atom, while E_1 is the rest-energy which the atom would possess if it absorbed and retained the incident quantum. Then

$$\nu_0 \frac{1-\beta_0 \cos \vartheta_0}{\sqrt{1-\beta_0^2}} \frac{2hE_0}{E_1^2-E_0^2} = \nu_2 \frac{1-\beta_2 \cos \vartheta_2}{\sqrt{1-\beta_2^2}} \frac{2hE_2}{E_1^2-E_2^2}$$

When the values of β_2, E_1, etc., obtained from the solution of the dynamical problem are put in this equation, it specifies the entire frequency change caused by the initial motion of the atom, its recoil from the quantum and the change in its quantized energy. Just as in Compton's revised theory, the shift will be indeterminate if we suppose that an electron is ejected.

It is quite possible that this wave-length change is the cause of some of the mysterious continuous spectra lying in the region of the ordinary spectrograph. Suppose, for example, that a vapor for which $\nu_s = 40{,}000$ cm.$^{-1}$ is illuminated with light of wave length 2,000 A. That part of the scattered radiation which is not of wave length 2,000 A will lie at frequencies lower than 10,000 cm.$^{-1}$, corresponding to 1 μ. In other words, it will appear as radiant heat. Shorter incident wave lengths might give a spectrum extending into the visible. Therefore, it seems important to photograph the spectra of vapors which are scattering intense radiation of short wave lengths.

It may be pointed out that spark lines having frequencies greater than the highest series limit of the neutral atom should give rise to a scattered line spectrum provided that $\Delta\lambda$ does not depend on the relative phases of the atom and the incident quantum. Spectrum lines of this character would be strictly analogous to the displaced lines of Kramers and Heisenberg. Apparently such lines do not exist in the spectra of the alkaline earths.

It remains for us to consider whether the scattered combination frequencies of Kramers and Heisenberg can be detected experimentally. When sodium vapor is illuminated with light of the second member of the sodium principal series, the resonance radiation contains both the first and second members of the series (and presumably 4 pairs of lines in the infrared). Bohr states that phenomena of this kind constitute a special case of those predicted by Kramers and Heisenberg. Here the D lines are to be considered as a difference frequency, in accordance with the equation

$$1s-2p = (1s-3p) - (2p-3p).$$

The emission of a summation frequency may be obtained by illuminating mercury atoms in the $2p_1$ state with light of the line $2p_1-3d_2$, for example. The emitted light will contain $2p_2-3d_2$, and

$$2p_2-3d_2 = (2p_1-3d_2) + (2p_2-2p_1).$$

In these instances the atomic resonator is so sharply tuned that a very slight deviation from the correct frequency causes the amount of scattering to decrease tremendously. Similar remarks apply to molecular resonance spectra excited by monochromatic light. It seems very doubtful that the combination frequencies can be detected in the case of ordinary Rayleigh scattering.

PAUL D. FOOTE
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BUREAU OF STANDARDS
WASHINGTON, D. C.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

BOTANICAL SCIENCES AT THE WASHINGTON MEETING

(*A report for Section G appeared in Science for February 6.*)

The Botanical Society of America

President, William Crocker.

Secretary, Ivey F. Lewis, University of Virginia, University, Va.

(*Report by Ivey F. Lewis, unless otherwise noted*)

The Washington meeting of the Botanical Society of America was the most largely attended and one of the most successful in the history of the society. The names of 88 new members were added to the roll of the society, and the following corresponding members were elected: Professors V. H. Blackman and A. C. Seward, of England, and Karl Goebel, of Germany. The officers elected for 1925 are: J. R. Schramm, *president*; W. J. V. Osterhout, *vice-president*; G. E. Nichols, *treasurer*. C. E. Allen was elected to represent the society in the National Research Council, Division of Biology and Agriculture, and H. C. Cowles was elected to the editorial board of the *American Journal of Botany*. The society endorsed the proposed deep sea exploration of the United States Navy. Forward steps were also taken in conjunction with the Ecological Society of America and the American Phytopathological Society, looking toward the convening of an International Botanical Congress in Ithaca in August, 1926. The exhibits by members proved exceptionally interesting and attractive. These included, among others, cytological preparations by W. R. Taylor, R. E. Cleland and A. M. Showalter, and a very fine exhibit of plant pigments by F. M. Schertz. The Botanical Society will meet with the American Association in Kansas City in 1925. The program, as usual, was carried on by sectional groups.

General Section, B. S. A.

Chairman, D. S. Johnson; *secretary,* W. R. Taylor.

The papers before the General Section covered, as usual, a wide range. The algae were particularly well represented with seven papers, covering the cytology of Sargassum and Nitella, a new type of red snow algae, a new Oedocladium, distributional studies in Massachusetts and Florida, photoperiodism in Chara and periodicity in Dictytota. Morphological studies included papers on Batis, Quercus, Petunia, Podophyllum, Poa, Xanthium, the peanut, roots and rootstocks, abscission in woody plants, the development of vessels from cambium, cleavage polyembryony in Conifers, plant galls, and Devonian fossils mostly of Cordaitean affinities. Cytological studies were reported on Zea, Tradescantia, Gasteria and other genera, while a particularly full account of fertilization in Riccardia and Fossombronia was given by A. M. Showalter. Other papers covered the local flora of Cold Spring Harbor, fifty years changes in the flora of Penikese Island, the biology of *Lewisia rediviva,* and the position of botany in the college curriculum, with a completion test in biology for use in college classes. The following officers were elected: *Chairman,* R. B. Wylie; *vice-chairman,* J. T. Buchholz; *secretary-treasurer,* P. B. Sears. At the joint session with the Ecological Society of America, twelve papers were given. Descriptions were given of ecological conditions in the Mediterranean region, Brazil, Texas, the Amazon Valley and the western Himalayas. Other subjects were the principles of competition as illustrated by the growth of wheat, the grouping of plants, the effect of salinity in determining the distribution of plants on river estuaries, animal communities of an Illinois forest, enlarged trunk bases in black ash and the ecology of Scolopendrium. P. L. Ricker spoke on the preservation of our native flora and reported on the proposed national arboretum and botanical garden in Washington.

Mycological Section, B. S. A.

Chairman, H. S. Jackson

The program of the Mycological Section included taxonomic studies on Astrocystis, Conidiobolus, Uredinales, Helicodesmus and Choanephora. Papers of a physiological nature were read on Phytophthora and Penicillium. Life-history studies were presented on Pilobolus, Panaeolus, certain malodorous fungi, the stromatic Sphaeriales and Dictyuchus. The program also included papers on the cytology of Puccinia and heteroecism in rusts. The joint session of the Mycological Section with the American Phytopathological Society included studies of the citrus scab organism, Phytophthora, leaf spots of maize, bur clover and related plants, bud rot of the coconut, mosaic, crowngall and the genera Phoma and Macrophoma. An outstanding paper of the section was the report by A. H. Reginald Buller of the work of his students on sex in mushrooms and toadstools, the beauty of the experiments and the clearness and definiteness of the results being perhaps unique in this difficult field. E. M. Gilbert was elected chairman of the section for 1925.

Systematic Section, B. S. A.

Chairman, William R. Maxon; *secretary,* Agnes Chase

(*Report by W. R. Maxon and I. F. Lewis*)

The formal program, of three sessions, included a discussion of experimental methods in taxonomy, the progress of classification of cultivated plants and the taxonomic characters of Helianthus. H. M. Hall's paper on "Experimental methods in taxonomy" attracted much attention. W. W. Eggleston gave a biographical account of William F. Cusick, the Oregon botanist. A special session was devoted to a round-table discussion of the training of systematists in college, university and research institutions. Fruitful points of view were presented, and it was voted to publish a summary of the impromptu discussion. A committee was appointed to study and report on this subject at the next annual meeting, consisting of K. M. Wiegand, M. A. Howe and C. R. Ball. Of the greatest interest to the section was the report of the chairman of the Standing Committee on Nomenclature, A. S. Hitchcock. After full discussion the following resolution was recommended to and at a later business meeting unanimously passed by the Botanical Society:

The Botanical Society of America recommends favorably the appointment, by the next International Botanical Congress, of an International Interim Committee of specialists in nomenclature to consider the Resolutions on Nomenclature adopted by the Imperial Botanical Conference held in London in 1924, the typification of the present list of *nomina conservanda,* and other matters of nomenclature, for report to the succeeding congress.

Physiological Section, B. S. A.

Chairman, W. J. Robbins.

Secretary-treasurer, S. C. Brooks, Hygienic Laboratory, Washington, D. C.

(*Report by S. C. Brooks*)

A meeting of all those interested in plant physiology was held on Monday morning, December 29, over one hundred being present. At this meeting Dr. Crocker, representing the majority of the committee appointed to investigate the proposed dissolution of the section, reported that sentiment was very strongly in favor of its continuance. This report was adopted by the section and later by the society, and will be

more fully presented in a report of the latter. Sessions of the Physiological Section for the reading of papers were held Monday afternoon, Tuesday morning and Wednesday afternoon, with an average attendance of about fifty. Thirty papers were read.

The optimum pH for the growth of *Lemna minor* was shown by F. B. Wann to lie between 5.0 and 6.0. *Chlorella* sp. was also grown in nutrient solutions by Dr. Wann and E. F. Hopkins, and shown to grow best at about the same reaction as *Lemna,* namely, pH 5.73. Sophie Satina and A. F. Blakeslee pointed out a very high but not absolute correlation between + sexuality and reducing power among Mucors; sodium tellurite was used as an oxidation-reduction indicator. The more nitrogen a seed contains the greater is shoot growth as compared to root growth, and this, as Mary E. Reid explained, is largely independent of species or family.

At the meeting Tuesday morning G. W. Scarth discussed the swelling of gelatin: the resistance to stretch is affected by varying pH in much the same way as the swelling; gels of equal concentration obtained by allowing dry gelatin to swell in water and by allowing hot sols to cool were of unequal elasticity. E. F. Hopkins showed that at low temperatures respiration and total sugar content of potato tubers ran parallel. Wounding produced similar parallel changes in sugar content and respiration; there is apparently a close correlation between sugar concentration and respiration. H. W. Popp, using an admirably thorough technique, gave conclusive evidence that, total radiant-energy supply being constant, sunlight ultra-violet could be eliminated without any noticeable effect on the growth or habit of a wide variety of vascular plants; but that elimination of all light of wave lengths shorter than the blue-green produced marked changes in their growth and composition. Similarly, thorough experiments by John M. Arthur, H. W. Popp and James E. Webster showed the influence of the intensity and duration of light under controlled environmental conditions, with and without enrichment of the air with CO_2.

An extra session was held Wednesday afternoon to complete the scientific program. A group of papers by T. Morinaga and by W. E. Davis treated of the germination of seeds. Dr. Morinaga showed that alternating periods of warmth and coolness accelerated germination of many seeds. This effect was often masked if the seeds were germinated under water, which also promoted germination of many species; reduction of the oxygen tension also accelerated germination of some seeds, masking the effects of immersion and alternating temperatures, and was apparently a fundamental factor. Certain seeds required increased oxygen tension when immersed. Studies on catalase content and on the effect of removing the outer coats of certain seeds led W. E. Davis to conclude that germination is dependent upon optimum ventilation of the seed. A paper upon the conditions affecting germination of the spores of *Onoclea sensibilis* presented by Constance E. Hartt aroused much interest, as did also the studies of D. M. Moore upon breaking the dormancy of tulips by the use of low temperatures, and the ingenious experiments of W. J. Himmel on the mechanical characteristics of *Podophyllum* petioles.

After the conclusion of the scientific program plans for the further development of the section were discussed and referred to the Plant Physiological Board for final action.

Genetics Section, B. S. A.

This section operates with the Genetics Section of the American Society of Zoologists, the two forming the Genetics Sections, reported below.

The American Phytopathological Society

President, F. D. Fromme.

Secretary, R. J. Haskell, U. S. Department of Agriculture, Washington, D. C.

(*Report by E. C. Stakman and F. J. Schneiderhan*)

If attendance is a reliable criterion the interest and zealousness of the members of the society is showing a healthy yearly growth. All records for attendance were broken at the sixteenth annual meeting. A total attendance of approximately 226 was registered. This is 34 per cent. of the membership, which now numbers 668. The attendance percentages of meetings of the society in recent years at Cincinnati, Boston and Toronto are 140 (25 per cent.) 95 (17 per cent.) and 85 (16 per cent.), respectively. Forty-nine papers were presented at the regular meetings. Compared to the 114 papers presented at the Cincinnati meeting it is evident that the number presented at the Washington meeting was less than half. This, however, is a fortunate result of the action taken at the Cincinnati meeting to limit the number of papers to completed or nearly completed research and not to include progress reports. Furthermore, the ruling requiring abstracts to be sent in a month earlier than hitherto also reduced the number of papers. The average quality of the papers was this year very high. The average time allotted to each speaker was longer and the general arrangement of the program, particularly the division of the society on January 1 into three sections for vegetable, cereal and fruit diseases, was productive of good results in crystallizing interest and expediting the presentation of the program.

Two joint sessions were held, one with Section G of the American Association for the Advancement of

Science and one with the Mycological Section of the Botanical Society of America. Of interest to phytopathologists were two symposia held by the Potato Association of America, in which the problem of potato improvement and the results of dusting and spraying experiments on potatoes were discussed. A conference of extension workers in plant pathology was held on Tuesday afternoon, led by F. C. Meier. The 49 papers presented at the regular sessions of the society may be conveniently classified as follows: vegetable diseases, 16 papers; cereal, 11; fruit, 8; mosaic, 4; fiber crops, 2; forage, 1; taxonomic, 2; technique, 2, and miscellaneous papers, 3. A brief digest of some of the more noteworthy papers follows: G. N. Hoffer and J. T. Trost pointed out a striking relation between severity of infection by root rot of corn plants grown under conditions of balanced nutrient supply and with deficiency of phosphates and potash. Infection was markedly greater when phosphates and potash were deficient. W. H. Tisdale and V. F. Tapke demonstrated for the first time that infection by loose smut of barley resulted from inoculating seed with spores. Floral infection had hitherto been considered to be the only known method of infection. F. R. Jones divides the soil-inhabiting fungi parasitic on peas into three groups based on the part of the plant invaded. The important point he made was that *Aphanomyces euteiches* Drechsler was the most widespread cause of destructive root rot of peas. Resistance to three different diseases in rye appears to be due to separate factors independently inherited. Resistance to each disease is dominant in rye according to E. B. Mains. A. G. Newhall showed that tip-burn of lettuce is not of bacterial origin but is due to disturbed physiology resulting from fluctuating temperature and moisture in the presence of readily available potassium and nitrogen. Donlad Folsom and Reiner Bonde gave evidence that *Alternaria solani* can cause tuber rot of potato. A new and ingenious method of determining the approximate number of ascospores of the apple scab fungus in the air was described by G. W. Keitt. In two papers F. J. Schneiderhan pointed out the correlation between ascospore discharge and seasonal infection by apple scab, the direct relation of rainfall to ascospore discharge and the occurrence of three definite cycles of infection in the early growing season. The first detailed knowledge regarding the effect of removing bitter-rot mummies and infected fruit in apple orchards was presented by R. H. Hurt. He showed that seasonal infection can be reduced to a minimum by this removal. S. M. Dietz amplified our knowledge of the relation of crown rust of oats to its alternate hosts of the four Rhamnaceous genera, Berchemia, Ceanothus, Zizyphus and Rhamnus. He also showed that resistance to oat stem rust is dominant in crosses of eight different pure lines of oats. Flax rust and wilt resistance are not correlated. Rust resistance is dominant and probably can be combined with satisfactory morphological characters in flax, according to a paper by A. W. Henry and E. C. Stakman. The minimum, optimum and maximum temperatures of flax rust spores together with ecologic factors were worked out by Helen Hart. Perley Spaulding presented results of extensive experiments on longevity in spores and sporidia of *Cronartium ribicola*. Two new species of leaf spot of maize, a disease distinct from leaf blight, were described by Charles Drechsler. E. F. Gaines discussed the results of ten years of breeding for bunt resistance with 500 varieties and selections of wheat and for smut resistance with 208 varieties of oats. Resistance in wheat is recessive, while in oats it is dominant, and multiple factors are most important in explaining inheritance of disease resistance in these cereals. A. J. Riker gave two papers throwing additional light on the thermal relations influencing the development of crowngall and the cell behavior in infected tissue. Symptoms distinctly different from tobacco mosaic can be obtained on tobacco plants inoculated with extract from mosaic potato leaves, according to James Johnson. Cane plants selected for resistance to mosaic have maintained resistance for three years. C. W. Edgerton's paper declares this to be a probable case of acquired resistance. C. M. Tompkins gives some interesting data on the effect of temperature on masking mosaic. Temperatures above 24 degrees C. are unfavorable to mosaic development. A new piece of apparatus known as a fluometer has been devised for measuring water flow interference in diseased stems by I. E. Melhus, J. H. Muncie and Wm. T. H. Ho.

C. W. Edgerton, of the Louisiana Experiment Station, was elected president and M. F. Barrus, of Cornell University, vice-president.

The American Society of Plant Physiologists

President, Charles A. Shull.

Secretary, Wright A. Gardner, Alabama Experiment Station, Auburn, Ala.

(*Report by Wright A. Gardner*)

The first annual meeting of the American Society of Plant Physiologists was held at the fifth Washington meeting of the American Association for the Advancement of Science, from December 29 to January 1. The meeting was well attended, and much important business connected with the future development of the society was transacted. Two program meetings were held and four business meetings, and a

luncheon was arranged as a joint feature between the American Society of Plant Physiologists and the Physiological Section of the Botanical Society of America. There was a noteworthy freedom of discussion of the papers, a thing which is all too rare in connection with such meetings of scientific societies. A few of the most outstanding contributions may be mentioned. G. W. Scarth, of McGill University, presented a paper on the relation of elasticity of gelatin to swelling and pH content. The curve of resistance to stretching plotted against the pH value resembles the swelling curve; but chemical changes and solubility effects complicate the imbibition effects. Protoplasmic contraction was held to correspond to volume shrinkage of colloids at the isoelectric point. The speaker also showed clearly that determinations of the pH value for cells by the usual methods of colorimetric tests apply only to the vacuolar fluids, or to protoplasmic inclusions; they do not tell us the conditions of the protoplasm itself. Dr. E. S. Johnston, of the University of Maryland, reported that good agreement was found between satisfactory atomic proportions of the fertilizer elements in sand cultures and the proportions of the same elements in a fertilizer found best for potatoes through several years of practical experience. Dr. S. Lepovsky, of the University of Wisconsin, reported on the physiological instability of wheat and metabolism in the sugar beet. Metabolic changes were correlated with environmental changes. In the leaf, glucose content varies with solar radiation, but in petiole and root it varies more with the temperature. Variations in sucrose in leaf and petiole followed somewhat the fluctuations of temperature and of the saturation deficit of the air, while in the root these varied with solar radiation. Soluble proteins followed radiation, insoluble proteins were dominated by temperature. Dr. F. M. Eaton discussed photosynthetic efficiency of tobacco plants grown under continuous illumination, in which 6.4 per cent. of the light received was used by the plants. Dr. R. B. Harvey, of the University of Minnesota, discussed the use of ethylene and acetylene in blanching celery and reported that the self-blanching sorts have mosaic disease. Dr. Charles A. Shull, of the University of Chicago, described a continuous-reading respirometer devised by Mr. Junji Ota. The apparatus is suited to continuous studies of the respiratory rates of small objects for long or short periods.

The most striking feature of the meeting was a paper on "The mechanism of conjugation in Spirogyra," by Professor Francis E. Lloyd, of McGill University. It dealt with the details of the maturation of the germ cells, gametic fusion and zygotic contraction, every phase of the process being well illustrated by means of beautiful photographs taken of living material. Zygotic contraction was shown to be caused by numerous explosive contractile vacuoles. All features were related to fundamental changes in permeability, viscosity and osmotic pressure.

The American Fern Society

President, William R. Maxon.
Secretary, C. S. Lewis, Trenton, New Jersey.

(*Report by William R. Maxon*)

A single meeting was held on the morning of January 1. The formal program was as follows: C. A. Weatherby, "William Stout, a forgotten student of ferns"; R. C. Benedict, "Variations of the Boston fern"; E. T. Wherry, "The Appalachian Aspleniums"; Paul Bartsch, "Ferns of the District of Columbia"; William R. Maxon, "Some curious ferns." Miss Mabel R. Hunter also discussed the occurrence of the hart's-tongue (*Phyllitis scolopendrium*) in central New York and its threatened extinction at one of its best-known localities near Jamesville.

The Wild Flower Preservation Society

President, Henry C. Cowles.
Secretary, Mrs. E. G. Britton.

(*Report by Edgar T. Wherry*)

A meeting for reorganization of the society was held Sunday afternoon, December 28, with President Cowles in the chair and Dr. Edgar T. Wherry as secretary *pro tem.* About 30 representatives of local chapters and societies having similar aims were present. The chief business before the meeting consisted in receiving reports of committees authorized at a meeting of delegates from Wild Flower Preservation Society chapters held in Cincinnati in the preceding May. The name of the national organization becomes "The Wild Flower Preservation Society" and the local chapters are urged to use this name, adding a local designation to show their relationship to the national society. The quarterly journal, *Wild Flower,* published by the Cincinnati Chapter, is to be designated as the official organ of the society. Junior membership among school children is to be arranged for by individual chapters. The national headquarters is to prepare educational circulars, posters, lantern slides, etc. And local chapters are to contribute to the support of the headquarters. The following officers were elected: *President,* Mr. Percy L. Ricker; *first vice-president,* Professor John W. Harshberger; *second vice-president,* Professor Henry C. Cowles; *additional members of the Executive Committee:* Dr. E. Lucy Braun, Mrs. Elizabeth G. Britton, Mrs. Fanny D. Farwell (3-year term); Mrs. E. H. Bouton, Miss C. A. Mitchell and Dr. Edgar T. Wherry (2-year term); Mrs. T. W. Adams, Mrs. W. R. Mercer and Professor M. C. Quillian (1-year term).