrated salt (magnesium or ammonium sulfate) solution. The purified crystalline inactive trypsin becomes active simply on standing in neutral solution without the addition of salt. When purified inhibitor is added to purified inactive trypsin the mixture behaves like the crude solution and does not become active until salt is added. The effect of salt upon the activation of crude inactive trypsin solutions, therefore, is to destroy the effect of the inhibitor. The transformation of the inactive to the active form of the enzyme is caused by the active enzyme itself. The experiment, therefore, represents the "propagation" of the active enzyme, since the addition of a small amount of active enzyme results in the production of a very large amount of "itself"; just as inoculating a culture media with bacteria results in the production of many more bacteria. The effect of the inhibitor is to inactivate the trypsin in the same way as an antiseptic would prevent multiplication of bacteria.

Some aspects of anesthesia and irritability: W. J. V. OSTERHOUT and S. E. HILL. Cells of the fresh-water plant *Nitella* respond to electrical stimulation like nerve

fibers but have the great advantage that each cell can be studied separately and is readily accessible to treatment with reagents. The irritability of the cell depends on a substance, or group of substances, which we may for convenience call *R*. This is shown by the fact that cells kept for 2 days in distilled water lose their irritability. The water in which cells have been standing contains substances which, when suitably concentrated and applied to the cell, quickly restore irritability. Such substances appear to be widely distributed, as might be expected in view of the general occurrence of irritability. For example, when irritability has been lost it can be restored in a few seconds by treatment with human blood. If the substances causing this effect are responsible for the irritability of nerve and lead to disturbances in nervous functions when deficient, such substances must play an important part in ontogeny and in phylogeny as well as in pathology. These experiments suggest that some anesthetics may produce their effects in the same way as distilled water, *i.e.*, by removing substances from the protoplasm. What is said of irritability applies also in general to the potassium effect, *i.e.*, the large *P.D.* (about 85 mv.) observed in leading off from a spot in contact with 0.01 *M* KCl to one in contact with 0.01 *M* NaCl. (In this respect the cell acts somewhat like a potassium electrode.) The loss of this property is an additional indication of the profound change in the protoplasmic surface caused by dissolving out *R*. What is the nature of *R*? One way of attacking this problem is to observe the effect of various pure substances. We find that the following can restore irritability or the potassium effect or both: NH_3, NH_4Cl, tetra ethyl ammonium chloride, guanidine, adrenaline and ephedrine. In some cases only one effect was secured and when both were obtained one was usually restored before the other. This indicates that they depend upon somewhat different conditions. It would not be surprising to find that a variety of substances are effective. We should expect that any substance capable of facilitating the breakdown of the non-aqueous protoplasmic surface under an applied *E.M.F.* would tend to restore irritability. Any substance which decreased the mobility of the sodium ion as compared to that of the potassium ion (*e.g.*, by forming complex ions) or which increased the concentration of potassium ions (*e.g.*, by chemical reaction) would probably tend to restore the potassium effect.

What are resting states and active states in chromatophores, particularly melanophores?: G. H. PARKER. In the past different investigators have expressed various views as to the resting state of Melanophores. Some have declared that the state with dispersed pigment is a resting state; others that the state with concentrated pigment is a resting one and still others that some intermediate state is that of rest. Experimental evidence shows that none of these views is correct. Any state of inaction, irrespective of the position of the pigment, is a resting state as contrasted with one of pigment movement which is an active state. In this respect Melanophores are like smooth muscle-fibers and unlike cross-striped muscle-fibers. The resting state of any Melanophore is ordinarily determined by its neuro-humoral environment.

Four theorems on the envelope of extremals: MARSTON MORSE.

Tauberian gap theorems: NORBERT WIENER.

Analysis of 18,000 proper motions derived at the Leander McCormick Observatory: P. VAN DE KAMP and A. N. VYSSOTSKY.

Observational evidence of an Einstein-red-shift in Class O stars: ROBERT J. TRUMPLER. According to Einstein's Generalized Theory of Relativity the gravitational field of the sun or the stars causes a slight increase in the wave-lengths of lines observed in the spectra of these bodies. The solar or stellar lines thus appear shifted toward the red as compared with similar lines of a laboratory source of light. This red shift is proportional to the mass of a star and inversely proportional to its diameter. For the sun it is small and difficult to verify, but in stars of small diameter or of large mass it becomes considerable. Stars of spectral Class O, which are of the highest temperature and the greatest luminosity, are known to be the most massive, and these stars were therefore selected for a test of the red shift. For stars in general the relativity shift of spectral lines can not be separated from the Doppler shift caused by their motion toward or away from the observer. Fortunately, many stars of Class O occur in galactic star clusters. Since the stars of such a cluster form a physical system, they must have nearly the same motion. The latter can be obtained from observations of the fainter cluster stars, for which the red shift is small because of smaller luminosity, lower temperature and smaller mass. The radial velocity observations of galactic star cluster which are in progress at the Lick Observatory are at present sufficiently complete to allow such a test in six clusters. The 9 Class O stars of great luminosity contained in these all show a decided positive excess of radial velocity for which there seems to be no other explanation but that of a relativity red shift. Its average amount is 10.8 km/sec or 17.1 times the shift predicted for the sun. An accurate numerical comparison with the theory is not possible because we do not know the masses of the individual stars; but if our interpretation of this effect is correct, we can use the observed red shift to determine the masses. The average value of 180 times the sun's mass thus obtained is somewhat larger than the rather uncertain value furnished by spectroscopic binaries. The difference is perhaps due to the particular selection of our stars, but the observed red shift is at least of the right order of magnitude.

Report on the progress of the Yale zone observations: FRANK SCHLESINGER. Yale Observatory has now completed the reobservation by photography of five of the Astronomische Gesellschaft Zones, embracing the positions of 40,980 stars. According to an agreement with the Astronomische Gesellschaft and with the Cape Obser-

vatory in South Africa, arrangements have now been made for covering the whole sky in this way. Yale's share in this work is the area between the equator and declination $-30°$, and this is being done on fields of 110 square degrees with a Ross camera. These zones have shown a general improvement in accuracy until now the weight of a star position is double that in our first zone.

Meningitis in man caused by a filterable virus: THOMAS M. RIVERS and T. F. MCNAIR SCOTT. To be printed in SCIENCE.

New endocrine complexes from recombinations of old breed types: C. R. STOCKARD.

Significance of the amnion: GEORGE L. STREETER. In early stages of primate embryos, hitherto unavailable, it is found that the amnion is more closely related to the trophoblastic elements of the egg, in its origin, than to the cells that are to form the embryo proper. Thus embryologically it is a transitional structure, serving only during fetal life, and is to be grouped with the allantois, yolk-sac and placenta. In its development and later structure the amnion is essentially a serous membrane, functioning somewhat like the pleura and peritoneum. Containing more fluid than these, it provides the growing fetus with ample freedom for movement.

Relative importance of various genes to the organism: M. DEMEREC (introduced by A. F. Blakeslee). Present-day genetics visualizes the appearance of an organism as a result of the interaction of the whole complex of genes possessed by the organism and the environment in which that organism develops. Assuming that the environment is constant, the relative importance of the genes will be discussed here. The whole complex of genes forms a balanced system which is sensitive to various changes occurring in that system. The disbalance produced by such changes affects the organism and in many instances shows up as a new characteristic, usually detrimental to the organism. Studies with deficiencies, *viz.*, the material in which certain genes are missing, indicate that not all genes are of equal importance in the life of an organism. In the case of *Drosophila melanogaster*, where chromosomes are paired and each gene therefore is represented twice, the following categories of genes have been recognized. (1) If one gene of the two is missing it shows up as a detrimental characteristic on the organism; if both are missing the cell-lethal effect is produced, *viz.*, even a small group of cells of such constitution is unable to live (Notch, Minutes, Plexate). (2) If one gene is missing and the other is the wild-type allel the organism is not visibly affected, but if the other gene is a mutant allel the character is exaggerated; deficiency for both genes is cell-lethal (forked, tan, sable, tiny, rudimentary). (3) Deficiency for one gene has no effect on the organism, deficiency for both is cell-lethal (dusky, miniature, fused). (4) Deficiency for both genes is not cell-lethal, but is lethal to the whole organism (cut, yellow, scute). (5) Presence of the gene is detrimental and its absence beneficial to the organism (Bar).

The mechanism of sexual reproduction in Neurospora and Gelasinospora: B. O. DODGE. In normally bisexual races of *Neurospora* the ascogonium is quickly surrounded with a weft of sterile tissue. Spermatization, or conidiation, is not necessary and no trichogynes are formed when the ascogonium is provided with nuclei of opposite sex-reaction from the beginning. There is no pause in the development of the ascocarp. When unisexual mycelia are grown separately the same type of incipient perithecium is formed, but after it has reached a certain size trichogynous elements grow out through the sterile envelope. No further growth occurs unless microspores or monilioid conidia of the other sex-reaction come in contact with these receptive elements. If this occurs fertilization follows and the ascocarp matures. It will be shown that when unisexual races of opposite sex are grown together from opposite sides of a plate culture there is a more effective method of bringing the two kinds of nuclei together. This feature also determines the perithecium distribution pattern so characteristic of many pairs of races. *Gelasinospora tetrasperma* does not produce spermatia or other asexual reproductive bodies, yet fertilization occurs readily in mixed cultures of facultatively heterothallic races. The way this is brought about will be described.

The genetic control of developmental relationships and its bearing on the theory of gene action: E. W. SINNOTT (introduced by R. A. Harper). It has been shown that fruit shape in Cucurbita is controlled by a series of genetic factors and that these produce their effects independently of the size of the organ. They evidently control relative rather than absolute growth. When F_2 shape indices are plotted arithmetically they show marked positive skewness, which disappears in logarithmic plotting, indicating that the genic effect is an exponential rather than an additive one. Other dimensional relationships in the fruit behave similarly. Widely diverse shape types can be derived graphically from a basic type by plotting it in a series of logarithmic coordinates of various sizes, and the series of fruit patterns thus seems to be the result of modifications of an axial exponential gradient. A genic control of the steepness of this gradient would account for most of the shape differences observed. Simple quantitative traits like fruit weight show a similar skewness in F_2 (though often not in environmental variability) and it may be that here, also, it is developmental relationships of various sorts, rather than absolute quantities, which genes determine. This is further suggested by the fact that size differences are found to be due to differences in the relative extent of various aspects of the developmental schedule, notably, cell division and cell enlargement. It is suggested that in all inherited traits the relationships between rates rather than the absolute rates themselves are what genes control.

Old and new criteria for determining the relationships of higher plants: WALTER T. SWINGLE.

Analysis of rotatory dispersion curves of members of homologous series of the type $H-\underset{\displaystyle R}{\overset{\displaystyle CH_3}{\overset{|}{\underset{|}{C}}}}-(CH_2)_nX$.

P. A. LEVENE AND ALEXANDER ROTHEN. In the above formula n=0 or an integer, R=a normal alkyl or an aryl group, X=a functional group. When n=0, on substitution of X by Y, depending upon external conditions, one of two stereoisomeric substances may form. Neither one's configuration can be determined by direct chemical means. When n=1 or an integer, then only one isomer can be formed, inasmuch as no inversion takes place during the reaction of substitution. Through the analysis of the rotatory dispersion curves it is possible to determine in each case the partial rotations of X and of the rest of the molecule. In the case when n=an integer, it was found that on substitution of X by Y or Z, or some other atom or group, the change in rotation is independent of the value of n. On the basis of the analysis of the events following the substitution of X by Y in this group of substances, it was attempted to predict the result of the reaction in the cases when n=0.

The oxygen equilibrium of hemoglobin and its structural interpretation: LINUS PAULING. It is shown that the data on the oxygen equilibrium of hemoglobin indicate that the four hemes of the molecule are arranged at the corners of a square; each heme is connected with two others in such a way as to give rise to an interaction energy of 1,500 cal./mole for each pair of adjacent oxyhemes, and each heme contains two acid groups, the interaction energy of each with the oxyheme being 820 cal./mole. It seems probable that the hemochromogens differ from hemoglobin mainly in that in the hemochromogens the hemes are independent and in hemoglobin four hemes form a conjugated system.

Some physical properties of rubber prepared by fractionation and crystallization: W. HAROLD SMITH (introduced by W. W. Coblentz). A method of preparing pure rubber hydrocarbon from *Hevea latex* aims to preserve intact its physical structure. The purified rubber is separated into two fractions by ethyl ether. Approximately 75 per cent. is soluble. Each fraction yields crystals which differ in their melting behavior. The stress-strain characteristics of vulcanized fractions and x-ray diffraction data indicate other differences. The molecular weight of the soluble fraction is much greater than any value which has ever been reported for total rubber.

Quadratic wave equation—flood waves in a channel with quadratic friction: M. A. BIOT (introduced by C. A. Adams). A mathematical investigation is here made of what happens in a channel or a river in the case of the bursting of a dam. When the retaining wall of a water reservoir suddenly gives way, a flood wave propagates in the channel with a constant speed. The height of the wave varies all the time and decreases according to a certain law.

Electrical communications, past, present and future: FRANK B. JEWETT.

X-ray wave-lengths and the fundamental constants: J. A. BEARDEN (introduced by R. W. Wood). The scale of x-ray wave-lengths has been obtained by three independent methods. (1) A plane grating (ruled by Professor R. W. Wood) 75 mm long ruled with 100 lines per mm has been used in an ionization double crystal spectrometer to measure the wave-length of the copper $K\alpha_1$ line. These results are in good agreement with the author's 1931 photographic ruled grating measurements. (2) X-ray refraction measurements using a diamond prism have been made within an accuracy of 1 part in 10,000 and the x-ray wave-lengths obtained agree with the ruled grating results. (3) Larsson has used a 5 meter concave grating to compare the high orders of the Al $K\alpha_{1,2}$ line with the first order of a known spark line. These results are also in agreement with those of (1) and (2). Thus the absolute wave-length of x-ray lines is now known to within 1 part in 10,000. Since there is no evidence that would indicate the existence of a mosaic structure in crystals normally used for x-ray work, and since many crystals have been found that fulfil the theoretical requirements of a perfect crystal, one should be justified in using the absolute x-ray data for calculating Avogadro's number N. Such a calculation gives $N = 6.022 \times 10^{23}$ mol. per mol. Then by the use of the Faraday constant we can get the charge on the electron or $e = 4.803 \times 10^{-10}$ e.s.u. This result is 0.75 per cent. higher than is obtained from the oil drop experiment. Planck's constant h as obtained from the high frequency limit of the continuous x-ray spectrum is increased to $h = 6.608 \times 10{-}27$ erg. sec.

Spectroscopic investigations in the extreme ultra-violet: K. T. COMPTON and J. C. BOYCE. The Carnegie Institution of Washington vacuum spectrograph, which is located in the spectroscopy laboratory of the Massachusetts Institute of Technology, provides sufficient dispersion and resolving power, over a broad range, to make possible a considerable program of spectroscopic research in the extreme ultra-violet. The instrument has already been used on a number of investigations of emission spectra of atoms and of molecules, and of absorption spectra of molecules, some of which have already been published. Among the more recent and unpublished results of the group of workers collaborating in the use of this spectrograph are those which revise and extend the term analysis of argon, krypton and phosphorus. In argon, de Bruin's term assignments for A II have been somewhat revised, additional triplet terms in A III have been discovered, and a start has been made on the doublet system in A IV.

A model of atomic nuclei: WILLIAM V. HOUSTON.

A new type of excitation function for nuclear reactions: E. O. LAWRENCE, EDWIN MCMILLAN and R. L. THORNTON. The voltage excitation functions for the

reactions in which radioactive Na^{24} and Al^{28} are formed from sodium and aluminum by deuteron bombardment have been investigated up to a deuteron energy of 3.3 Mv. These results show a type of behavior quite different from that to be expected on the basis of the Gamow theory of nuclear penetration. The differential excitation curves, plotted against the deuteron range, start to rise appreciably at about 1.0 Mv, build up exponentially to about 1.8 Mv,[1] and then become linear and remain so to the highest energy of 3.3 Mv. A sharp contrast thus exists between the experimental results and Gamow's formula, since the latter predicts a rapidly increasing slope over the whole energy range. It was also found that deuteron bombardment caused radioactivity in copper, an element of surprisingly high atomic number for such an effect. The radioactive product has a half life of 6 hours and is presumably the copper isotope also formed by neutron bombardment. The excitation curve in this case starts at 1.5 Mv, and is still increasing in slope at 2.8 Mv, but not nearly as rapidly as predicted by the Gamow theory. A theoretical interpretation of these results has now been found by J. R. Oppenheimer.[2] The reactions mentioned above are all of the type in which a deuteron gives up its neutron to a nucleus. If this involves the entry of the whole deuteron into the nucleus, the Gamow theory should hold; but a process is also possible in which, while the deuteron is just outside a nucleus, the neutron leaks through the potential barrier separating its normal state in the deuteron from a bound state in the nucleus. This barrier is in general much more penetrable than that opposing the entry of the whole deuteron. The numerical consequences of this theoretical picture have been worked out by Professor Oppenheimer and Dr. M. Phillips for the cases described above. The form of the resulting curves depends on the value assumed for the binding energy of the neutron. An extremely good fit with the experimental curves in all three cases is given by his formula with the binding energy taken as 1.7 Mv; values differing from this by 0.9 Mv give curves in gross disagreement with the experimental results. It thus appears that the present results and their theoretical interpretation offer a new method of evaluating the binding energy of the deuteron and hence the mass of the neutron. The values thus obtained are very near to those now accepted.

Further experiments on the cosmic ray longitude effect: ROBERT A. MILLIKAN and H. VICTOR NEHER.

Exact solutions of wave diffraction and scattering problems in elliptic and spheroidal coordinates: PHILIP M. MORSE (introduced by John C. Slater). The solutions of the wave equation in spheroidal and elliptic cylinder coordinates, discussed by Stratton in the preceding paper, have been computed, in part by the differential analyzer, and tabulated. These tables, together with the addition formulae expressing the plane wave in terms of the spheroidal functions (see Morse, *Proc. Nat. Acad.*, 21: 56, 1935) make it possible to obtain exact solutions of a large number of diffraction and scattering problems. As an example of the method, the scattering of a plane wave by a long, perfectly reflecting ribbon of width d and the diffraction of a plane wave by a slit of width d have been computed for a range of wave-lengths of the order of magnitude of d, for different angles of incidence and for different boundary conditions. The problems are related by Babinet's theorem. The resulting curves evidence interesting resonance effects when the wave-length equals d or 2d. The results of the scattering problem are useful in a study of the acoustical properties of ribbon microphones and loud speakers. Other problems which can be solved exactly by the use of the tables are the scattering of waves (sound, light or electron) by prolate spheroids or by round disks, the radiation of waves from these objects and the diffraction of waves by circular apertures.

On the fundamental equations of elasticity, with special reference to the behavior of solids and liquids under extreme pressures: F. D. MURNAGHAN (introduced by Joseph S. Ames). Formulae are derived for the components of the stress tensor in terms of the energy of deformation and its derivatives with respect to the components of the strain tensor (the latter being referred to the strained position of the medium), without making the usual assumption that the deformation is infinitesimal. As a special result it turns out that for media under uniform (hydrostatic) pressure p is a function of the quantity $e = \left(\frac{V_o}{V}\right)^{2/3} - 1$. On testing the cubic expression $p = ae + be^2 + ce^3$ on recent experimental results of Bridgman on lithium, sodium and potassium with a pressure range of 2,000 to 20,000 atmospheres (the constants a, b, c being determined by the values at 2,000, 10,000 and 20,000 atmospheres) the theoretical formula agrees, over the entire range, with the experimental results to within one half of 1 per cent. For liquids (n-amyl iodide and n-butyl iodide) over a range of 500 to 12,000 atmospheres there was agreement to within 2 per cent. (all but four out of some fifty calculated values being within 1 per cent. of the observed values). The values of the constants for the solids were: *Lithium:* $a = 179.11 \times 10^3$; $b = 140.0 \times 10^3$; $c = 145 \times 10^4$; *Sodium:* $a = 94.13 \times 10^3$; $b = 251.8 \times 10^3$; $c = 47 \times 10^3$; *Potassium:* $a = 44.81 \times 10^3$; $b = 124.72 \times 10^3$; $c = 142.5 \times 10^3$.

The width of spectrum lines: F. K. RICHTMYER and E. RAMBERG. According to classical theory the observed width of spectrum lines depends on (1) the Doppler effect due to the thermal motion of the emitting atoms; (2) interruptions of the vibrating mechanisms by collisions with other atoms; and (3) radiation damping, the greater the damping the wider the line. In the optical

[1] These curves had been examined previously to 1.9 Mv. (E. O. Lawrence, *Phys. Rev.*, 47: 17, 1935; E. M. McMillan and E. O. Lawrence, *Phys. Rev.*, 47: 343, 1935). In this voltage range the observed deviation from the Gamow formula was so slight that it was not considered significant at that time.

[2] We are much indebted to Professor Oppenheimer for his valuable cooperation in this work.

region (3) is very small compared to (1) and (2). In the x-ray region (1) and (2) are negligible compared to (3), which is large enough to permit measurements of widths. Such measurements, however, show that x-ray lines are, in general, much wider than would be expected from (3). This is explained on the quantum theory as follows. In the quantum theory, radiation damping is replaced by "mean life" of the atom in a given excited state, the shorter the mean life, the greater the effective width of the state. The mean life is determined not only by the radiation transitions between states (corresponding to radiation damping) but by the probability of radiationless transitions (Auger effects). Quantum mechanical calculations show that the widths of a large number of the excited states, and hence of the spectrum lines resulting from transitions between states, are due in large part to Auger effects. There is qualitative agreement between the computed and the observed widths.

Intensities of x-ray satellites: ANNA W. PEARSALL (introduced by F. K. Richtmyer). After a brief survey of the bearing of the problem of the intensities of x-ray satellites on the origin of x-ray spectra, a résumé is given of previous measurements of satellite intensities, particularly those associated with the L-series spectral lines. The present paper reports measurements on the intensities of the satellites accompanying the strong K-series lines, $K\alpha_1$ and $K\alpha_2$. These data are the more important because of the recently published theory of Coster and Kronig (*Physica*, II, 13, 1935) concerning the relation of the Auger effect to the origin of satellites. Since the type of Auger effect discussed by Coster and Kronig can play no part in the origin of K satellites, it might be expected that the variation of their intensities with atomic number would obey a very different law from that applicable in the case of L satellites. Using a Siegbahn vacuum spectrograph, spectrum plates were made of the $K\alpha$ lines with accompanying satellites $K\alpha_{3,4}$ for elements in the atomic number range S(16) to Cu(29) inclusive. From microphotometric records of these plates, intensities of $K\alpha_{3,4}$ relative to $K\alpha_1$ were obtained. These intensities vary from 0.7 per cent. for Cu(29) to some 3 per cent. or 4 per cent. for Cl(17) and K(19). No sharp maximum of intensity similar to that found with the L satellites was observed.

The ancestral tree of the Proboscidea. Discovery, evolution, migration and extinction over a 50,000,000 year period: HENRY FAIRFIELD OSBORN. Ancestral Titanothere tree embraces 15 phyla extending over 20,000,000 years, Lower Eocene to Lower Oligocene; exhibits independent origin and evolution of bony horns, independently arising as "aristogenes." Proboscidea exhibit 30 independent lines of descent, extending over period of 50,000,000 years; superior tusks take the place of horns. In contrast to arrested evolution of titanothere grinding teeth, Proboscidea exhibit 30 distinct lines of evolution in the grinding teeth coordinated with special adaptations of either superior or inferior tusks; adapted to variations of herbivorous diet ranging from arctic to equatorial conditions in all continents except Australia. Aristogenesis can now be measured as to secular rate of evolution. It is in widest possible contrast with the D. mutations. Aristogenesis in the origin of the cones of the grinding teeth is in accord with 18 principles, namely: Every single aristogene obeys the eighteen principles of biomechanical adaptation; it has its own individual and particulate adaptive history; it is coordinated with the functions and adaptations of the organism as a whole; its survival and relative strength or its reduction and elimination is determined by its degrees of service. Evolution of proportion (Alloiometrons) is in contrast with Aristogenesis and follows two principles, namely: (1) Irrespective of remote ancestry and remote phylogenetic affinity, closely similar adaptive changes of proportion in the cranium and in the segments of the limbs arise in different lines of mammalian and reptilian descent. (2) Convergent alloiometrons in the limbs, cranium and grinding teeth arise as relatively rapid secular changes following adaptive radiation in habit and function. They are most strongly convergent where there are the most intense similarities in the geographic and geologic environment. Alloiometrons are extremely rapid and entirely independent of ancestral hereditary influence; that is, similar changes of proportion may occur in the limbs of dinosaurs and of mammals. Aristogenes (*e.g.*, horns of titanotheres, dental cones of proboscideans) are absolutely dependent upon ancestral heredity and arise only in long periods of geologic time. The author's thirty-four-year research on the evolution of Titanotheres and Proboscidea yield all the known modes and principles of the origin of species as defined by biomechanical characters.

The change in the range of accommodation with age and its connection with the length of life: FELIX BERNSTEIN (introduced by Franz Boas). A systematic study of the inheritance of the duration of life is difficult because death is due to accidental as well as to natural causes. Therefore, I tried to substitute the study of the heredity of the span of life by the study of the physiological aging of the organs of the body. The easiest measurement in that respect is that of the change in the elasticity of the lens of the human eye manifested in the loss of the power of refraction with age which becomes apparent as a defect during middle age (presbyopia). Data on 5,000 cases of presbyopia gathered from the university clinics of Goettingen and Leipzig and from two private oculists, and followed individually from the first tests until death, proved that presbyopia is correlated with the duration of life in such a way that the early presbyopes die early and the late presbyopes die late. This whole correlation applied only to those who died from brainstroke and heartstroke, constituting about half of the material. The other half, who died of pneumonia, diabetes, cancer and other diseases, were not at all or only slightly correlated. By classifying the data in three classes, normal, sub-normal and super-normal presbyopia, we found, for instance, that the expectation of life length in the three classes at

the age of 50 amounted to more than eleven years difference between the highest and lowest class of those who died of arteriosclerosis. During the summer and fall of 1933, family data on the range of accommodation have been collected with the aid of a grant from the Rockefeller Foundation given to the Biological Laboratory at Cold Spring Harbor. In order to compare the data of different ages, all persons were reduced to a normal age taking in account the development of the range of accommodation as determined by the whole material. We compared the standard deviation of the range of accommodation among the members of the same family from the family mean with the standard deviation of all individuals from the mean of the whole material. The average square of the deviation from the general mean was 9.97; on the other hand, the average square of the deviation from the family mean was only 3.58. This shows conclusively that the physiological aging measured by the range of accommodation is essentially hereditary. In the year 1934–35 the data of 95 families were collected in Jersey City, N. J. From these the square of the standard deviation of the members of the family from the family mean amounted to 2.9; the square of the standard deviation of the whole population from the general mean amounted to 8.7. This result confirms the previous conclusions. The investigations do not indicate any sexual difference in regard to the range of accommodation. The fact that women actually live one year longer on the average than men, therefore, is not due to hereditary causes, but is due to the differences in the conditions of life in both sexes. These implications of natural span of life are especially important in regard to the fact that the natural causes of death come more in the foreground the more the infectious diseases are brought under control.

The tempo of growth of fraternities: FRANZ BOAS. Previous investigation has shown that the tempo of development from six years to adult life must be considered as a unit so that children who at six years are developing rapidly will continue to do so and reach adult life more quickly than those who at six years are retarded. A study of the growth curves of brothers and sisters of rapidly developing children shows that these also will develop rapidly and that the brothers and sisters of those retarded will develop slowly. The tempo of development must therefore be considered as in part determined by heredity. At the same time the influence of environment must be recognized. The average dates of maturity of Hebrew and Northwest European girls, both in private schools and in orphan asylums, are practically the same, namely, 12 years and 5 months, while Negro girls in orphan asylums, on the average, mature 6 months earlier. The influence of environment upon bodily form is also expressed in a comparison between the statures of immigrants and their descendants. It is well known that stature in Europe has been constantly increasing. The stature of immigrants, on the other hand, between 1860 and 1920 has remained constant, while the stature of their American-born children has been constantly increasing. In 1910 I showed that the cephalic index of immigrant Hebrews was on the average 83.0, that of their descendants born in the United States 81.4. Children of Hebrew mothers born in the United States had an index of 79.7. At that time families in which both parents were native born were difficult to find. Measurements made by Dr. Nicolai Michelson during this winter gave an index for children of native-born Hebrews of 78.7.

The neural basis of memory in primates: C. F. JACOBSEN (introduced by Robert M. Yerkes). Two basic types of modification of behavior through experience have been distinguished: (1) Modification of response which does not suggest any change in the innate connections between receptor and effector mechanisms (progression of physiological states), and (2) modification which implies a change in the pattern of connections between receptors and effectors (associative memory, conditioned reflexes). The latter kind has been regarded as the type of all true learning, and efforts have been made to describe complex behavior as combinations of simple associations. According to this view the concept of learning and memory embraces a unitary process. However, distinctions have been made between various forms of memory—motor habits, associative memory, conditioned reflexes, logical memory and reproductive memory or recall. These distinctions rest largely upon differences in the stimulus-response relations involved, and it has often been assumed that the variety of phenomena resulted from different methods of study. But this array of phenomena justifies raising the question whether the concept of memory can be studied as a unitary process or whether it comprehends phenomena having no common organic basis. In this paper evidence will be presented that memory embraces qualitatively different phenomena mediated by different neurological mechanisms. In the investigation of the neural basis of memory, monkeys and chimpanzees were tested on a battery of behavioral problems, subjected to surgical lesions of the cerebral cortex, and examined for deficits in the abilities measured before operation. The tests ranged from simple conditioned reflex situations to complex "insight" problems, and included tests of instrumentation, delayed response, sensory-motor habits and visual discrimination. Complete bilateral extirpation of the frontal association areas caused failure on those problems which required some capacity for reproductive memory. Injury to the frontal areas not only caused amnesia for previous acquisitions of this kind, but produced a permanent loss as evidenced by failure to improve with extensive reeducation. On the other hand, the subjects which exhibited profound deterioration of reproductive memory suffered no amnesia for discrimination habits and problem box solutions and showed no retardation in the acquisition of new habits of a similar nature. Control observations indicate that this impairment of recall can not be attributed merely to an extensive injury to the cortex, since lesions in the temporal, parietal and motor regions caused no deterioration of this function. Lesions of the frontal cortex cause not general weakening of memory but only

deterioration of a special form of memory. It thus seems that the various phenomena of learning and memory can not be regarded merely as different aspects of an essentially unitary process. On the contrary, the concept of learning and memory is seen to comprehend at least two, and probably more, diverse processes which are mediated by different neurological mechanisms.

A habitation site and workshop attributable to so-called Folsom Man: FRANK H. H. ROBERTS, JR. (introduced by John R. Swanton). A significant addition to the material illustrating an early phase of aboriginal American culture was obtained during October and November, 1934, in northern Colorado, where indications of a camp site and workshop attributable to so-called Folsom Man were brought to light. A whole series of stone implements—several types of scrapers, a variety of cutting edges, drills, engraving tools—and numerous examples of the characteristic point identified by the name Folsom were found in situ in a dark layer of earth 14 feet below the present ground level. The layer, which was exposed in the side of a deep and narrow gully, also contained quantities of cut and broken animal bones, stone chips and flakes resulting from the manufacture of tools, charcoal and ashes, and other refuse such as accumulates around habitations. The concentration undoubtedly was a midden, and remains of dwellings probably are nearby. Whereas the only traces of a presumably early hunting people prior to this find were typical finely chipped points of stone, there is now a definite complex of associated implements. In addition the scrap flakes give evidence of the technique employed in the manufacture of implements, and the spalls and nodules indicate that the stone-working was done on the spot. Raw material suitable for making tools is plentiful in the neighborhood. The points which became the pattern for the type were found by a party from the Colorado Museum of Natural History in 1927 near the small town of Folsom, New Mexico, hence the name. They were in association with skeletons of an extinct species of bison, one which is considered as having lived at the close of the glacial period. Since then other points of that type have been found at different localities along with bones of another extinct species of bison, of an unidentified musk-ox like creature, and of the mammoth. The supposition that the type represents considerable antiquity rests upon these associations. Whether the finds actually date man in North America at the beginning of the post-glacial period or demonstrate a later survival of Pleistocene animals is a phase of the problem which the geologist and paleontologist must solve. Archeologists generally concede that the Folsom points belong to the earliest phase of aboriginal American culture yet discovered. The main importance of the Colorado find lies in the fact that for the first time a variety of implements has been obtained for that horizon. The site was originally discovered by Judge C. C. Coffin and his son, A. L. Coffin. It was brought to the attention of the Smithsonian Institution by Major Roy G. Coffin, of Colorado State College, Ft. Collins.

Event classifications in Navaho, a study in linguistic psychology: E. SAPIR. Any "event" may, for purposes of linguistic reference, be classified from various points of view. A number of such points of view, applying to the Navaho verb, are briefly summarized in this paper. The complex formal system of the Navaho verb can be functionally analyzed from five points of view: 1, voice; 2, person (including number); 3, state ("neuter" and "active"); 4, tense-mode; and 5, aspect (*e.g.*, momentaneous, continuative, repetitive). In many ways these Navaho classifications come closer to a freshly objective view of the nature of events than do those of such languages as English or Latin.

Some reactions of Mongolians and Caucasians in an emotional situation: G. M. STRATTON and FRANKLIN M. HENRY. Chinese and Japanese, together with Americans of the Caucasian race—about fifty persons of each of these three kinds; about 150 persons in all—were placed singly in a laboratory situation aimed to be at least mildly stirring. And the conditions were such that the slight stir of emotion might not have an obviously different association with the different ancestral cultures involved. It, however, is not claimed that the influence of racial culture has been completely excluded. A large and heavy wooden hammer, about six feet long and mechanically controlled, was watched by the subject as it fell from a considerable height and struck a resounding blow close to his outstretched hand. There were instrumental records of the involuntary movement of the hand, together with records of changes in the breathing, pulse rate, blood pressure and the electrical resistance of the skin. The present report is concerned only with the movement of the hand. In this both the Chinese subjects and the Japanese subjects, in the average of their reactions, appear to be significantly different from the Caucasian subjects, giving smaller reactions than do the Caucasians; while the Chinese subjects and the Japanese do not, on the whole, seem significantly different from each other.

Biographical memoir of Edward Sylvester Morse: L. O. HOWARD.

Biographical memoir of George Perkins Merrill: WALDEMAR LINDGREN.

Biographical memoir of Edward Wight Washburn: W. A. NOYES.

Second report on the physical studies of the members of the National Academy: ALEŠ HRDLIČKA. Final report on the speaker's measurements and observations on 150 members of the National Academy, 100 of which were old Americans (all members of whose families were American born for at least three generations), 50 European-born or of more recent American derivation. The studies were complicated by the somewhat small numbers of the subjects and the advanced age of many of the members; nevertheless a number of interesting points came out quite clearly. The outstanding results are as follows: (1) The two classes of members showed unexpected general similarity, differing only in certain few characters (cephalic index, some facial dimensions, etc.). (2) The membership as a whole rep-

resents in every respect a remarkably normal group, above the average of the general population. (3) The members in whom the body proportions have not yet suffered notably from senility, in both groups, show tall stature, higher than even that of the old Americans at large. (4) The head in the academicians, both groups again, is both absolutely and relatively to stature distinctly larger than that in the general American population; and the increase is especially in the breadth of the head, which raises somewhat the cephalic index. (5) All the facial features, particularly in the old American members, tend towards reduction. (6) The chest in the members of both groups is spacious and especially deep. (7) In pigmentation the members of the academy show absence of pronounced blonds, absence of marked reds and frequency of dark hair (though now mostly gray). The total of the results indicates that, barring rare exceptions, the membership of the academy represents not only mentally but also physically a select group.

(To be continued)

OBITUARY

DAVID GRIFFITHS

BORN at Aberystwith, Wales, on August 16, 1867, son of David and Rachel (Lewis) Griffiths, he died at Emergency Hospital, in Washington, D. C., on March 19, 1935.

He came to the United States with the family when about three years of age, settling on a farm in South Dakota, his early education being in the local schools, including Groton, S. Dak., Academy and Aberdeen, S. Dak., High School. Having taken a general scientific course, majoring in botany, he was graduated from the South Dakota Agricultural College in 1892, receiving his M.S. in 1893. During his attendance in college he taught school in winters, and from 1893 to 1898 taught biology, physics and chemistry in the Aberdeen, S. Dak., High School. Specializing in botany and zoology at Columbia University, he received his Ph.D. in 1900. At this time he was interested in the study of fungi, publishing contributions on powdery mildews, smuts, ergots and others in *Asa Gray Bulletin, Torrey Botanical Club Bulletin* and elsewhere.

He was professor of botany and botanist of the Experiment Station of the University of Arizona in 1900–01, there beginning the studies of grasses and other range plants and range management which continued through the first fifteen years of his service in the Federal Bureau of Plant Industry, which he entered in 1901 as expert in charge of field management in the Office of Grass and Forage Plant Investigations. This work involved extensive travel and field studies of native pasture grasses, salt bushes and cacti, from the Canadian border southward well into Mexico. These studies resulted in numerous department publications in which, along with other conclusions of scientific interest and practical importance, the imperative necessity for avoidance of overstocking the ranges with resultant depletion of plant cover and destructive erosion was emphasized. In these studies he became impressed with the economic importance of the cacti as forage plants, and through utilization of native stands and experimental plantings in Texas and California established the usefulness of some of these as emergency forage reserves to tide over drouth shortages. His published results of experiments with "spineless" prickly pear constituted the most important stabilizing factor during the extravagantly optimistic exploitation of this plant which occurred during the first decade of the present century, and served effectively to warn the public against the indiscriminate extensive planting of the spineless forms in climates to which they are not adapted because of their susceptibility to injury by cold.

Appreciating the possibilities of cacti as ornamental plants, he early assembled a comprehensive collection of species and varieties at the Plant Introduction Garden at Chico, Calif., which afforded material for the preparation of a fine collection of colored illustrations, unfortunately as yet unpublished. Close to 3,500 numbers of Opuntia were included in the Chico collection. From these experimental studies of the cacti resulted a steady flow of papers on taxonomic, agronomic and horticultural phases, published by the Department of Agriculture, the Missouri Botanical Garden, with which close cooperation existed, and in various scientific and popular journals from 1905 to about 1920. These materially enlarged available knowledge of cacti and were of particular importance because of their timeliness in relation to the development of the wide-spread and intensive interest in them as agricultural and horticultural plants.

His steadily increasing interest in the horticultural field resulted in his eventual assignment to the bulb production project of the Bureau of Plant Industry, to which approximately his last twenty years were devoted. Some preliminary experimentation in the commercial production of Dutch bulbs, in distinction from the flowering of the imported bulbs both out of doors and under glass, had previously been done, with results which indicated probability of developing satisfactory production of some species. Economic conditions differed so widely from those in the European countries from which the imported supply came, and the lack of training and experience in the art of bulb growing