remarked: "The doctrine of the immortality of the soul is not so wonderful as that of the conservation of energy or of the indestructibility of matter."

The evidence of the existence of spirit is precisely analogous to the evidence for matter; matter, as we have seen, is revealed to us only as its phenomena, extension, weight, color, behavior when subjected to heat, etc., affect our senses; of its essence we know nothing; spirit, likewise, is revealed to our consciousness through its powers of thinking, feeling and willing, but of the essential spirit the finite mind knows nothing. "Matter," writes an American scientist, "is the thing perceived, spirit the thing perceiving, matter is the passive, spirit the active principle. Without a belief in spirit, therefore, not only can there be no religion, no virtue, but there can be no philosophy or science. * * * The very origin of our notion of force is the consciousness of our own mental energy, and this universal energy of Nature is an effluence of the Divine Being."

Faith, both in science and in religion, is belief based on suitable evidence from sources outside of personal experience, both are fruitful in different ways, the former affecting the intellect and the latter the heart of man; scientific faith bears fruit in the steamship and in the telegraph, Christian faith in works of mercy and charity and in a life of love shown toward mankind and to God; it is

> "The subtle chain
> That binds us to the Infinite."

On the other hand, some students of science, accustomed to exercise faith in their attempts to solve obscure problems in the material world, hesitate (and a few refuse) to extend this intellectual power to the spiritual universe; this is undoubtedly due to the operation of the will, for

> "A man along that road is led
> Which he himself desires to tread."

The supreme goal of the student of science was admirably conceived and expressed in a single sentence by the renowned Kepler, when he wrote nearly three centuries ago:

"The scientist's highest privilege is to know the mind and to think the thoughts of GOD!"

H. Carrington Bolton.

Washington, D. C.

THE SOCIETY FOR PLANT MORPHOLOGY AND PHYSIOLOGY.

The Society met, together with the American Society of Naturalists and the Affiliated Societies, at Johns Hopkins Medical School, Baltimore, Md., December 27–28, 1900, under the presidency of Professor D. P. Penhallow. There was a large attendance of members, and the meeting was in all ways profitable and successful. The presidential address dealt with 'A Decade of North American Paleobotany'; it was published in this Journal for February 1st. The most important business of general interest was the presentation of the report of the Committee (Messrs. Farlow, MacDougal and von Schrenk) appointed to consider methods of securing improvements in reviews of current botanical literature. Copies of the report were distributed to members present, and have been sent to other botanists throughout the country. It shows a completely successful result of the Committee's work, and comments upon it will appear later in this Journal. A committee was also appointed (consisting of Messrs. Ganong, Lloyd and Atkinson), to take into consideration the formulation of a standard college entrance option in botany. On Saturday, December 29th, the members of the Society, with guests, made an excursion to Washington, where they were shown the work of the Department of Agriculture, and were received by the Honorable Secretary for Agriculture, who made a brief informal address. Later they were entertained at luncheon by the botanists resident in Washington. The following new members were elected: M. A. Carleton, Department of Agriculture, Washington, D. C.; F. D. Chester, Delaware Agricultural College, Newark, Del.; E. B. Copeland, University of West Virginia, Morgantown, W. Va.; T. H. Kearney, Department of Agriculture, Washington, D. C.; J. W. Toumey, Yale Forest School, New Haven, Conn. Officers for the ensuing year were elected as follows: *President*, Erwin F. Smith; *Vice-Presidents*, F. C. Newcombe and L. M. Underwood; *Secretary*, W. F. Ganong. The following papers were presented, the abstracts of which in most cases have been furnished by the authors:

Notes upon Albinism in Sweet Corn: PROFESSOR BYRON D. HALSTED, Rutgers College.

Complete albinism has been found in a sweet corn cross between 'black Mexican' and 'Egyptian' after the second year. The tests show that the albinos come from the white, pink and purple grains in about equal numbers and in some instances fifteen per cent. are white plants. These albinos have the normal vigor and in every way adhere to the type, except in the lack of a capacity to produce chlorophyll. They begin to lag behind their green mates after two weeks and perish a fortnight later. In the dark they grow like the normal plants, except that no etiolin is produced. A large number of seeds, germinated under unfavorable conditions, were not influenced in the percentage of albinos, and it seems quite certain that the albinism is acquired before the tests were made. Some ears in the lot of crossed corn produced no white plants, while others show many, and it seems to be a fact that grains from overburdened plants, *e. g.*, where there are three large ears, are more apt to produce albinos than those from stalks with a single ear. The cross may have been such that the last act in the drama of perfect seed-production was not reached. Again, the close breeding of the crossed grains, all plants in the plot being of the same mother and with no pollen from other plots, may have had its effect in the manner mentioned.

A Disease of the Locust: DR. HERMANN VON SCHRENK, Shaw School of Botany.

A destructive disease of the black locust (*Robinia Pseudacacia*), due to *Polyporus rimosus*, was described. The fungus destroys the heart wood of this tree, leaving a soft, yellow mass. The fruiting organs form on the trunk and larger branches for many years, discharging their spores in the summer and fall. Attention was called to the fact that the mycelium grows only in the heart wood of living trees, and dies as soon as a tree is cut down. This is probably due to changed conditions of aëration, moisture and temperature. This fungus must be considered as a special class of saprophyte.

Observations on the Mosaic Disease of Tobacco: MR. ALBERT F. WOODS, Department of Agriculture.

The author presented the results of numerous experiments showing that the mosaic disease of tobacco may be artificially produced in the following ways: (1) By cutting plants back during any stage of active growth, thus removing most of the reserve organic foods and stimulating rapid growth of lateral buds in the absence of sufficient albuminoid reserve. This causes a remarkable increase in the activity of oxidizing enzymes. These enzymes inhibit the action of the translocation diastase of the cells, thus preventing the movement and assimilation of starch. When a plant once reaches this stage it seldom recovers, all new growth becoming diseased. He was able to produce the same disease in the same way, in tomato, potato, petunia, phytolacca, violet and other plants. (2) The disease may be reduced by repotting or transplanting a plant in active growth, thus stimulating a rapid root development. New leaves that form at this time often come diseased. Leaves that form at the time of the development of the flowers also often come diseased, as do also rapidly developing suckers. The pathological changes are the same in these cases as when the disease is produced by cutting back. (3) The disease may be produced by injecting the sterile juice of diseased plants into the growing bud or by pouring it on the roots. Perioxidase obtained from healthy or diseased plants and injected into the bud or poured on the roots may also cause the disease. The author concludes as follows: "The evidence which I have collected, taken along with that obtained by other workers, especially Mayer and Beijerinck, is therefore very strongly in favor of the infectious nature of the trouble under certain conditions. The matter can not, however, be considered as settled. So far as the evidence at hand goes, it appears that in growing cells there is possibly a definite relation between active oxidizing power, through the medium of oxidizing enzymes, and the availability of reserve food to the growing cells. It appears that this balance between the oxidizing enzymes and the availability of reserve foods can be broken by removing, on the one hand, the supply of reserve foods, in any way during growth, in which case the enzyme content of the cell is increased from two to four times the normal activity. This removal of reserve food may be either the result of diversion to other parts of the plant or of direct removal, as in the case of cutting back or of sucking insects, and possibly also can be brought about by other conditions not at present understood. On the other hand, the most remarkable thing is that the introduction of the enzyme in question (perioxidase) sets up the same series of pathological changes as is brought about by the removal of reserve food, namely, the increase of the normal enzyme of the cell, and the decrease of availability of reserve foods. When this pathological condition is reached it is very difficult for the plant to correct the trouble. The perioxidase probably moves from one part of the plant to another, though how much of the general spread of the disease in the plant is due to such movement has not been determined. The evidence of the communicability of this disease is quite as strong, if not stronger, than that upon which rests the belief in the communicability of ordinary variegation through grafting on healthy plants. The two groups of diseases are at least very closely related and are probably simply different phases of the same malady. Possibly peach yellows and the California vine disease belong here also and are to be similarly explained. Die-back of the orange may also belong here.

The paper was illustrated by two colored-plates and four half-tones, and will be printed as a bulletin of the U. S. Department of Agriculture.

Report of the Committee appointed to consider Methods of securing Improvements in Reviews of Current Botanical Literature: Presented by the Chairman, Professor W. G. Farlow, Harvard University.

This report has already been referred to, and a further account of it will be found in a later number of this Journal.

The Cause of the Red-brown Color in certain Cyanophyceae: Dr. G. T. Moore, Dartmouth College.

The various theories which have attempted to explain the cause of the red-brown color in *Anabaena*, *Gloiotrichia*, *Oscillatoria* and other so-called 'blue-green algae,' were discussed. It was shown that this color could not be due to sulphur granules, as has been supposed,—neither was it possible to demonstrate any definite coloring matter within the cell itself. Numerous experiments with *Oscillatoria prolifica*, Gorn., a plant particularly favorable for study, showed that the red color must be caused by the refraction due to the presence of large numbers of gas vacuoles, as suggested by Klehban. The effect of a large number of reagents, spectroscopical analysis and the examination of microtome sections, all strengthened this theory. As far as could be determined the enclosed gas seemed to be nitrogen. It would seem that the buoyancy common to so many Cyanophyceae, is particularly due to the presence of these vacuoles, for in material of the normal blue-green color the plants remained at the bottom of the dish, while those containing vacuoles and consequently of a red-brown appearance, always floated upon the surface.

Improved Methods for obtaining Pure Cultures of Fresh-water Algae: DR. G. T. MOORE, Dartmouth College.

The results of some methods for obtaining pure cultures of algae, by the modification of the nutrient medium, were shown. It was found that algae might be separated from contaminating forms by a very slight modification of the salts upon which they are grown. Luxuriant growths of Cyanophyceae were obtained upon a decoction of *Zamia*, with the addition of peptone and sugar. It required less than one-half the time for algae grown on this medium to nearly double the growth of those on mineral salt solutions. The possibility of using heat in separating blue-green algae from grass-green forms was also referred to.

A Second Preliminary Report on Plant Diseases in the United States due to Rhizoctonia: DR. BENJAMIN M. DUGGAR, Cornell University and MR. F. C. STEWART, New York Experiment Station.

This report presented notes upon the occurrence and destructiveness of American forms of *Rhizoctonia* observed by the authors. Since the first report (presented to this Society in 1898), the occurrence of *Rhizoctonia* on some entirely new hosts has been observed, and also upon other hosts new to America. As principal host plants among vegetables may be mentioned bean, sugar-beet, cabbage and cauliflower, carrot, celery, cotton, lettuce, potato, radish and rhubarb; and among flowers, asparagus, china aster, carnation, coreopsis, sweet william and violet; also about ten other less important hosts. In many cases the *Rhizoctonia* is truly parasitic and undoubtedly the cause of the disease in question, as has been abundantly proved by experiment; but in other cases inoculation experiments are yet lacking. Morphological studies and extensive inoculation experiments are in progress to determine more carefully the physiology of the forms and the limitations of species.

The Bacterial Diseases of Plants: DR. ERWIN F. SMITH, Department of Agriculture.

This consisted of a stereopticon lecture before a joint meeting of the Society for Plant Morphology and Physiology and the Society of American Bacteriologists. Three diseases were described, namely, the wilt of cucurbits due to *Bacillus tracheiphilus*, the brown rot of solanaceous plants due to *Bacillus solanacearum*, and the black rot of cruciferous plants due to *Pseudomonas campestris*. Fifty-eight slides made from the author's clear and beautiful photographs and photomicrographs were exhibited, showing symptoms, location of the bacteria in the tissues, etc. Many of these illustrations will be published in the near future in *Centralblatt für Bakteriologie*, 2te Abteilung.

Notes on the Life History of certain Uredineae: M. A. CARLETON, Department of Agriculture. (By invitation.)

Four species of rust fungi were investigated. In the case of *Uromyces euphorbiæ* Cooke & Peck, the well-known rust of *Euphorbia*, it was demonstrated by three separate series of experiments that the rust is able to propagate itself constantly through the germinating seed of its host, and therefore becomes in that way practically a perennial species. It is the only demonstrated example of this manner of propagation in the whole order of Uredineae. Actual cluster cups may be seen in the hulled seeds of *Euphorbia dentata.* Seedlings kept under bell jars become rusted three months from the date of planting, showing all stages of the rust, while seeds disinfected with mercuric chloride produce no rusted plants.

Culture experiments were also performed with the common sunflower rust, which showed that the *Puccinia* and *Æcidium* found on sunflower are stages of one and the same species. At the same time it is made probable that all the species of *Helianthus* affected bear the same rust and that there is no distinction of host forms. The peculiar, thick-walled, one-celled spores of *Puccinia vexans* Farl., have at last been successfully germinated after repeated failures, and it is now seen that these spores are neither properly uredospores nor teleutospores, but partake of the nature of both. They make up a distinct new spore form for this order of fungi, and may be called *amphispores.* True uredospores were also found and germinated. Other experiments and observations have shown that *Æcidium tuberculatum* Ell. & Kell. is commonly a perennial species in its perennial host *Callirrhoe involucrata*, producing spores able to germinate during the coldest winters.

Rheotropism of Roots: PROFESSOR FREDERICK C. NEWCOMBE, University of Michigan.

The phenomenon of rheotropism is manifested by a curvature of the root when growing in streaming water. In all cases so far observed the response has been positive, *i. e.*, the root-tip curves against the stream. The present research has included 32 species of plants, of which 15 have shown themselves rheotropic and 17 insensitive. Nearly related plants behave similarly; but of two genera of the same family, one may respond to the current of water, and the other may be insensitive. Species differ greatly in degree of response. Members of the *Cruciferæ* are among the most sensitive plants found, their roots often attaining an angle of 90° from the vertical.

The velocity of current calling forth the best response lies between 100 cm. and 500 cm. per minute. A velocity of 2,000 cm. per minute will in most plants bring a mechanically negative curve, and the responses in currents less than 100 cm. per minute are weak and transitory. However, a velocity as low as one cm. per minute will bring a curvature in the majority of roots of the garden radish.

The latent period at the optimum temperature for growth is one hour or more.

The area which perceives the stimulus includes the apex of the root and the elongating zone.

Roots of mature plants as well as those of seedlings are responsive.

The author four years ago suggested that the stimulus might really be referred to the one-sided pressure of the water upon the root. Considerable evidence is now offered to confirm this view.

Thigmotropism of Roots: PROFESSOR FREDERICK C. NEWCOMBE, University of Michigan.

Only two authors have claimed for ordinary roots the presence of sensitiveness to contact or pressure. Darwin believed he had found a negative response (a turning away), when the sloping side of the root apex touched a foreign body; and Sachs in a single and simple experiment found some roots bending positively when a pin or a thin wooden rod was brought against the root 2 to 4 mm. back from the apex. Wiesner and others have shown Darwin to be mistaken, and the author of the paper here abstracted has repeated Sachs' tests many times without convincing results.

That roots are, however, responsive to pressure on the elongating zone can be shown by two kinds of experiments. Seedlings of buckwheat or radish are placed upright with their roots immersed in water, and a loop of very thin rice paper attached to a light pendulum is made to pull lightly on the elongating zone. Not more than half the roots bend, but all that do curve become concave on the side pressed by the paper. A better method is employed when gravitation is neutralized by revolving the seedlings in a vertical plane by the use of a klinostat. In this experiment the seedlings are supported in a damp chamber while their elongating zone rests lightly on a fixed glass rod. In sensitive roots, the tip of the root curves partially around the glass rod as growth goes on. These experiments show that some species respond and some do not respond to pressure. As far as the study has been carried, roots which are rheotropic are also thigmotropic. This agreement is strong evidence for the view that rheotropism is really thigmotropism. Neither rheotropism nor thigmotropism would seem to be of biological import to the plant. The response may be of the same class of phenomena as shown by tendrils when in contact with a solid object.

The Effect of Mechanical Shock on Longitudinal Growth of Plant Organs: DR. JAS. B. POLLOCK, University of Michigan.

The plant organs used were hyphæ of *Phycomyces*, hypocotyls of *Brassica*, *Raphanus*, *Helianthus*, *Lupinus*, and *Cucurbita*, the epicotyl of *Phaseolus*, and the leaf sheath and first leaves of *Avena* and *Triticum*.

Single shocks were given by pressure (*Phycomyces*) as by forcibly bending from side to side.

In *Phycomyces* there was a retardation after pressure, then a recovery in 5–30 minutes, usually in about 10 minutes, and the growth was then sometimes faster and sometimes slower than at first.

On bending, the larger plants first elongated considerably, were then retarded for a short time and recovered in 20–50 minutes, so they grew at a fairly constant rate, this rate being sometimes greater, sometimes less than at first.

Continuous shock was produced by several pieces of apparatus worked by electricity, water motor or clockwork, and was either a swaying from side to side or a jolting upon a board hinged at the middle.

The results were very decisive only in the case of *Cucurbita*, and showed a decided acceleration, due perhaps to the swaying from side to side. With all the other plants used the results were quite variable, but, taken as a whole, give evidence of acceleration as the result of not too vigorous swaying from side to side.

The Limits of Variation in Plants: DR. JOHN W. HARSHBERGER, University of Pennsylvania.

The study of the limits of variations in plants was undertaken as in part a contribution to the problem of species. It was stated, as a well-known fact, that more plants are produced than can survive, necessitating the destruction of many, and the survival of those that have fitted themselves by certain aptitudes to do so. As in part an answer to the evolutionary difficulty of small or initial variations, a careful statistical inquiry was made by comparative measurements of various plant parts. It was found, that the size and shape of leaves, the weight and size of fruits varied by mathematically ascertainable quantities. These were determined for a number of plants and tabulated. It was discovered that in *Liriodendron tulipifera*, *Sanguinaria Canadensis*, *Ailanthus glandulosus* variations in the size and configuration of the leaves were in part due to the persistence of juvenile forms, to the arrested development of some leaves, and to their evolution and transformation to higher forms. The amount of these differences was ascertained, contrasted and tabulated. In conclusion, it was stated that these changes are in most cases due to two causes, viz., the internal hereditary impulse determining, as in *Ailanthus glandulosus*, the asymmetry of the lateral, paired, leaflets, and to the direct, environmental influence, fitting the leaf to utilize the space at its disposal, thus enabling it to present the largest amount of leaf surface to light action.

Critical Points in the Relation of Light to Plants: PROFESSOR D. T. MACDOUGAL, New York Botanical Garden.

The following statements, upon the basis of accepted facts, may be made as to the influence of light upon plants:

1. Light exercises a direct chemical effect upon the substances of which protoplasm is composed.

2. It stimulates protoplasm to the formation of chlorophyll, although its action is not necessary to the process, and its direct chemical effect disintegrates this substance.

3. It constitutes a source of energy, which is absorbed by the chlorplasts.

4. Absence of light constitutes a specific stimulus, calling out the various reactions of etiolation.

5. Light acts as a directive or orienting stimulus to which the plant responds by locomotory or bending movements.

6. Different portions of the spectrum are operative in producing these separate effects.

If an examination is made of the facts upon which these generalizations rest, with reference to the current conceptions of *phototonus*, *paratonic influence* of light, *maximum*, *minimum* and *optimum*, it will be found that illumination is not necessary to the motility of protoplasm, and conversely that deprivation of light does not induce a condition of *rigor*, but sets up various pathological phenomena, among which is the breaking down of chlorophyll.

Light does not exert a paratonic or retarding effect upon growth. Its chemical action may hinder the accumulation of somatic material however. The altered development of plants in darkness is an adaptive response which has for its purpose the elevation of the chlorophyll screen and reproductive bodies.

Chemical, photosynthetic and phototropic maxima, minima and optima are so widely separated that *phototonus* as a term to designate the condition of a plant when acted upon by light of an optimum intensity, or of an intensity between the maxima and minima, is useless and untenable, as are also light optimum, maximum and minimum when applied in generality to the light relations of the plant.

Propagation of Lysimachia terrestris: PROFESSOR D. T. MACDOUGAL, New York Botanical Garden.

The development of the secondary and tertiary branches of the stems of *Lysimachia terrestris* is arrested by conditions unfavorable to seed formation, and these branches assume the form of short cylindrical organs less than 1.5 cm. long without epidermal openings, and consisting of 3 to 5 internodes. The stele shows only protphloem and protoxylem. These bulbils fall to the ground and may survive under the cover of dead leaves to reproduce the plant in the next season. The bulbil completes its development as a rhizome and does not perish, as in most cases of bulbs and bulbils. Bulbils are quickly killed by desiccation and freezing temperatures.

Seedlings of Arisœma: PROFESSOR D. T. MACDOUGAL, New York Botanical Garden.

The seedlings of *Arisœma Dracontium* generally do not develop the plumule. The cotyledon pushes down into the soil carrying the hypocotyl, the base of which enlarges to form a bulb, in which is stored the reserve material withdrawn from the seed and not used. In a few instances, however, a single small leaf is developed; usually this does not take place until the second season of activity or the third season of existence of the seed. Similar saprophytism is exhibited by the seedlings of *Arum maculatum* which never develop the plumule until the second year of growth.

The Insular Flora of Mississippi and Louisiana: PROFESSOR FRANCIS E. LLOYD, Teachers College, and PROFESSOR S. M. TRACY, Biloxi, Miss.

The paper deals with the climate, physiography and the vegetation of the Mississippi Sound Islands and Delta, and is especially concerned with a comparison of the ecological conditions in this region and that recently studied by Kearney, namely, Ocracoke. The results show for the former a longer growing season, more favorable wind conditions and a greater amount of sunshine.

The islands of the Delta region are of three kinds, the sand islands, the muck-marsh islands and the mud-lumps.

These islands have a strand vegetation of which four formations are recognizable, viz., the beach, sand plain, dune and salt marsh formations.

The beach formation contains succulent annuals of a halophytic character such as *Suœda linearis*, *Salsola kali* and *Sesuvium portulacastrum*, and in its upper zone some tropical strand plants such as *Ipomœa pes-capræ*, *I. acetosæfolia* (two prostrate leaf-succulent morning-glories), and rarely *Canavalia obtusæfolia*. The back beach plants are chiefly grasses, of which *Panicum amarum*, common along the north Atlantic Coast, and *Uniola paniculata*, a more southern strand plant, are the leading elements.

The sand plain contains succulent perennials as well as annuals, of prostrate and cespitose habit. The most striking plants of the sand plain are *Iva imbricata* and *Serenoa serrulata*, a prostrate palmetto, both of which build a pedestal dune.

The dune formation has two leading associations. One of these is the thicket (Ilex-Myrica) association inhabiting small established dunes which support a plentiful herbaceous undergrowth. The larger dunes are inhabited by *Serenoa serrulata*, *Rhus copalina* and several grasses. These dunes may attain a height of twenty meters and in their leaward march may bury the trees in their path.

The salt-marsh associations of chief interest are those of the muck-marshes. Two such are to be seen, namely the *Batis-Salicornia* association composed of leaf and stem succulents, and the grass association of which *Spartina* (two species) is the leading type. On the muck-marsh is sometimes superposed a water-moved shell dune composed of shell fragments and supporting a vegetation of annual and perennial plants of less marked halophytic character.

Some Problems connected with Fertilization in Plants: Lecture by PROFESSOR G. F. ATKINSON, Cornell University. (Illustrated by stereopticon.)

Professor Atkinson discussed recent advances which have been made in the study of fertilization in plants and their significance, and pointed out the problems still awaiting solution.

The Morphology of the Fruit of Opuntia: PROFESSOR J. W. TOUMEY, Yale University. (By invitation.)

Primarily the function of fruits is seed production, secondarily protection of seeds and aid in their dissemination. The fruit of the *Opuntia* does not deviate from this general law; although, in many instances, it has developed special adaptations. Under their desert environments, with many species, the germination of seeds and development of seedlings are rarely attained, the dependence for reproduction being almost entirely upon vegetal dissemination. In *Opuntia fulgida* the fruit is mostly sterile, but is particularly adapted to aid in the dissemination of the tumid spine-covered terminal joints, as these joints become attached to animals that feed upon the spineless fruit and thus become scattered by them. In this special case the function of the fruit is no longer to produce seeds, but to entice animals to the plant that the fragile, terminal branches may adhere to them and become disseminated. As before stated, the fruit is frequently sterile. In some instances, however, we find clusters of spineless, short, proliferous joints which resemble the fruits externally, but are entirely without evidences of even an abortive ovary. These proliferous clusters of spineless stems, in the economy of the plant, serve the same purpose as the fruit clusters and without the necessity of floral development, which would be a useless waste of energy on the part of the plant.

Notes on Long Island Pine Barrens: Dr. Hermann von Schrenk, Shaw School of Botany.

Photographs were exhibited illustrating the manner in which young trees of *Pinus resinosa* form basal shoots after the tops have been killed by fire. Some trees do this four years in succession, showing an unusual vitality in the root system. The effect of repeated fires on the barrens was discussed, and it was pointed out that a gradual degeneration of the forest is very marked.

Suggestions for an Attempt to secure a Standard College Entrance Option in Botany: Professor W. F. Ganong, Smith College.

The author pointed out the advantage to any science of the interest taken in its teaching by experts and scientific societies. The increasing use of botany as a college entrance option is emphasizing the lack of differentiation and definiteness in the secondary teaching of the science, as well as the diversity of requirement through which a great burden is placed upon those preparatory schools which fit students for a number of colleges. A summary is given of the requirements made in this subject by leading colleges. The history of the efforts to secure the formulation of a widely acceptable standard preparatory course was traced, culminating in the 'Report of the Committee of the National Educational Association in 1899.' The reasons why the latter is not more widely adopted were traced, and suggestions made as to the characteristics of a course likely to be more generally accepted. It was recommended that a committee be appointed to take the subject into consideration, and to endeavor to secure the formulation and adoption of such a course. This committee was appointed, as already mentioned in the introduction to this article.

Further Notes on Spermatogenesis of Zamia: Dr. Herbert J. Webber, Department of Agriculture.

The mature pollen grain of *Zamia* was found to contain two well-marked prothallial cells, and besides these a dark, refractive slit could frequently be observed in the wall of the pollen grain, at the base of the other prothallial cells, indicating that the first prothallial cell cut off becomes oppressed and largely resorbed during the development of the pollen grain as in *Ginkgo*.

These cells the writer referred to as the first, second and third prothallial cells, in the order of their formation.

During the development of the pollen tube and prothallial apparatus in the nucellar tissue after pollination, the second prothallial cell crowds out into the third prothallial cell which meanwhile retains its original point of attachment and comes to surround the second prothallial cell like a root-cap. When the third prothallial cell divides to form the stalk cell and central cell (Körper cell, generative cell), the spindle is formed diagonally in the cell, the nucleus of the forming stalk cell being crowded to one side by the intruding second prothallial cell. When the stalk cell is cut off by the completion of the division, it appears nearly cylindrical and completely surrounds the second prothallial cell except at the base, where both cells retain their original attachment. This same structure and development have been found by the writer to occur in *Ginkgo* also, and while in *Ginkgo* the division of the third prothallial cell has not been observed, the writer thinks there can be no doubt that the development is the same as in *Zamia*. This interpretation, it should be added, is totally different from that described by Ikeno and Hirase as occurring in *Cycas* and *Ginkgo*, but neither of these investigators observed the division of the third prothallial cell.

During the development of the apical end of the pollen tube in the tissue of the nucellus, the vegetative nucleus passes into the tube and during the growth of the latter remains near its apex. When the proximal end of the tube (the pollen grain end) begins to grow down toward the archegonia, shortly preceding fecundation, the vegetative nucleus travels back through the entire length of the tube, two or three millimeters, and takes position in the proximal end of the tube near the central cell. This change of position suggests that the nucleus governs and directs growth, and changes its location in the cell in order to be nearest to the point of most active growth, a factor emphasized by Haberlandt in his 'Function und Lage des Zellkernes.'

Notes on the Spermatozoids of Ginkgo: ERNST A. BESSEY, Department of Agriculture. (By invitation.)

In Washington the spermatozoids of *Ginkgo* are developed between August 25th and September 10th, as extremes, the most favorable time for finding them being September 1st to 3d. They are developed in the night or early morning. They are about $105 \times 75–82\,\mu$ in size, with nucleus $71–75\,\mu$. The nucleolus is $7.5\,\mu$ in diameter. The cilia are about $15\,\mu$ long. There are three turns in the spiral band which bears the cilia. The spermatozoid has no tail such as Hirase described, the latter's observation being probably on injured specimens, as Fujii has recently pointed out.

The ciliar motions are the regular tremulous motions of the cilia and also a series of waves passing from the apex to the base of the spiral. The body of the spermatozoid is very movable, especially the ciliferous portion, twisting, bending, elongating and contracting very remarkably. At the base of the cell, exactly opposite the apex of the spiral, there is a trembling motion apparently coincident with, and connected with the movement of the cilia. Its significance has not been determined.

Spherites and Sphere Crystals and their Relation to Plant Structures; DR. HENRY KRAEMER, Philadelphia College of Pharmacy.

On the basis of their physical properties the author has grouped the substances making up the contents and walls of plant cells into (1) the cell liquids or cell fluids; (2) sphere crystals; and (3) spherites. The cell liquids include the organized contents of the cell and a portion of the unorganized contents as cell sap. The sphere crystals are spherical aggregates of crystals with sharp angular contours, which are made up of but one substance and include various calcium salts, alkaloids, glucosides, etc.

The spherites resemble somewhat the sphere crystals, but are distinguished from them by the fact that the molecule is complex and the individual crystals have either a somewhat rounded outline or are imbedded in colloidal substances in which the crystalline or crystalloidal character is more or less obscured and hence with difficulty discerned. These include inulin, starch and the principal substances entering into the composition of the cell wall. The spherites are further distinguished from the sphere crystals in that they are capable of taking up or holding certain coloring principals as safranin, gentian, violet, etc.

The mode of formation of spherites and sphere crystals appears to be the same whether observed in nature or as carried out artificially by crystallization of salts from solutions or by precipitation, and hence the conclusion is reached that there is a play of similar forces in their formation.

An examination of the crystal masses remaining in watch crystals after the spontaneous evaporation of various substances under varying conditions, shows not only the formation of crystals which resemble those produced in the plant cell, but other rather striking forms of combination which are very suggestive indeed. Indeed the arrangement of the crystals in such a watch crystal reminds one of the appearance of our woods, at this season of the year, when the absence of leaves permits the observance of the fundamental lines of development in shrubs and trees.

The Cardinal Principles of Morphology: PROFESSOR W. F. GANONG, Smith College.

Although in most of its phases botany is making remarkable advances in America, it is still in one respect very backward, namely, in the morphology of the higher plants. Not only is little research being carried on in this direction, but it is still treated, particularly in its teaching, in the old formal idealistic manner, with little of the modern realistic spirit which the research of the past quarter century has infused into it elsewhere. The characteristics of the two systems, which differ less in fact than in point of view, are contrasted, and the attempt made to reduce these characteristics to definite named principles. Of these principles the author recognizes seven, in five of which the two systems do not differ materially, but in the other two they differ greatly. These are, the principle of metamorphosis by transformation or alteration as contrasted with metamorphosis by differentiation, a principle which is fundamental with the modern school of morphologists of which Goebel is the leader, and the principle of the existence of degrees of morphological rank culminating in morphological independence to which any part may attain. On this principle any part may become a center of variation and modification, and hence a true morphological member, and the number of members is not limited to three or four for the higher plant, as generally taught by us, but is indefinite.

Relation of Water-plants to the Solid Substratum: R. H. POND, Maryland Agricultural College. (By invitation.)

Many of our well known text-books contain the statement that the roots of water plants serve for attachment only ; that the function of absorption is unnecessary because transpiration is absent and the plant is bathed in a nutrient solution.

The evidence now at hand seems to require a modification of this statement. Six of our common and widely distributed aquatic species have been investigated. The results in general are:

1. Plants rooted in soil exceed in vegetation and dry weight plants rooted in sand or merely suspended.

2. Plants rooted in sand or merely suspended contain starch, calcium and magnesium in excess, while they are lacking in nitrogen, potash and phosphoric acid.

3. Lithium nitrate is absorbed by the roots and conducted to the upper portions of the plant where it may be detected with the spectroscope.

4. A volumetric measurement of root absorption has been made.

The work which has yielded these results has been done by the author while a special assistant to the U. S. Commission of Fish and Fisheries.

Positive Geotropism in the Hypocotyl: PROFESSOR E. B. COPELAND, University of West Virginia. (By invitation.)

The curve by which the primary root is bent downward if it emerges from the seed in any other direction is usually executed in the hypocotyl. By decapitation experiments and by a careful study of the location of the curving region, with reference to the growing tip, it is shown that the stimulus causing this curve is received by the root tip. To distinguish between the parts played by the root tip and the hypocotyl Czapek's terminology is adopted, the latter being geotropic, the former, geoæsthetic. The positive geotropism of the cotyledon of the date and other plants, where it is the first part of the embryo to elongate actively, is explained in the same way; the stimulus is received by the root tip, and the response is executed in the elongating zone above it, which is here in the cotyledon.

The Toxic Action of certain Salts on Marine Algæ: DR. BENJAMIN M. DUGGAR, Cornell University.

Plasmolytic studies upon some marine algæ at the Naples Biological Station demonstrated that KNO_3 is too toxic to be used for such work. This led to a study of some of the common nutrient salts as toxic agents in comparsion with some salts of the heavy metals and with certain acids.

In general the results indicate that potassium salts are much more toxic than those of sodium and magnesium. All the algæ used were killed by an exposure of three days in $\frac{n}{25}$ K_2HPO_4 in sea water K_2SO_4, KNO_3, and KCl were also toxic in a slightly decreasing ratio. With the magnesium and sodium salts used, and for a similar period of time, no injury occurred at $\frac{n}{5}$. Salts of the heavy metals were much more toxic than for the fungi; and in general, the acids used were very slightly toxic at $\frac{n}{1000}$. With no salt tested was it possible to keep the plant alive for more than a few hours in a solution of that salt isotonic with sea water. *Griffithsia Schousberi*, *G. opuntioides*, *Pleonasporium coccinium*, and *Chætomopha* sp. were the algæ used.

Loss of Vigor in Corn from Inbreeding: DR. HERBERT J. WEBBER, Department of Agriculture.

In maize the loss of vigor caused by close inbreeding was found to be very marked. Seeds of Hickory King, a race grown commonly in the eastern States, produced by inbreeding with pollen of the same stalk, yielded the next year at the rate per hundred stalks of 46 ears, weighing 9⅓ pounds. Seeds of the same race in every way comparable, but produced by crossing different seedlings, yielded under the same conditions at the rate per 100 stalks of 82 ears, weighing 27½ pounds.

In attempting to fix hybrids of Hickory King ♀ × Cuzco or Peruvian Corn ♂, some ears were inbred with pollen from the stalks bearing them, while others were pollinated with pollen from other hybrid seedlings of the same parentage. The hybrids of the second generation, where the seed was inbred with pollen from the same stalk, showed great loss of vigor, being small in stature and almost totally sterile; while those produced from seed which was inbred with pollen from a different seedling were much more vigorous and productive, seeming to have lost but little by this process of inbreeding.

Judging from these observations, it would seem that in fixing corn hybrids in practical plant-breeding it will be found desirable to cross different hybrid seedlings of the same parentage, which are found by careful observation to present the same characters, rather than inbreed a hybrid with its own pollen, as is somewhat generally directed by plant-breeders. It is of the utmost importance in plant-breeding that the best methods of fixing hybrids of various kinds of plants be determined, and further observations on this point with other plants are greatly needed.

W. F. Ganong,
Secretary.

WASHINGTON UNIVERSITY.

The new grounds of Washington University are situated at the western boundary of the city just west of Forest Park. The distance from the Mississippi River is about six miles and from the business center of the city about five miles. The most direct approach from the city is along Lindell Avenue. The site covers 153 acres and cost $350,000. The eastern boundary of the ground is Skinker Road, from which the land rises rapidly westward for about 1,000 feet. About 1,200 feet from Skinker Road is placed the main building of the institution, to be called University Hall and to be devoted to the offices of administration and to those subjects which do not require a laboratory or a drawing room. This building forms the eastern side of the first quadrangle; the other buildings on this quadrangle are Busch Hall, to be devoted to chemistry, Cupples Hall No. 1, to be devoted to Civil Engineering and Architecture, and the Library which separates the first quadrangle from the second.

On the second quadrangle are also to be Cupples Hall No. 2, which is to be devoted to electrical and mechanical engineering, a building for physics, and sites for other buildings not yet planned. The first and second quadrangles are to be devoted exclusively to buildings for instruction. The other quadrangles are to be devoted to dormitory buildings. Those to the north of the Broad Walk are intended to be occupied by women students and those to the south of the Broad Walk by men students. The Broad Walk, something over a third of a mile long, leads to the gymnasium, near which is the athletic field, which will be excavated in the top of the hill in the form of an amphitheater. The architects, Messrs. Cope & Stewardson, of Philadelphia, have so arranged the quadrangles as to occupy the highest land of a long hill whose general direction is east and west.

Seven of the buildings shown on the general plan are to be constructed at once, and five of them are already under construction. The St. Louis, Kansas City and Colorado Railroad, running along the north line of the property at the bottom of the hill, makes it easy to bring in the supplies for the University. The power house, located beside the railroad track, will provide heat, light and power for all the buildings. The buildings generally will be two stories high on the quadrangles and three stories high on the opposite sides. The buildings to be erected immediately will cost about $700,000, and about $100,000 will be expended in the grading and planting of the grounds.

The style of architecture is what is called