DEMONSTRATIONS

The demonstrations listed below will be displayed Monday through Thursday morning.

Arnott, H. J. The University of Texas, Austin.—MITOCHONDRIAL CRYSTALS IN THE BARBADOS-CHERRY (MALPIGHIA GLABRA).—Young and mature fruits of *Malpighia glabra* have been studied using electron microscopy, X-ray diffraction and light microscopy. Studies of tissues fixed in glutaraldehyde-acrolein followed by osmium tetroxide revealed that two types of organic crystals are present in many cells of the pericarp. The first type is found free in the cytoplasm and is sometimes seen in clustered arrays of up to 17 crystals. The maximum dimension of a single crystal is about 0.5μ; in sectional view these crystals are polygonal, exhibiting 4, 5, 6, or 7 sides. They are sometimes associated with the endoplasmic reticulum (both smooth and rough), especially when they appear to be undergoing breakdown. A second type of organic crystal occurs in the matrix of mitochondria. These, also, are polygonal in shape but are smaller than those free in the cytoplasm. These crystals often show very close association with one or more crista and are frequently in contact with the inner limiting membrane at the periphery of one side of the mitochondrion. Variation in the orderly patterns (lattice planes) seen in sections of different crystals and the nature of the crystals as determined from serial sections and reconstructions are discussed. A report on the progress in isolation and identification of these organic crystals is given. In addition to the organic crystals, calcium oxalate crystals are found in many cells; all three types of crystal sometimes occur in a single cell.

Arnott, H. J., and **R. M. Brown, Jr.** The University of Texas, Austin.—THREE-DIMENSIONAL RECONSTRUCTIONS OF THE CELLS OF TETRACYSTIS EXCENTRICA.—The cells and various organelles of the green alga *Tetracystis excentrica* have been investigated with the electron microscope, using serial sections. From these studies a series of three-dimensional reconstructions of the cells and organelles have been made, using a recently developed photographic process. In particular, the authors were interested in demonstrating the relationship between the nuclear membrane, certain parts of the endoplasmic reticulum, and the Golgi bodies, a relationship referred to as "amplexi" (see Brown, R. M., and H. C. Bold. 1964. Phycological Studies. V. Univ. Texas Publication 6417). The serial section technique combined with reconstructions was, also, used to study the elongate, tortuously shaped mitochondria and to obtain more complete data on the number and distribution of Golgi bodies in this organism. In addition to the display of 3–D photographic reconstructions, the demonstration will exhibit serial electron micrographs, diagrams, and electron micrographs showing the ultrastructure of this organism as seen in a variety of fixation procedures.

Arnott, H. J., and **P. L. Walne.** The University of Texas, Austin, and the University of Tennessee, Knoxville.—ULTRASTRUCTURAL INVESTIGATIONS OF EUGLENA GRANULATA.—Using the electron microscope, X-ray diffraction, polarization microscopy, histochemistry, and single frame analysis of high speed movies, certain aspects of the ultrastructure of this organism have been studied. Electron micrographs illustrating various details of the ultrastructure are presented with particular attention to the characteristics of the stigmata, chloroplasts, flagella, crystal chambers, and pellicle. A discussion of a proposed mechanism of metaboly in this organism is given.

Bachmann, M. D., D. S. Robertson, and **C. C. Bowen.** Iowa State University, Ames.—DEVELOPMENTAL CHANGES IN THE FINE STRUCTURE OF CHLOROPLASTS IN ETIOLATED LEAVES OF ZEA MAYS.—Dark-grown seedlings of normal plants, white-albino (w_3), its pale green allele (pastel 8686), and the heterozygous cross were exposed to light and the developing chloroplasts studied as a part of a larger genetic and biochemical study of white-albino and related mutants. The w_3 produces chlorophyll which is destroyed in light and has no colored carotenoids, although it does accumulate carotenoid precursors. This latter accumulation and the tendency of the chlorophyll and carotenoid contents to vary simultaneously in the pastel allele indicated a need for studies correlating carotenoid and chlorophyll constitution with chloroplast structure. The structural changes which occur in chloroplasts of the four genetic strains grown in the dark and exposed to light are compared in a series of micrographs to show: structure and disorganization of the prolamellar body; lamellar formation; and, subsequent breakdown or aberrant organization of the mutant plastids. A clearer view of the morphological variations in plastid inclusions, lamellar organization and aberrant grana may give some insight into the relationship of carotenoids and chlorophyll to chloroplast structure when compared with the chemical analyses of mutant and normal cells.

Bracker, C. E. Purdue University, Lafayette, Ind.—THE CLEAVAGE APPARATUS OF GILBERTELLA.—In sporangia of the mucoraceous fungus *Gilbertella persicaria* cleavage is initiated by the fusion of vesicles and completed by convergence of furrows. Single-membraned cleavage vesicles form prior to cleavage with small granules along the inner surface of the vesicle membrane. Evidence suggests the origin of cleavage vesicles by budding from membrane-bounded cisternae. After initial fusion the vesicles develop into a system ramifying throughout the sporogenous zone. Growing as an interconnected tubular network, the pattern of cleavage profiles suggests the outlines of spore initials during mid-cleavage. Flattening and expansion of the cleavage network produces furrows. In late cleavage new cells are connected by protoplasmic bridges which are later severed. The cleavage vesicle membrane is transformed into the plasma membrane of spore initials leaving the granules on the outer surface of the new plasma membrane. The granules fuse to form a network that eventually becomes a continuous envelope. Inside the envelope spore wall material is laid down leaving the envelope as the outer layer of the spore wall. The sequence of transformations leading to spore formation is demonstrated by electron micrographs.

Branton, Daniel. University of California, Berkeley.—FRACTURE FACES OF FROZEN MEMBRANES.—Heretofore unseen faces of cellular membranes are exposed during freeze-etching, a technique which reveals the ultrastructure of fracture planes in frozen material—specifically, sites of hydrophobic bonding within membranes. As a result, the true membrane surface (the interface between a membrane and any contiguous protoplasm, cell wall, or vacuolar material) is rarely seen. Instead, the fracture process used in freeze-etching splits the membrane and exposes an internal membrane face. Small particles (75 A–200 A in diameter) on these faces are interpreted as subunits of the membrane. Examples of several different types of membranes—plasmalemma, nuclear, chloroplast, etc.—demonstrate that the number and manner in which these particles are associated within a given membrane is in large part a function of the type of cell organelle examined. Comparison of these examples suggests that the biological membrane is organized in part as an extended bilayer and in part as globular subunits.

Horner, H. T., Jr., N. R. Lersten, and **C. C. Bowen.** Iowa State University, Ames.—SPORE DEVELOPMENT IN THE LIVERWORT RICCARDIA PINGUIS.—Spore development was studied at both light and electron microscope levels. Three

stages of development were arbitrarily defined; spore mother cell (SMC); early tetrad (nonpigmented and unsculptured walls); and mature tetrad (pigmented and sculptured walls). The quadrilobed SMC has a two-layered wall, a central nucleus, many chloroplasts, lipid bodies, and other organelles. Rearrangement of these cellular components occurs during sporogenesis. During and following meiosis, cell plates form from coalescing Golgi vesicles. These plates eventually fuse to form a septum, completing the tetrad. The septum comprises the middle lamella and primexine, which is continuous on both ventral and dorsal surfaces of the tetrad. Within and interior to the primexine, the exine (sexine and nexine) and intine develop from material deposited by more Golgi vesicles. The contents of the vesicles change during sporogenesis, corresponding to the different wall layers being formed. We conclude that wall formation is controlled entirely by the spore protoplast and that the pattern of the mature exine is determined by the papillate primexine acting as a "mold."

Lacey, W. S., and **K. Trewren.** University College of North Wales, Bangor, Wales.—A CUTINIZED SEED IN THE INDIANA PAPER COAL.—During the course of a recent senior year class in paleobotany, Indiana paper coal, supplied by J. E. Morris, was used for routine demonstration of maceration techniques. A sample of a few grams only yielded the well-known pinnules, pinnae and rachides which Guennel (1958) compared with *Sphenopteris bradfordii* Arnold, many spores attributable to different taxa, and a single example of the incomplete cutinized seed illustrated in the photographs exhibited. The seed is about 2.75 mm long and 1.5 mm wide. It consists of an inner-folded megaspore membrane, surrounded by an outer membrane marked with a conspicuous reticulate pattern. The seed agrees very closely, both in dimensions and in structure, with *Spermatites reticulatus* described by Arnold (1949) from three localities in the Upper Pottsville of southern Michigan and can be referred to that species. Since Guennel (1958) found no seeds in the first examination of the Indiana paper coal, the present record is of some interest and suggests that careful examination of a large bulk of the material might have interesting results. Further work is in progress.

Mueller, Sabina. University of North Carolina, Chapel Hill.—CUTICULAR PATTERNS WITHIN THE GENUS VACCINIUM (ERICACEAE).—Photographs of plastic replicas of leaf surfaces of various species of *Vaccinium* are exhibited. Adult foliage of each species has a distinct, recognizably different, cuticular pattern, although very ornate patterns are more difficult to distinguish. Two types of stomates, the anisocytic type and the more frequent and characteristic paracytic type, can be recognized by the apparent size difference and cuticular pattern. Juvenile foliage does not resemble adult foliage of the same plant or cutting, and there are no distinguishing differences in the pattern from one species to another. Adult foliage, whether taken from the same plant in different years or obtained from greenhouse-grown cuttings, is recognizably the same. The differences noted within an individual genotype appear to be in density and prominence of the cuticular striations. Two horticultural varieties of blueberry, 'Menditoo' and 'Croatan', have complex, but different, cuticular patterns, and the artificial hybrid between them has a pattern different from either parent. The cuticular pattern obtained from 'Croatan' in 1963 is the same as that obtained from a 1965 collection, although the plants were grown under different conditions. Suspected natural hybrids between *V. vacillans* Torrey and *V. tenellum* Aiton have a cuticular pattern different from (but not necessarily intermediate between) both parents, and the populations containing the suspected hybrids are found to be quite variable as to interstomatal pattern.

Stebbins, G. Ledyard, and **Alva Day.** Department of Genetics, University of California, Davis.—PLANTAGO INSULARIS: A PROMISING SPECIES FOR INVESTIGATIONS IN EVOLUTIONARY AND DEVELOPMENTAL GENETICS.—The annual species, *Plantago insularis,* native to the southwestern deserts of North America, has the somatic chromosome number $2n = 8$. The chromosomes have marked individuality which they retain throughout the mitotic cycle and at meiotic prophase. The plants are small, their reproductive cycle from seed to seed requires about 10 weeks, and they are easily grown under controlled conditions. The effects of hybridization with the Old World species *P. ovata,* which also has $2n = 8$, are described, as well as the mutagenic action of ethyl methane sulfonate.

Wilson, B. F., and **W. H. Lyford.** Harvard Forest, Harvard University, Petersham, Mass.—THE RHIZOTRON: CONTROLLED GROWTH OF ROOTS FROM MATURE FOREST TREES.—A modified root-pruning technique produces root tips at known points on the root system. The tips are then grown in inexpensive trays while still connected to the mature tree. Examples are given of some applications of the technique, both through controlling the environment of the trays and by experimenting with individual roots.

DEVELOPMENTAL SECTION

Session 1. Monday Afternoon. Symposium.

ARE GROWTH AND DIFFERENTIATION INCOMPATIBLE? Co-sponsored by the Developmental Biology Division of the American Society of Zoologists, the Society for Developmental Biology, and the American Society of Plant Physiologists. W. M. LAETSCH, *presiding.*

2:00 **Haber, Alan H.,** and **Donald E. Foard.** Oak Ridge National Laboratory, Oak Ridge.—EXPERIMENTAL SEPARATIONS OF GROWTH, DIFFERENTIATION, AND CELL DIVISION IN INTACT PLANTS.

2:45 **Holtzer, Howard.** University of Pennsylvania, Philadelphia.—SPECULATIONS ON THE ROLE OF MITOSIS IN DIFFERENTIATION.

3:30 **Recess.**

3:45 **Halperin, Walter,** and **Donald F. Wetherell.** University of Connecticut, Storrs.—STUDIES OF GROWTH AND MORPHOGENESIS IN CARROT CELL SUSPENSIONS.

4:30 **Discussion.**

Session 1. Tuesday Morning. R. R. MACMAHON, *presiding.*

9:00 **Van't Hof, J.** University of Minnesota, Minneapolis.—EXPERIMENTAL CONTROL OF DNA-SYNTHESIZING AND DIVIDING CELLS IN EXCISED ROOT TIPS OF PISUM.—The number of dividing and DNA-synthesizing cells in excised pea roots can be regulated by eliminating the carbohydrate normally supplied in the culture medium. When the excised roots were allowed to remain for 24 hr in a medium lacking carbohydrate, the number of mitotic figures and tritiated thymidine (H^3–T) labeled cells was reduced almost to zero. After an additional 24 hr in the incomplete culture medium, 15% of the interphase cells were H^3–T labeled, the percentage of the cells that were dividing never exceeded 1.4, and 30% of these were H^3–T labeled. When the roots remained in the deficient medium for 72 hr, neither cell division nor cells synthesizing DNA were observed. Upon addition of 2% sucrose, cell division and

DNA synthesis were resumed in the roots that were maintained for 24 or 72 hr without an exogenous carbohydrate supply. It has been hypothesized that some proliferative systems consist of two cellular subpopulations which selectively stop or remain in either the pre-DNA synthetic (G_1) or post-DNA synthetic (G_2) periods of the mitotic cycle. The addition of sucrose, H^3–T, and 5-aminouracil to the medium, after the roots had been maintained for 24 hr without a carbohydrate, indicated that most of the proliferative cells in the roots had accumulated in either G_1, a quasi–G_1 condition, i.e., DNA synthesis stopped sometime before completion, or G_2 periods of interphase; the majority, however, were in G_1 or quasi–G_1 conditions. The results suggested that DNA synthesis (S period) and mitosis or the onset of these processes have the highest metabolic requirements in the mitotic cycle and that G_1 and G_2 were the most probable states for proliferative cells in a meristem with a low metabolic level.

9:20 **Schulz, Sister Richardis,** and **William A. Jensen.** University of California, Berkeley.—ULTRASTRUCTURE AND HISTOCHEMISTRY OF THE EMBRYO SAC AND YOUNG EMBRYO OF CAPSELLA BURSA-PASTORIS.—The embryo sac of *Capsella* is eight-nucleate, seven-celled, and contains the egg, two synergids, two polar nuclei and three antipodals. An ultrastructural and histochemical survey of the structure and composition of the cells of the embryo sac and young embryo shows that they possess characteristic differences. The central cell contains a huge central vacuole and has many large plastids with well-developed lamellar systems concentrated around the fused polar nuclei. The synergid cytoplasm appears very active having numerous dictyosomes, large amounts of endoplasmic reticulum and many mitochondria. A PAS-positive filiform apparatus protrudes into the micropylar end of each synergid as an extension of the cell wall. The egg cytoplasm appears inactive having few dictyosomes and little endoplasmic reticulum. The egg also possesses a large vacuole, is very densely packed with ribosomes and stains intensely for nucleic acids and protein. The pollen tube enters and deposits its contents in one of of the synergids. Double fertilization takes place forming the zygote and primary endosperm nucleus. The first division of the zygote is unequal giving rise to a large, highly vacuolate basal cell and a small, more densely cytoplasmic terminal cell. The next several divisions follow a regular pattern and give rise to a long suspensor with a large basal cell at one end and the embryo at the other end. There are differences in vacuolation, electron density and histochemical staining of the cytoplasms of the embryo and suspensor cells. There are also characteristic ultrastructural changes during the development of the basal cell with special reference to the cell wall.

9:40 **Schulz, Sister Richardis,** and **William A. Jensen.** University of California, Berkeley.—ULTRASTRUCTURE AND HISTOCHEMISTRY OF THE CHALAZAL PROLIFERATING CELLS IN THE OVULE OF CAPSELLA BURSA-PASTORIS.—The chalazal proliferating tissue is formed by the enlargement of several nucellar cells at the chalazal end of the embryo sac. When the embryo reaches the early globular stage these enlarged cells start to disintegrate, beginning with those immediately bordering the embryo sac and continuing until all have broken down. The ultrastructural changes which accompany the destruction of the chalazal cells follow a characteristic pattern. The mature cells form increased numbers of active dictyosomes and large amounts of endoplasmic reticulum which often appears in stacks of three to eight cisternae. Electron density of the cytoplasm increases as the cells begin to deteriorate. The nuclei are large, often deeply lobed and contain densely staining chromatin areas near the nuclear membrane. Soon the dictyosomes disappear and the stacked endoplasmic reticulum is dispersed. At this time there is a notable increase of single-membrane-bound organelles which have a lysosome-like appearance. Vacuolation increases and the plastids disappear. The nuclear membrane becomes prolific and then disorganizes. The plasmalemma disappears and the cell wall breaks down releasing the remaining cytoplasmic contents into the embryo sac. Changes in histochemical staining also accompany these events.

10:00 **Gifford, E. M., Jr.,** and **K. D. Stewart.** University of California, Davis.—FORMATION OF PHENOLIC SUBSTANCES AND VACUOLE ORIGIN IN THE SHOOT APEX OF BRYOPHYLLUM AND CERTAIN OTHER GENERA.—Phenolic substances are produced in association with internal membranes of proplastids. After their accumulation within the proplastid, the phenolic substances are isolated from the remainder of the organelle by the formation of a membrane septum which is an invagination of the inner plastid membrane. The plastid membrane adjacent to the phenolic substance becomes disorganized in a region that is approached by an ER cisterna. The ER is associated with ribosomes in all parts of the cell, but the extension of the rough ER that approaches the proplastids is smooth. In some manner not completely understood the smooth extension of the rough ER produces a tonoplast around the phenolic substance. In the apex the phenolic substances are observed in proplastids, small pre-vacuoles, and in the large vacuoles of the pith rib meristem. The idea is advanced that vacuoles are first formed, not by an accumulation within the ER cisternae, but by smooth extensions of the ER around hydrophilic substances (phenolic substances) produced within the plastids or in the cytoplasm.

10:15 **Recess.**

10:20 **MacMahon, R. R.** State University of New York at Albany.—CYTOHISTOLOGICAL ZONATION IN THE SHOOT APEX OF OSMUNDA CINNAMOMEA L.—The purposes of this study of *Osmunda cinnamomea* L. were to delimit critically the boundaries of the promeristem and to demonstrate physiological differences among the various zones of the apex by cytohistological techniques. Slides were prepared from actively growing shoot apices of *Osmunda* after incorporation of tritium-labeled thymidine, uridine, and leucine, and were then examined cytohistologically for the quantities of histone, DNA, RNA and total protein in the various zones of the apex. High grain counts in nuclei and nucleoli of H^3–uridine-labelled tissue, as well as large nucleolar volumes, indicated that the superficial layer and the procambium are metabolically the most active tissues. The incipient vascular tissue showed lower H^3–uridine grain counts and smaller nucleolar volumes, except at the lower margin of this tissue where the procambial cells begin to elongate. At this level the grain counts were very high. The pith mother cells consistently showed the lowest level of H^3-uridine grain counts and the smallest nucleolar volumes. Nuclei of superficial cells further differed from nuclei of the subjacent prestelar tissue in that they contained large amounts of acidic nuclear protein. It is concluded that the superficial layer alone is the promeristem, that the totipotency of these cells is perhaps related to the large amount of acidic nuclear protein found within them, and that the initial differentiation of tissues occurs in the subjacent prestelar tissue.

10:40 **West, W. C.** Rutgers—The State University, New Brunswick, N. J.—HISTOCHEMICAL STUDIES OF CHANGES IN GROSS METABOLITES ASSOCIATED WITH GROWTH AND DIFFERENTIATION IN THE SHOOT OF BRACHYCHITON ACERIFOLIUM F. MUELL.—The first 4 mm of the vegetative shoot of *Brachychiton acerifolium* (Sterculiaceae) were studied anatomically as well as histochemically for RNA, protein, and cell-wall carbohydrates. Cellular growth in this shoot is quite different from that reported by other authors. An initial growth phase occurs during the first 0.5 mm in which both radial expansion and cell elongation occur. After the first half mm, cell elongation ab-

ruptly ceases, but radial expansion continues throughout the 4 mm studied. Cell elongation resumes at an unknown distance from the tip (in the range of centimeters). The amount of RNA per unit volume is higher in the flanking zone than in the other zones of the meristem, but on a per cell basis RNA is highest in the pith rib meristem. Protein follows a pattern similar to that of RNA. Cell wall carbohydrates in the meristem are most concentrated in the central zone, but on a cellular basis they are highest in the pith rib meristem. Over 50% of the cell wall carbohydrates in the meristem are of the pectic substance type. Cellulose is almost non-detectable in all zones. All metabolites studied were much lower on a per cell basis in the meristem than in the developing pith. Also, a sharp rise in all metabolites per cell is found at increasing distances from the meristem. At approximately 0.5 mm from the tip all metabolites "level off" or at least increase at a much slower rate. The significance of this close correlation between cessation of cell elongation and changes in synthesis of metabolites will be discussed.

11:00 **Ashton, M. E.,** and **W. A. Jensen.** University of California, Berkeley.—STUDIES ON PROTEIN BODIES IN COTTON NUCELLUS.—An ultrastructural and histochemical study was undertaken on protein bodies in the nucellus of cotton. The bodies are concentrations of protein within large cisternae of the endoplasmic reticulum. Prior to fertilization these bodies are primarily found in the first row of nucellar cells beneath the egg apparatus. Subsequent to fertilization the number of cells containing protein bodies increases in a pattern starting at the embryo sac and developing toward the integuments. The cells that contain protein bodies, however, are restricted in the nucellus to those micropylar to the zygote or embryo. When the zygote divides (3 to 4 days following fertilization) the cells containing the protein bodies begin to disintegrate in a pattern starting from the embryo sac and working toward the integuments. In the disintegrating cells the protein bodies are the last structures to disappear. The details of these events and their relation to the course of embryo development will be discussed.

11:20 **Spelsberg, Thomas C.,** and **Igor V. Sarkissian.** West Virginia University, Morgantown.—IAA-INDUCED MODIFICATIONS OF PROTEINS OF VARIOUS PLANT TISSUES.—Soluble proteins were extracted from variously treated hypocotyledonary hooks (1-cm sectors below cotyledonary node) of 7-day-old bean seedlings. The treatments consisted of incubating the excised tissues for various intervals in IAA (10^{-3}M–10^{-7}M); in IAA and sucrose; in tryptophan; under aerobic and anaerobic conditions; in IAA and NaCN; and in water. The protein extraction medium was 0.1M borate buffer, *p*H 8.1. Following $(NH_4)_2SO_4$ precipitation (70% saturation), the proteins were electrophoresed on acrylamide gel columns. The banding patterns of extracts from the controls (water incubation) revealed 11 proteins. There were no changes in protein patterns when the tissues were incubated 12 hr in tryptophan, in 10^{-3}–10^{-7}M IAA under anaerobic conditions, in IAA and sucrose, in IAA and NaCN, and in NaCN. The only striking change in protein electrophoretic pattern was observed after tissues were incubated in 10^{-3}–10^{-4}M IAA. This treatment resulted in loss of one protein as detected by electrophoresis. The protein was lost when incubation in 10^{-3}M was carried out only 2 hr. At weaker IAA concentrations, 10^{-5}–10^{-6}M, the protein in question was not eliminated entirely but was reduced markedly. Since these results were observed on proteins of tissues composed mainly of meristematic and elongating cells, it was of interest to study the effects of IAA on proteins of tissues with maturing or matured cells. When such tissues were incubated in IAA, it was observed that their electrophoretic patterns approached those of the undifferentiated hypocotyledonary hook region not treated with IAA.

11:40 **Van Fleet, D. S.** University of Georgia, Athens.—DEVELOPMENT OF POLYACETYLENES AND THEIR VALUE IN ANALYSIS OF CELLULAR AND ENZYME DIFFERENTIATION.—The remarkable fine structure of the U. V. maxima of conjugated polyacetylenes was used to localize their origin in specific cell types. An increase in the number of ethylenic bonds in polyacetylene essential oils was found to be related to stages in development and differentiation. The sharply defined U. V. maxima of polyacetylenes in *Psilotum* gave bathochromic shifts from shorter to longer wavelengths with progression in ethylenic bond increase and concomitant changes from dormancy through differentiation to adult tissue. Changes in U. V. maxima to longer wavelengths with age were in the order of 250–350 A and too large to be related to stereoisomerism. The extreme antibiotic and pathogen-blocking action of polyacetylenes is an apparent reason for their production and survival value to plants in evolutionary scale from *Psilotum* through the Compositae. Plants from families not recognized as containing polyacetylenes were found to produce polyacetylenes under adventive conditions of wounding. Endodermal and specialized glandular cells are responsible for polyacetylene production normally and adventively. The probable sequence in enzyme activation and differentiation has been adduced from preliminary elementary experiments.

Session 2. Tuesday Afternoon. W. F. MILLINGTON, *presiding.*

2:00 **Green, Paul B.** University of Pennsylvania, Philadelphia.—CELLULAR MORPHOGENESIS AS A FUNCTION OF THE LOCAL BEHAVIOR OF CELL SURFACE.—It can be shown that a given change in cell shape—or even the extension of preexisting cell shape—can be brought on by an unlimited variety of local surface expansion patterns. Local surface behavior involves both the rate of area expansion and the directed nature of area expansion (anisotropy). These are readily computed from linear extension rates measured in two directions. This type of analysis shows that the internode of *Nitella* has pronounced longitudinal anisotropy throughout with no gradient in the rate of area expansion. The apical cell, which ultimately gives rise to the internode, has a gradient in the area rate of expansion (fast at the tip, slow at the base) and also shows a predominant transverse extension at the base. This last distortion could possibly align initially random microtubules into their typical (for elongating cells) transverse arrangement.

2:20 **Anderson, C. E.** University of Oklahoma, Norman.—PRESSURE EFFECTS ON CORN ROOT CELLS.—Corn root cells are compared following treatment with pressure induced by growing the roots through small holes and by exposing them to pressures induced by a pressure chamber. The ability of the cells to produce chromosomes, nuclei, and new cells will be considered. Histological and other general cytological changes will be discussed.

2:40 **White, P. R.** The Jackson Laboratory, Bar Harbor, Maine.—SOME ASPECTS OF WALL FORMATION IN SPRUCE CELLS CULTIVATED IN VITRO.—The occurrence of well-defined pores, the development of a variety of extrusions through these pores, and some methods by which specialized patterns are formed in the secondary thickenings and in the cytoplasm of spruce cells grown in vitro will be reported. Some physiological factors influencing these specializations will be discussed.

3:00 **Thomson, R. C.,** and **W. F. Millington.** Marquette University, Milwaukee, Wis.—PHOTOPERIODIC REGULATION OF THE CATAPHYLL-FOLIAGE LEAF TRANSITION IN SUGAR MAPLE.—During the formation of the winter bud in maple there is an alternation in the production of cataphylls (bud scales) and foliage leaves by the shoot apex. Beginning at about the time the bud breaks in spring, under

increasing daylength conditions, the primordia at the apex develop as a series of cataphylls (ca. 20). This continues until early July when, under decreasing daylengths, an abrupt transition to foliage leaves occurs (ca. 4–6 are formed). Experimental regulation of the photoperiod affects this pattern. In young trees under short-day treatment the cataphyll number is reduced to approximately one half (10–12) followed by the formation of foliage leaves. Application of gibberellic acid restores the cataphyll number to that of the controls. Increasing the daylength up to and including continuous illumination results in increasing numbers of cataphylls formed before the transition to leaves occurs. Maximum cataphyll numbers (22) occur at 20 hr light. Bioassays show the presence of a growth inhibitor in greater amounts during cataphyll formation than during foliage leaf formation.

3:15 **Recess.**

3:20 **Burk, L. G.** U.S.D.A., Agricultural Research Service, Crops Research Division, Beltsville, Md.—VARIEGATION: A MEASURE OF LEAF AND CELL DEVELOPMENT IN TOBACCO.—Color contrasts provided by variegations, like ploidy differences in cytochimeras, offer a means of equating the 3 outer layers of the apical meristem (L-I, L-II, and L-III) with the 6 or 7 layers in mature leaves. Excluding occasional interhistogenic cell movement, L-I is the source of the upper and lower epidermis. At one time L-II was considered the source of the palisade and lower parenchyma only. However, stable-homoplastidic patterns like G-W-G show that L-II may contribute to the central parenchyma from leaf edge to varying points at mid-lamina. The line of demarcation between L-II and L-III is seen as a sinuate line. In cross-section, green cells from L-III constitute the central layers of parenchyma adjacent to the midrib and progressively fewer layers as L-III blends with L-II. Vascularization, once thought to be exclusively of L-III origin, can be produced by L-II. Thus geographic location (a cell's position with respect to other cells) is more important to cell differentiation than its histogenic layer of origin. Interhistogenic cell movement shows that cells from L-I, II or III occasionally intrude into adjacent layers. Thus variegated patterns can be altered depending on the developmental stage at which the intrusion occurs. G-W-G can become G-G-W, W-G-G, G-G-G, or W-W-W. Reorientations of this sort may find former epidermal Layer I producing parenchyma cells. This merely emphasizes the importance of cell location to eventual differentiation. Geographic location apparently selectively affects repression-derepression genetic mechanisms which control differentiation.

3:40 **Khan, Anwar A.** New York State Agricultural Experiment Station, Cornell University, Geneva, N. Y.—BREAKING OF DORMANCY IN XANTHIUM SEEDS BY KINETIN, A REVERSIBLE PHOTOREACTION.—"Upper" seeds in the fruit (bur) of *Xanthium* are dormant under usual growing conditions and do not germinate for months and sometimes years. Kinetin at 5×10^{-4} M broke the dormancy of these seeds. All seeds germinated within 6–8 days. "Lower" seeds do not show any dormancy and germinate in 4–5 days. IAA at 5.7×10^{-5} M, GA_3 at 2×10^{-4} M and CCC at 2.5×10^{-3} M were unable to break the dormancy of the upper seeds and had no effect on germination of the lower seeds. Breaking of dormancy by kinetin occurred only in light and was shown to be controlled by the reversible red–far red photoreaction. This kinetin-induced photoreaction in upper seed was inhibited by 8×10^{-6} M actinomycin D but not by puromycin up to 5×10^{-4} M. Actinomycin D up to 8×10^{-5} M and puromycin up to 5×10^{-4} M had no effect on germination of lower seeds. It is concluded that kinetin is possibly acting by derepressing a repressed site which determines dormancy in upper seeds of *Xanthium* and that breaking of dormancy is independent of de novo protein synthesis. That an inhibitor controlling dormancy in these seeds is an agent of repression will be discussed.

4:00 **Grove, Sister Ann Cecilia.** Howard University, Washington, D. C.—THE GROWTH AND DEVELOPMENT OF THE PODETIA OF CLADONIA CRISTATELLA AND RELATIONSHIP TO ENVIRONMENTAL FACTORS.—To determine a sequential development and growth pattern of the podetia of *Cladonia cristatella* and its relationship to environmental influences, many consecutive field observations and measurements were made and supported by photographic record during the period June, 1965, to July, 1966. The species was observed on a clay soil with a *p*H of 4.4, high in aluminum and potassium. Twenty podetia were measured and the environmental factors of temperature, humidity and precipitation were noted. Tests were performed on podetia, soil and litter to determine chemical content. Pictures were taken, both in the field and in the laboratory, of the podetia in all stages of growth from the pycnidia to full maturity. Data on the growth rate, developmental pattern and environmental influences have been compiled and will be discussed.

4:20 **Kanjiraparamban, Sr. C.,** and **W. F. Millington.** Marquette University, Milwaukee, Wis.—CELL NECROSIS IN THE MORPHOGENESIS OF THE LEAF.—Perforations in the leaves of certain species of *Monstera* are caused by the necrosis of patches of cells which drop out as the hole they leave expands with growth of the leaf. The perforation pattern becomes discernible during the third plastochron as groups of cells extending through the leaf die in unison during early blade development. There is no apparent progression of necrosis from the cells initially affected, necrotic areas being sharply delimited at inception. Cells adjacent to the necrotic sites continue cell division uninhibited. It has not been possible to induce hole formation in leaves of non-perforate species by grafting onto perforate stocks. Cytochemical studies have not revealed precursory changes in advance of cell death. Preliminary studies indicate that perforations are suppressed in low light.

Session 1. Wednesday Morning. R. M. KLEIN, *presiding.*

9:00 **Hagen, G. L.** The Institute for Cancer Research, Philadelphia.—IAA DESTRUCTION BY NICOTIANA PARENT AND HYBRID STEM TISSUES AND BY TUMOR TISSUES.—The evidence that abnormal growth in some tobacco hybrid tissues is related to peculiar auxin metabolism has previously been presented. This evidence, in general, suggests that the tumor potential tissues have a significantly higher level of auxin than do parental tissues. The high auxin level could be a function of a higher production of auxin or reduced destruction of the auxin produced. The analysis of stem tissues from *N. glauca, N. langsdorffii* and their hybrids for enzymes capable of destroying indoleacetic acid indicates that all potential tumor-forming plants have higher extractable levels of auxin-destroying enzymes than do the non-tumor-forming parents. Extractable inhibitors of this enzyme system are, however, low in the non-tumor formers, are higher in tumor potential tissue and are extremely high in the tumor tissue itself. In spite of the high levels of auxin-destroying enzymes in tumorous tissues, apparently they can maintain high auxin levels partly because of the reduced effectiveness of the auxin-destroying system mediated by high inhibitor levels. Additional analysis indicates that there exists a spatial separation of enzymes and inhibitors in vivo which may make the auxin-destroying enzyme active under limited conditions.

9:20 **Davidson, D.,** and **R. D. MacLeod.** Western Reserve University, Cleveland, Ohio.—RESPONSES OF COLCHICINE TREATED ROOTS TO IAA.—Roots of *V. faba* exposed to 3×10^{-4}M IAA for 24 hr either die or show severe disturbances within 4 days. If they are treated with 0.025% colchicine for 1–3 hr one day before they are exposed to IAA, they show greater resistance to the auxin treatment.

Over 95% of primary roots die when treated with 3×10^{-4}M IAA; pretreatment with colchicine reduces this frequency to 84%. With lateral roots a colchicine pretreatment reduces the frequency of IAA-induced dead roots from 86% to 26%. These changes follow a trend we have previously observed with respect to mitotic index: the results suggest that following treatment with colchicine, there is a change in the levels of endogenous growth factors in roots. This change can be reversed by the addition of exogenous IAA. Low concentrations of IAA (10^{-6}–10^{-8}M IAA) will stimulate growth of colchicine-treated roots. Higher concentrations of IAA, however (10^{-4}–10^{-5}M), inhibit root growth or induce death of the roots; these effects can be mollified by colchicine pretreatments. It is suggested that the levels of endogenous auxins in roots fall following colchicine treatments, and the effects seen in treated roots are largely due to the change in available auxins.

9:40 **Lippincott, James A.,** and **Barbara B. Lippincott.** Northwestern University, Evanston, Ill.—PROMOTION AND INHIBITION OF CROWN-GALL TUMOR FORMATION BY ELEVATED TEMPERATURE TREATMENT.—Crown-gall tumor initiation is remarkably temperature sensitive and this feature has provided a means of following events in the tumor induction process. A series of experiments involving temperature variations was consequently undertaken to characterize tumor induction on the pinto leaf host system. Tumor initiation on the pinto leaf will be shown to be sensitive to temperatures of 32 C or higher and, in general, the higher the temperature and longer the treatment, the fewer tumors initiated. Temperatures of 32 to 45 C may also promote tumor initiation up to 200% of the controls. This promotion is commonly observed in experiments in which the elevated temperature treatment in the dark immediately following infection is followed by a dark period at 27 C for a combined time of 72 hr before being moved to the greenhouse. Samples maintained at 27 C in the dark for 72 hr serve as controls. As the temperature is increased, this promotion occurs sooner and extends over a shorter period of time. Application of a 4-hr period at 40 C at various times in a 72-hr period at 27 C shows a maximum promotion at about 8 hr and a maximum inhibition at 18 hr. By subjecting bacteria to a 5-min treatment at 45 C prior to inoculation a similar promotion of infectivity can be obtained without change in viability. The promotion obtained by temperature treatments of infected leaves, therefore, may be due to action on the bacterium.

10:00 **Lippincott, Barbara B., Marvin W. Meyer,** and **James A. Lippincott.** Northwestern University, Evanston, Ill.— TIME OF TUMOR INITIATION BY AGROBACTERIUM TUMEFACIENS ON PINTO BEAN LEAVES.—A knowledge of the time following infection at which tumor induction occurs in the *A. tumefaciens*-host complex is fundamental to our understanding of the process of tumorogenesis and to the design of experiments elucidating this process. We have utilized two approaches, one direct, the other indirect, to determine the time of tumor initiation on pinto leaves. By growing the bacterium in P^{32}-containing medium for short periods of time, we have obtained sufficient labeling of the bacterium to result in a viability half-life of 9.5 hr when stored at 4 C. The specific infectivity (number of tumors initiated per viable bacterium inoculated) of the labeled bacteria is not significantly different from the non-labeled controls. Thus the bacterial viability requirement for infection is met by these bacteria despite their shortened life expectancy. As in other host systems, tumor initiation by *A. tumefaciens* on pinto bean leaves is prevented at 32 C. A 72-hr period at 32 C immediately following infection reduces the number of tumors by about 98%. Interrupting this treatment for varying periods at 27 C shows that tumor initiation can occur in less than 2 hr at the lower temperature. The time of 50% tumor initiation, however, as judged by loss of temperature sensitivity is not reached until 16 hr after inoculation. This time may be shortened to 8.5 hr by pretreatment at 32 C, suggesting that some of the events leading to tumor formation can occur at this temperature. Either the host, the bacterium, or both impose a varying time requirement at individual sites before the event conferring temperature resistance.

10:15 **Recess.**

10:20 **Lipkin, S.,** and **G. L. Hagen.** The Institute for Cancer Research, Philadelphia.—PROTEIN STUDIES ON A TUMOR-FORMING TOBACCO HYBRID AND ITS PARENTS USING IMMUNODIFFUSION TECHNIQUES.—Tumors are spontaneously formed in the tobacco hybrid but parent tissues show no comparable response. In tissue culture an array of additives is necessary for the growth of parental tissues, while hybrid tissues can grow on a basic medium supplemented only with sucrose. This kind of response strongly suggests that the hybrid tissues are able to produce in vivo all of their requirements for growth. This further suggests that the hybrid tissues have the enzyme systems necessary for the biosynthesis of the substances required by the parents. In an attempt to comparatively analyze extracts of hybrid and parent stem tissues and tumor tissue, the Ouchterlony technique of immunodiffusion has been used. The results indicate that, with respect to some proteins at least, the hybrid produces a combination of proteins peculiar to the individual parents. Whether these proteins are critical to tumor inception and growth is being investigated.

10:40 **Doerschug, Marcia R.,** and **Carlos O. Miller.** Indiana University, Bloomington.—CHEMICAL CONTROL OF ADVENTITIOUS ORGAN FORMATION IN LACTUCA SATIVA EXPLANTS.—Both kinetin (6–furfurylaminopurine) and adenine (6–aminopurine) promoted formation of adventitious buds from in vitro cultures of excised cotyledons of *Lactuca sativa*, 'Grand Rapids.' Controls lacking these substances formed abundant roots but never any buds. Inclusion of 0.5 mg/l kinetin in the agar medium containing mineral salts, sucrose, vitamins, and indoleacetic acid readily switched the cotyledon cultures from root to shoot formation. Within 2 weeks many buds were visible over the surface and roots appeared only on the new shoots. When adenine (40 mg/l) was substituted for kinetin, there was at first a proliferation of roots, as on the controls. However, after 3–4 weeks buds started to appear among the roots. Eventually this bud growth became quite extensive. Thus although the pattern of development was different with adenine and kinetin, both brought about regeneration of buds. Indoleacetic acid, ammonium ions, and iron were also essential for shoot initiation. Although cotyledons readily developed shoots under the conditions described, excised root sections displayed a low propensity toward bud formation and typically developed callus tissue with roots. Growth of hypocotyl sections was intermediate with respect to bud formation. Shoot initiation in lettuce thus varied with the region of the seedling as well as with the culture medium. Bud formation from roots could be greatly increased by addition of acid-hydrolyzed casein (3 g/l), but never did 100% of the root sections develop into budding strains.

11:00 **Hackett, Wesley P.,** and **James M. Anderson.** University of California, Los Angeles.—GROWTH OF AXILLARY BUDS ON EXPLANTED STEM SECTIONS OF OLEA EUROPAEA.—Axillary buds on rapidly growing olive shoots elongate forming side-shoots, but on slowly growing shoots the buds are quiescent. Decapitation or defoliation of slowly growing shoots induces elongation of the quiescent axillary buds. When explanted stem sections containing a single bud but no leaves are placed on White's nutrient medium, little elongation of the bud axis occurs and a very short rosetted shoot is formed. Of several growth-regulating substances

tested, only 2,3,5-tri-iodobenzoic acid (10^{-5}M) and p-chlorophenoxyisobutyric acid (10^{-5}M) induced elongation of buds on stem sections. Gibberellic acid at a very low concentration (0.1 ppm) inhibits bud growth and causes callusing of the buds. In combination with tri-iodobenzoic acid, G. A. promotes elongation in short-term experiments but has little effect in longer-term experiments. These results will be discussed in relation to the control of bud elongation on olive shoots.

11:20 **Ahuja, M. R.,** and **G. L. Hagen.** The Institute for Cancer Research, Philadelphia.—CHROMOSOMES AND NUTRITIONAL REQUIREMENTS OF A TUMOR-FORMING NICOTIANA HYBRID AND ITS DERIVATIVES.—The chromosomal basis of tumor formation in the hybrid *Nicotiana glauca* (GG) × *N. langsdorffii* (LL) has been analyzed. The tumorous interspecific triploid carrying two genomes of *langsdorffii* and one of *glauca* (LLG or $9_{II} + 12_I$), derived by crossing the tumorous amphidiploid GGLL to LL, is partially fertile and has been employed in the cytogenetic analysis. Twenty-two % of the derivatives obtained by selfing the triploid (LLG × LLG) were tumorous. The cytological constitution of the tumor-forming derivatives ranged from $9_{II} + 2_I$ to $10_{II} + 8_I$; non-tumorous derivatives ranged from $9_{II} + 1_I$ to $9_{II} + 4_I$. These results show that tumors can develop on hybrid derivatives in the presence of an incomplete *glauca* genome on an LL background. Since the tumor size varies in these derivatives it is postulated that tumor initiation and the enhancement in the growth in size of tumors are two separate phenomena. Whether both male and female gametophytes of GLL contribute critical *glauca* chromosomes to tumor initiation is being analyzed by using reciprocal crosses between GLL and LL. Tissue culture studies of these derivatives indicate that, although tumors develop on some hybrid derivatives in vivo, potential tumor-forming stem tissues from these plants have special nutritional requirements for growth. Generally, plant tumor tissues require minimal additions to a basic inorganic medium. By contrast, tumor potential tissues from GLL require IAA and the tumorous derivatives show varying requirements for IAA, kinetin, vitamins, etc., while non-tumor derivatives are like the LL parent, requiring the further addition of glutamine and nucleic acid precursors.

11:40 **Aronoff, K.,** and **D. J. Niederpruem.** Indiana University Medical Center, Indianapolis.—POLYOL UTILIZATION IN BASIDIOSPORE GERMINATION OF SCHIZOPHYLLUM COMMUNE.—Previous work has shown that while exogenous sugar alcohols do not stimulate ungerminated basidiospore respiration (Niederpruem, 1964), germlings which arise in glucose-asparagine broth show enhanced oxygen consumption by certain polyols including mannitol, even though mannitol dehydrogenase and aldose reductase are already present in basidiospores of *S. commune* (Niederpruem, Hafiz, and Henry, 1965). Additionally, various exogenous polyols fail to sustain spore germination of this mushroom after 30 hr incubation (Gutwein and Niederpruem, 1965). In the present study a more critical evaluation of carbon sources utilized in basidiospore germination of *S. commune* was undertaken. Germination was studied in a defined liquid medium containing $(NH_4)_2SO_4$ supplemented with individual carbohydrates as sole sources of carbon and energy. Microscopic measurements of individual spore lengths among cell populations were compared to turbidity measurements as well as terminal dry weight over a 7-day incubation period at 25 C on a shaker. Carbohydrates active for early germination (i.e., lag phase in turbidity of 18-20 hr) included glucose, while certain sugar alcohols were only active between 30 and 60 hr and included mannitol, sorbitol, ribitol, xylitol, arabitol, erythritol and glycerol. Compounds active between 30-hr and 7-days incubation were lactose, sorbose raffinose, melezitose, trehalose, ribose, melibiose, lyxose and arabinose. Carbon substances completely inactive were galactitol, inositol, succinate, acetate, gluconate, rhamnose and glucosamine. Certain sugar alcohols can, therefore, serve as sole carbon sources for spore germination in *S. commune* under conditions of prolonged incubation.

Session 2. Wednesday Morning. W. M. LAETSCH, *presiding.*

9:00 **Larson, Donald A.** University of Texas, Austin.—INTERRELATIONSHIPS BETWEEN PROTOPLASMIC AND MORPHOLOGICAL STAGES IN MICROSPORE-POLLEN DEVELOPMENT.—Electron microscopic studies of microspore-pollen development in several species has demonstrated that important changes in morphology may occur either non-simultaneously or simultaneously with changes in cytology. Protoplasmic fine structure at meiosis, pollen wall formation and maturity will be discussed along with the problem of non-simultaneous induction of cytological and morphological change.

9:20 **Matzke, E. B.,** and **L. Raudzéns.** Columbia University, New York.—APOSPOROUS DIPLOID GAMETOPHYTES FROM SPOROPHYTES OF THE LIVERWORT BLASIA PUSILLA.—Immature sporophytes are cultured on modified Knop's solution plus 1.5% agar in screw cap tubes in microphytotrons. After a protracted time, when the seta has enlongated and most of its cells have degenerated, certain epidermal and/or inner cells of the seta begin to proliferate to form either a cell mass or a germ tube. From these, thalloid diploid gametophytes develop. As many as 20 or more may arise from a single seta. These are morphologically similar to normal haploid gametophytes, with rhizoids, under leaves, lobes, auricles, discoid gemmae in flask-shaped receptacles, stellate gemmae. Archegonia have also been produced. Cells of haploid plants have nine chromosomes, those of aposporous diploids have eighteen. All of the cultures are maintained aseptically. Several other genera of anacrogynous Jungermanniales have yielded similarly formed aposporous gametophytes.

9:40 **Simone, L. D.** Columbia University, New York.—INDUCTION OF APOSPORY IN SEVEN GENERA OF LEAFY HEPATICS.—Aposporous gametophytes were obtained from the following genera: *Lophocolea heterophylla* (Schrad.) Dum., *Nowellia curvifolia* (Dicks.) Mitt., *Ptilidium pulcherrimum* (Web.) Hampe, *Scapania nemorosa* (L.) Dum., *Radula complanata* (L.) Dum., *Porella pinnata* L., *Jungermannia lanceolata* Schrad. Using the method of Matzke and Raudzēns (1966), developing sporophytes of 11 genera of acrogynous Jungermanniales were excised and planted on agar slants containing Knop's solution. The sporophytes remained green in culture for a time, but eventually turned white. Further progress seems to depend upon specific generic developmental patterns. In most of the genera studied, a cell mass appeared, and later a leafy gametophyte. However, in *N. curvifolia* the appearance of the gametophyte is preceded by a protonema, whereas in *R. complanata* a flattened membranous structure was observed prior to the formation of the leafy plant. In the above listed first five genera, chromosome counts were made of both normal gametophytes and those of sporophytic origin. These were shown to be haploid and diploid, respectively. Comparative studies of haploid and diploid plants are in progress and several differences have been observed. Diploid plants of *L. heterophylla, R. complanata* and *N. curvifolia* have a noticeably slower growth rate than the haploid gametophytes. In *L. heterophylla* the diploid gametophytes are larger than the haploids, branch infrequently and regularly produce antheridia and archegonia. In *R. complanata,* however, the plants are much reduced in size. In contrast to *L. heterophylla* and *R. complanata* the diploid growth of *N. curvifolia* usually consists of loose cell masses. Sometimes short axes bearing juvenile leaves and abnormal rhizoids are formed. No sex organs have been observed on the diploid plants of the latter species, although they occur abundantly in the haploid cultures.

10:00 **Horner, H. T., Jr.** Iowa State University, Ames.—DEVELOPMENTAL ASPECTS OF HETEROSPORY IN THE GENUS SELAGINELLA. A LIGHT AND ELECTRON MICROSCOPE STUDY.—In *Selaginella pilifera* and *S. lepidophylla* there is a consistent arrangement of two rows of microsporangia and two rows of megasporangia in terminal strobili. The sporophylls, each bearing one sporangium, are arranged in a decussate fashion, a convenient arrangement for following the ontogeny (in the same strobilus) of mega- and microspores from the shoot apex to the mature spores. Both types of sporangia differentiate very early into sporogenous cells, a single layer of tapetal cells, and two parietal layers. All of the potential megasporocytes, except one, become vacuolate and lose their ability to stain for RNA. The single functional megasporocyte undergoes meiosis to produce four megaspores. Almost all microsporocytes retain their ability to stain for RNA, and undergo meiosis. Partial cytokinesis occurs at the time of meiosis in the tapetum in both types of sporangia forming a multinucleate coenocyte. The coenocytic tapetum is of the secretory type, stains intensely for RNA, and exhibits abundant endoplasmic reticulum and Golgi bodies. Late in spore development the tapetal protoplasts are dispersed into the locule by a selective disintegration of radial walls. This breakdown of tapetal cells probably supplies the spores with certain reserves. In addition, these cells appear to be the site of sporopollenin precursors, which form the sporopollenin that eventually coats the surface of the mature spores. Changes occur in the organelles of wall, tapetal, and spore cells leading up to spore maturity.

10:15 **Recess.**

10:20 **Lersten, N. R.,** and **H. T. Horner, Jr.** Iowa State University, Ames.—MICROSPOROGENESIS IN CITRUS LIMON. I. A LIGHT MICROSCOPE STUDY.—*Citrus limon* blooms continuously, with each flower producing 20–40 stamens, thus providing ample material to study microsporogenesis. Sporogenous tissue, a tapetal layer, and five wall layers become distinct early in anther development. The tapetum is derived from the outer layer of sporogenous cells. Before meiosis the microsporocytes round up; each develops a thick special wall. This wall extends centripetally following meiosis and eventually separates the former microsporocyte into a tetrad of microspores. Interior to this special wall the exine layer is formed. Later, the intine develops beneath the exine, and appears translucent under light optics. It is generally thinner than the exine, except at pore regions, where it projects to the exterior. At the time of meiosis the tapetal cells stain densely, and their cell walls disintegrate. The tapetal cell protoplasts persist until the exine and intine layers of the microspores are well formed; then they break down completely and appear to give up their contents to the developing pollen.

10:40 **Horner, H. T., Jr.** and **N. R. Lersten.** Iowa State University, Ames.—MICROSPOROGENESIS IN CITRUS LIMON. II. AN ELECTRON MICROSCOPE STUDY.—This work utilized anthers from the same flowers studied with light microscope techniques. At the EM level the object was to re-examine all stages of microsporogenesis in terms of fine structure and to concentrate particularly on these questions: the succession and number of walls laid down by the sporocytes and developing spores; the structure and origin of the mature spore (pollen) wall; the type of cytokinesis (cell plate or furrowing) producing the tetrad; and the relationship of the tapetum to the developing microspores, with special attention to the possible time and mode of transfer of reserves from the tapetal cells to the developing spores.

11:00 **Heintz, C. E., R. A. Jersild, Jr.,** and **D. J. Niederpruem.** Indiana University Medical Center, Indianapolis.—ULTRASTRUCTURE OF GERMINATED OIDIA AND BASIDIOSPORES OF COPRINUS.—Comparative ultrastructural features of germinated oidia and basidiospores of *Coprinus* species were examined in order to define the nature and origin of complex cross-walls in these propagules. Germlings of both oidia and basidiospores possessed cell walls, plasma membranes, well-defined mitochondria, true nuclei enveloped by double-membranes, storage granules and endoplasmic reticulum. Typical complex dolipore septa and associated parenthesomes, often showing continuity with the endoplasmic reticulum, were also prominent in both situations. In the germinated oidia, on the other hand, conspicuous vesicular profiles were also frequently observed between the plasma membrane and the cell wall in the proximity of dolipore septa. These vesicles bear a distinct resemblance to lomasomes (i.e., border bodies) shown by Moore and McAlear (1961) in various fungi and in mesophyll cells of wheat (Manocha and Shaw, 1964). These elements have not been discerned in analysis of cross-wall structure in germinated basidiospores of either *Schizophyllum commune* or *Coprinus* to date.

11:20 **Yoo, B. Y.,** and **S. T. Bayley.** Division of Biosciences, National Research Council, Ottawa, Canada.—STUDIES ON THE SUBSTRUCTURE OF THE PORES IN ISOLATED PEA NUCLEI.—Membranes of nuclei were prepared from dark-grown, 5- to 6-days-old pea seedlings, and osmotically or sonically ruptured. The preparations were then stained with phosphotungstic acid. Thin sections of isolated pea nuclei embedded in Epon resin after fixation in glutaraldehyde and osmium tetroxide were also examined and served as a reference for the negatively stained pore preparations. The center-to-center distance varies from 950 to 1200 A; no regular pattern of pore distribution on the nuclear surface was observed. The diameter of nuclear pores falls in the range of 600–1000 A. There are eight subannuli in the annulus, and central and peripheral granules in the pore. Morphological features of the pore will be discussed and compared with the model suggested by Wischnitzer (J. Ultrastruct. Res. Vol. 1: 201–222, 1958).

11:35 **Yoo, B. Y.,** and **S. T. Bayley.** Division of Biosciences, National Research Council, Ottawa, Canada.—ELECTRON MICROSCOPIC STUDIES ON CHROMATIN FIBRES FROM ISOLATED PEA NUCLEI.—The fine structure of the chromatin fibres was studied with ruptured and whole isolated pea nuclei. The isolated pea nuclei were fixed in glutaraldehyde followed by osmium tetroxide or bismuth solution. The fixation was done in the presence and absence of Ca^{++} ion. For direct examination of the chromatin fibres the isolated nuclei were ruptured by sonic vibration, osmotic shock or repeated freezing and thawing, and then negatively stained with phosphotungstic acid or positively stained with uranyl acetate. It was found that the chromatin fibres constituted the basic units of nuclear organization of the interphase nucleus. Each chromatin fibre consisted of a core 40 ± 10 A in diameter covered by a sheath whose diameter varied widely depending on the method employed for preparation. To study the nature of the material forming the sheath of the chromatin fibres, various extraction procedures, including enzymes, were coupled with electron microscopic observations.

Session 2. Wednesday Afternoon. P. R. MOREY, *presiding.*

2:00 **Gaudet, John J.** State University of New York, Stony Brook, L. I.—THE GROWTH AND DEVELOPMENT OF ISOLATED LEAVES OF MARSILEA VESTITA.—The three youngest leaves were excised from sterile-cultured 30-day-old *Marsilea* plants and placed on nutrient agar or in liquid nutrient media. These excised leaves do not elongate as much nor do they live as long as comparable leaves left intact on the plant. A number of factors affect the final

length of the excised leaves, for example, temperature, photoperiod, age, growth regulators and type of medium. The most significant elongation occurred when indoleacetic acid was added to the medium, and this fact correlates very well with the work of others which shows IAA auxin to be a normal constituent of this plant. The life of the excised leaves was extended to 22 days by fortifying the medium with coconut water. Other organic substances such as yeast extract, casein hydrolyzate, and hexitols did not affect the leaves and light was found to actually shorten their life span.

2:20 **Hawkins, Eva Konrad.** The New York Botanical Garden, Bronx, N. Y.—INDUCTION OF CELL DIFFERENTIATION FROM DISSOCIATED CELLS AND FRAGMENTS OF CALLITHAMNION ROSEUM.—Branching in *Callithamnion roseum* regenerates is essentially a phenomenon of cellular differentiation. Starting from single cells or cell filaments, it involves a gradual morphological change in cell types: from parallel-walled branchless stalk cells to oblique-walled branch-bearing main axis cells of the young regenerate. The same morphological transition is now reported in germinating tetraspores of this plant, originating from diploid regenerates in non-axenic continuous cultures. Development of a plating technique allows one to study frequencies of induced branching in populations of regenerating, diploid, dissociated cells and fragments. The role of cell and/or fragment number, of dispersion of cells and/or fragments, "feeder" cells, and of "conditioned" medium has been investigated in inducing branching in artificial sea water media. Branch initiation is promoted in the presence of adenine. Developmental potentialities of some cell and fragment types will be considered in relation to the pattern of uptake and intracellular distribution of H^3–adenine.

2:40 **Torrey, John G.** Harvard University, Cambridge, Mass.— CELL DIFFERENTIATION IN VITRO.—Stem callus tissues of *Centaurea cyanus* were grown on complex and defined nutrient media in solidified and liquid cultures. Differentiation of tracheid-like xylem elements in the cell population was studied under a variety of physical and chemical environments. *Centaurea* callus tissue is of special interest since under certain conditions almost all of the callus cells differentiate into xylem elements. Work with root callus tissues of *Pisum sativum* and *Convolvulus arvensis* will also be reported. Present evidence concerning the role of the physico-chemical environment in initiating xylem differentiation will be reviewed.

3:00 **Fosket, D. E.,** and **J. P. Miksche.** Brookhaven National Laboratory, Upton, N. Y.—THE ROLE OF THE WOUND IN CALLUS INITIATION FROM CARROT TAPROOT PHLOEM EXPLANTS CULTIVATED IN VITRO.—Explants of carrot taproot phloem were cultured on either callus-forming medium (HW) or non-callus-forming medium (H4). At isolation and at daily intervals after isolation, explants were incubated 2 hr in H^3–thymidine (2μc/ml) in 2% sucrose and radioautographs were prepared. During the first 2 days of culture there was no significant difference in the numbers of labeled nuclei in the wound region (within 6 cells of the surface) between explants cultured on H4 and HW media. On H4 medium the frequency of labeled nuclei in the wound region increased during the first 2 days of culture and decreased thereafter. The frequency of labeled nuclei in the wound region of the HW explants continued to increase throughout the 4-day experimental period. The frequency of nuclei incorporating thymidine in the interior of the explants was approximately a tenth that of the wound region. In order to determine the effect of wound healing on the ability of explants to form callus, explants were isolated on H4 medium and transferred to HW medium after various intervals of time. A progressive loss of ability to form callus after transfer back to HW medium was observed, and explants cultured 12 days on H4 medium before transfer to HW did not form callus. However, callus-forming ability was restored when the explants were again wounded.

3:15 **Recess.**

3:20 **Jacobs, W. P.,** and **I. B. Morrow.** Princeton University, Princeton, N. J.—A NEW LOCUS OF SIEVE-TUBE DIFFERENTIATION.—Quantitative methods, with round-the-clock collecting of large samples, have uncovered an isolated locus of sieve-tube differentiation in young *Coleus* leaves. When the leaf is small (1–350μ), there are no sieve-tubes in the primordium itself, but sieve-tubes are differentiating acropetally in the two traces to the leaf. Fitting a regression line to the data shows, however, that sieve-tube differentiation in the traces is falling steadily farther behind the elongation of the leaf. Our previous work (1958) showed that leaves more than 500μ had sieve-tubes close to their tips. Obviously, some process must occur which reverses the early trend of *increasing* distance of sieve-tubes from the leaf tip. An intensive search of leaves of the intermediate lengths revealed that an isolated locus of sieve-tube differentiation occurs in leaves of a specific and narrow range of lengths (387–459μ). These relations were reproducible year after year. Every plant which had discontinuous strands of sieve-tubes in the second leaf-pair had discontinuous xylem in the third. This isolated locus, which is unexpected because of the often reported "continuous and acropetal" course of sieve-tube differentiation, was probably not seen before because of small sample-sizes and collections restricted to daytime. We found it mostly in night collections.

3:40 **Arnott, H. J.,** and **M. Dauwalder.** The University of Texas, Austin.—CRYSTALS IN XYLEM DEVELOPMENT IN MAIZE ROOT TIPS.—The development of cell lineages of the *Zea mays* root tip have been followed. The use of glutaraldehyde and glutaraldehyde-acrolein mixtures with osmium post-fixation has allowed the definition of structures which are characteristic only of the cells in the development of certain xylem elements (probably small vessel elements). In these cells crystals, most probably organic, are contained in double-membrane-bound organelles. At this time it is impossible to distinguish whether these organelles are of plastid or mitochondrial origin. Observation of divergent lattice parameters indicate that there may be at least two types of crystals present. The initiation of crystal development has not been observed; however, in the later stages of xylem development both types of crystals can be observed free in the cytoplasm while some remain membrane-bound even after fairly advanced breakdown of the protoplast. Stages in the breakdown of the organelles which release the crystals were commonly seen. The vessel elements are otherwise characterized by high Golgi apparatus activity, microtubules along the cellular periphery, and multilobed or fragmented nuclei.

4:00 **DeMaggio, A. E.** Dartmouth College, Hanover, N. H.—INDUCED PHLOEM DIFFERENTIATION IN WHITE PINE.—Physiological studies have demonstrated that auxins, sugars, or gibberellins may be limiting for the induction and differentiation of phloem in certain species of plants. To further evaluate the activity of various growth regulators, singly and in combination, in phloem differentiation, explants from dormant branches of white pine (*Pinus strobus* L.) were utilized. Sterilized segments consisting of secondary xylem, cambial zone, and secondary phloem were removed and sterilized micropipettes were inserted into the soft tissue of the cambial zone. The segments were placed in test tubes and supported on an agar-hardened nutrient medium. Solutions to be tested for their ability to induce phloem differentiation were supplied to the dormant cambial zone via the micropipette. Differentiating sieve cells in pine are easily recognized by their characteristic birefringence when examined in polarized light and therefore any treatment which stimulates phloem differentiation can be determined conveniently using this method of examina-

tion. Among the growth regulators tested, gibberellic acid solutions (10 and 100 ppm) were found to stimulate changes in the cambial zone when sectioned segments were examined. Immature sieve cells, components of the overwintering cambial zone, expand radially and exhibit cytological changes usually associated with spring maturation. Differentiation of sieve cells continues in response to gibberellic acid treatment and the increased number of cells can be quantitatively determined by polarized light examination. The contribution of auxins and sugars to phloem differentiation in white pine also will be discussed.

4:20 **Morey, P. R.,** and **J. Cronshaw.** University of California, Santa Barbara.—THE CONTROL OF THE DIFFERENTIATION OF CAMBIAL DERIVATIVES OF ACER RUBRUM BY VARIOUS AUXINS.—The auxin antagonist 2,3,5,-tri-iodobenzoic acid can be used to alter the differentiation of the cambial derivatives of *Acer rubrum* and it has been suggested that this effect is mediated through the control of auxin level. The effect of auxins in varying concentrations on the *Acer rubrum* system has been studied. The xylem formed during treatment with high concentrations of either naphthaleneacetic acid (NAA) or 2,4–dichlorophenoxyacetic acid (2,4–D) is characterized by the presence of libriform fibers and groups of densely pitted relatively narrow tracheary elements with a conspicuous angular appearance in transverse section. The initiation of groups of tracheary elements from the fusiform initials may be specifically correlated with high auxin levels in the vascular cambium. In response to application of relatively low levels of indole–3–acetic acid, NAA or 2,4–D, the rate of cambial activity in the stem below the treatment site is markedly accelerated and a thick ring of tension wood is differentiated from the cambial derivatives. This tension wood is characterized by the presence of a moderate number of wide tracheary elements in addition to tension wood fibers. A thick ring of tension wood, characterized by the presence of a number of wide tracheary elements, can also be induced by treatment of seedlings with 2,4–dinitrophenol. The possibility exists that more than one mechanism may be operable in the control of the differentiation of tension wood fibers from the cambial derivatives.

4:40 **Morey, P. R.,** and **J. Cronshaw.** University of California, Santa Barbara.—THE EFFECT OF GIBBERELLIC ACID AND OTHER GROWTH REGULATORS ON THE DIFFERENTIATION OF THE CAMBIAL DERIVATIVES OF ACER RUBRUM.—Tension wood fibers with a characteristic cell wall structure can be induced to differentiate on the upper side of stems and branches by bending them from their normal orientation positions. In upright seedlings of *Acer rubrum* a complete but rather thin ring of tension wood fibers is differentiated in the secondary xylem in response to 2,3,5-triiodobenzoic acid (TIBA) treatment. In response to simultaneous application of TIBA and gibberellic acid (GA), the rate of cambial activity in the stem below the treatment site is markedly accelerated and frequently a thick ring of tension wood fibers is differentiated from the cambial derivatives. With this treatment the initiation of tracheary elements from the fusiform initials is reduced and in some seedlings almost completely eliminated. In an additional series of experiments TIBA and GA were applied to internodes of *Acer rubrum* seedlings simultaneously with one of two auxins, indole–3–acetic acid (IAA) or naphthalene acetic acid (NAA). The xylem formed during TIBA-GA-auxin treatment is frequently characterized by the presence of many groups and tangential bands of densely pitted, relatively narrow tracheary elements. Application of IAA or NAA with TIBA and GA markedly inhibits the differentiation of tension wood fibers from the cambial derivatives. In the *Acer* system GA appears to control the rate of cambial activity. On the other hand control of the pattern of differentiation of the cambial derivatives appears to be mediated through an auxin level mechanism.

Session 1. Thursday Morning. WALTER TULECKE, *presiding.*

9:00 **Ball, Ernest,** and **P. C. Joshi.** North Carolina State University, Raleigh.—ADVENTIVE EMBRYOS IN A CALLUS CULTURE OF DIDISCUS COERULEA.—Callus produced in vitro from surface-sterilized stem segments upon agar slants of complex medium containing coconut water, 2,4–D and sucrose developed numerous adventive embryos. Some of them occasionally broke loose and fell to the bottom of the culture tube. Embryos retained within the callus often germinated to produce elongate seedlings with basal roots and leaves of the mature type. Those cast loose from the callus frequently underwent callusing to such a degree that the form of the embryo was obscured by the overgrowth. Conversely, certain callus cultures produced embryos in such great numbers that little or no growth of callus remained. The auxin used appeared to control embryo formation; they were numerous upon medium containing 2,4–D, but few or none at all on that with 2,3,5–T. The callus culture upon 2,4–D has been transferred five times at monthly intervals without apparent diminution in production of embryos.

9:20 **Ball, Ernest,** and **P. C. Joshi.** North Carolina State University, Raleigh.—EFFECT OF GIBBERELLIC ACID UPON ISOLATED TOBACCO CALLUS CELLS.—Tobacco callus during the first three monthly transfers upon complex agar medium produced, when shaken in liquid medium, living isolated cells with abundant streaming cytoplasm that are capable of division and growth. In subsequent transfers such shaken-off cells were cytologically aged and had progressively decreased amounts of cytoplasm with practically no streaming. Many were either dying or dead. Aging of the callus thus appears concomitant with a lessening of growth by single cells and a tendency to growth as a multicellular organism. When the liquid medium contained an appropriate concentration of gibberellic acid, the released cells of aged lines had abundant streaming of cytoplasm and were capable of division. Old lines which had not produced viable single cells for more than two years were thus rejuvenated. A probably important effect of gibberellic acid here was the stimulation of production of cytoplasmic protein.

9:40 **Venketeswaran, S.** University of Houston, Houston, Texas.—EFFECT OF GROWTH FACTORS ON CHLOROPHYLL SYNTHESIS IN CALLUS TISSUE OF AN ALBINO MUTANT OF TOBACCO.—Somatic cells of an albino mutant of tobacco have been maintained as proliferated callus cultures in completely defined salt-sucrose medium supplemented with indoleacetic acid (IAA), or IAA + kinetin, or IAA + 2,4–dichlorophenoxyacetic acid (2,4–D), all at 1×10^{-6} M. Large patches of chlorophyllous areas appeared in cultures growing in media with IAA or IAA + kinetin under very diffuse light (200–540 lux). Such chlorophyllous areas when isolated and grown continued to remain green. Spectrum analysis of these cultures revealed a similar a:b ratio and total chlorophyll:carotenoid ratio to the normal green leaf. The chlorophyllous tissues responded differently to these growth factors in further subcultures. Continued maintenance in an IAA + kinetin medium produced compact and hard growth, and the tissues remained completely chlorophyllous with maximum pigment contents. Transfer to an IAA medium produced less pigments. When transferred to an IAA + 2,4–D medium, after two subcultures, the cultures did not show any visible detection of pigments. The tissues appeared white and friable and the cells were highly vacuolated with high water content. Clones from single cells or small cell aggregates obtained by plating techniques or by filter paper nurse-tissue techniques retained their chlorophyllous nature in IAA or IAA + kinetin medium. The instability of chlorophyll synthesis in this mutant appears to be influenced by the nature of the

growth factors in the culture medium in which the cells are growing.

10:00 **Laetsch, W. M.** University of California, Berkeley.—CHLOROPHYLL SYNTHESIS IN CULTURED TOBACCO LEAF TISSUE.—Previous work has shown that tobacco callus has lower chlorophyll levels than leaves and that chlorophyll synthesis in the callus is dependent upon specific components in the medium. Leaf fragments have been cultured in an attempt to ascertain if similar factors are involved in chlorophyll synthesis in leaf cells. Dark-grown tobacco leaves can be obtained from lateral buds of plants which have been decapitated and placed in the dark. Entire dark-grown leaves or leaf explants of various sizes can be sterilized and cultured. The cultures can be kept in the dark for long periods or placed in the light. The rate of chlorophyll synthesis is related to the age of the dark-grown leaf, to the size of the explant, and to the time the explants are cultured in the dark. Growth regulators and nutrients influence chlorophyll synthesis in the explants and the nature of this regulation will be discussed.

10:15 **Recess.**

10:20 **Tulecke, Walter.** Boyce Thompson Institute, Yonkers, N. Y.—PORPHYRIN SYNTHESIS IN TISSUE CULTURES OF HIGHER PLANTS.—Protoporphyrin is formed from δ-aminolevulinic acid (ALA) by tissue cultures derived from the pollen of *Ginkgo biloba* L., stems of *Rosa* sp., and the pollen of *Taxus* sp., all of which lack chlorophyll. Protoporphyrin can be detected after 3–6 hours' incubation with the acid. Activity is localized in the plastids, but some porphyrins later accumulate in the cytoplasm; no porphyrins are found in the controls without ALA. Absorption spectra and paper chromatography of tissue extracts indicate that protoporphyrin is the main compound formed. No evidence of magnesium insertion into the tetrapyrrole was found, but uroporphyrin and coproporphyrin intermediates were detected in some extracts. These results will be discussed in relation to plastid function in tissue cultures of higher plants.

10:40 **Joshi, P. C.,** and **Ernest Ball.** North Carolina State University, Raleigh.—GROWTH VALUE AND REGENERATIVE CAPACITY OF MESOPHYLL OF ARACHIS HYPOGAEA GROWN AS CALLUS ON AGAR MEDIUM.—Mesophyll cells excised from leaflets grew as shake cultures in Heller's minerals, sucrose, several vitamins, inositol, sorbitol, acid-hydrolyzed casein, glutamine, 2,4-D, and kinetin into green spheres (1–10 mm diam) of compact, small-celled tissue. On the basis of one month of growth, and a starting fresh weight of 0.6 mg, these cultures showed a growth value of 404 (final fresh weight divided by initial fresh weight). This growth value is far greater than others reported by previous investigators of callus cultures (highest given are the 143 of Murashige and Skoog and the 244 of Linsmaier and Skoog, both for tobacco), and may depend, in part, on a demonstrable ability of the tissue to grow in vitro by its own photosynthetic ability. It is noteworthy that this value has been achieved on medium without coconut water; indeed, our tentative uses of this liquid endosperm have resulted in failure of growth. This kind of growth in shake cultures could be continued either by transferring entire spheres, or divided spheres, to new liquid medium. However, correlated with the rapidity of growth in the shake cultures, and the small-celled nature of the tissues, there was never regeneration of organs. When the spheres were transplanted to agar medium with the components of Linsmaier-Skoog to which were added acid-hydrolyzed casein or glutamine, the tissue grew much more slowly, producing a loosely arranged, relatively larger-celled mass. The growth value here, if the weight of the sphere was considered the inoculum, was 32. Correlated with its slow growth and large-celled nature, the callus grown on the agar medium has frequently shown from one to several adventitious roots per mass. No buds, however, have yet been observed.

11:00 **Stoutemyer, Vernon T.,** and **O. Kenneth Britt.** University of California, Los Angeles.—VARIABILITY IN TISSUE CULTURES OF ENGLISH IVY, HEDERA HELIX L.—Tissue cultures from adult stems of English ivy transferred at monthly intervals over a period of two years were stable in rate of growth. Occasionally however, sectors of translucent tissue were observed on the agar medium at the edges of normal cultures. When new cultures were started from these sectors they were found to grow more rapidly than cultures from the normal portions of the parent culture. These variants resembled cultures from young seedlings in rapidity of growth. They were also found to have different nutrient requirements from the original cultures. Coconut water was no longer required if an auxin (NAA) was present in the agar medium. With coconut water, they could be grown without auxin. These variants grew more rapidly with kinetin, but kinetin alone did not substitute for coconut water or auxin. The cells of the variant types differed in appearance from those of the parent cultures, producing large or elongated cells.

11:20 **DeMaggio, A. E.** Dartmouth College, Hanover, N. H.—BIOCHEMICAL AND MORPHOLOGICAL DIFFERENTIATION IN A HAPLOID TISSUE CULTURE OF LYCOPODIUM.—Sterilized spores of *Lycopodium obscurum* germinated on a simple nutrient medium produce a mass of undifferentiated tissue rather than the expected gametophytes (Freeberg, 1959). When transferred at monthly intervals to a medium supplemented with 4% sucrose and 10% coconut milk, maintained at 25 ± 2 C, and provided daily with 12 hr of illumination, the tissue proliferates slowly resembling undifferentiated callus cultures from higher plants. However, buds, and less often roots, develop from the nodular tissue masses when stimulated by the addition of appropriate chemicals. To date, sucrose (0.1, 0.4, and 1%) and autoclaved coconut milk (5 and 10%) singly and in combination have been found to be the most effective agents for inducing the differentiation of organs. Buds originate haphazardly from centers of mitotically active tissue and slowly assume the characteristic morphology of the young sporophyte. Cytological examination revealed that the experimentally initiated sporophytes retain the haploid chromosome number characteristic of the gametophyte callus. Results from experiments employing a variety of "bud-stimulating" chemicals illustrate that morphological differentiation of the sporophyte in this species can be stimulated by the chemical environment and proceeds without a change in chromosome number. To determine whether gross biochemical changes accompany a shift from haploid to diploid condition, an examination was made of secondary metabolic products found in *Lycopodium*. Although sporophytes of *Lycopodium* are known to elaborate a number of specific alkaloids, there are no data to indicate that gametophyte tissue forms the same metabolis products. An examination of extracted materials revealed that gametophyte tissue (haploid) of *Lycopodium* is capable of synthesizing many of the same alkaloids usually found in the sporophyte. These findings are interpreted to demonstrate that haploid plant cells retain the inherent totipotency for biochemical as well as morphological differentiation.

11:40 **Norstog, K.** University of South Florida, Tampa.—INFLUENCE OF NUTRITIONAL AND PHYSICAL FACTORS ON GROWTH OF CULTURED BARLEY EMBRYOS.—Cultures of excised embryos (0.2–1.2 mm) and proembryos (0.1–0.2 mm) were made on synthetic media in which concentrations of inorganic and organic components were varied, and the effects of light, darkness, temperatures and O_2 were studied. Growth of 0.3–1.2-mm embryos on a synthetic medium (medium A, based on White's minerals, containing autoclaved organic components: vitamins, glutamine 400 mg/

liter, alanine 400 mg/liter, five other amino acids at 60 mg/liter total concentration, 9% sucrose, malic acid, 0.9% agar), at pH 4.7–4.9, and in darkness at 25 C, compared favorably with natural growth rates. However, survival of embryos smaller than 0.3 mm was not satisfactory. Media containing filter-sterilized amino acids and vitamins (medium B) produced better growth of 0.3–1.2-mm embryos but did not affect survival of smaller embryos. Addition of kinetin (0.05 mg/liter) and 2,4-D (0.01 mg/liter) to medium B did not appear to affect growth rate but may have induced formation of observed additional shoot apices. Increase of K+ by 5- to 15-fold, noticeably increased survival of smaller embryos. Addition of ammonium malate (medium C), instead of malic acid, produced increased growth of scutellar tissue. "Aged media" (i.e., 3–5 days post-autoclaving) also proved to increase survivability rate of smaller embryos. Filter-sterilizing all organic components (with exception of agar) seemed to eliminate need for "aging" the medium. Growth at 20, 25, 30, 37 C occurred and was greatest in 25-30 range. Embryos cultured on B in N_2 atmosphere did not grow although growth occurred in low O_2 concentrations. Light produced greatly elongated scutella in embryos on medium C, and prevented "germination" of cultured embryos, as contrasted to "germination" and reduced scutellar growth of embryos maintained in darkness. Cultured embryos grown to normal "full-term" size in light were removed from media, desiccated, returned either to starch-agar or glucose agar and germinated, thus duplicating, in a sense, the natural embryonic growth, dormancy-desiccation and germination cycle.

Session 2. Thursday Morning. S. N. Postlethwait, *presiding.*

9:00 **Hayat, M. A.** North Dakota State University, Fargo. —Ultrastructure of leafy spurge root apex—Root apices of 2-cm-long seedlings were fixed in $KMnO_4$ as well as in GA–OsO_4. The nuclear membrane of the cells in the developing cortex showed numerous connections with the endoplasmic reticulum. The endoplasmic reticulum at its edges forms relatively large membrane-bounded vesicles which become detached and scattered throughout the cytoplasm. After separation these vesicles move and gather along the plasma membrane. On coming in contact with these vesicles the plasma membrane continuity appears to be temporarily disrupted. Thus the vesicles pass through the plasma membrane while retaining their membrane. This assumption is based on the fact that membranes were discernible around some of these vesicles after their passage through the plasma membrane. The vesicular swellings of the endoplasmic reticulum at its entire length were found to be in contact with the cell wall so that a direct connection is established between the wall material and the content of the endoplasmic reticulum. The membrane-bounded vesicles formed by the Golgi cisternae were comparatively dense and small in size. These vesicles also move and accumulate into pyramid- or dome-shaped masses along the cell wall. It is not certain at this stage whether these vesicles retain their membranes while passing through the plasma membrane or their membranes are incorporated into the plasma membrane. The formation of vesicles by endoplasmic reticulum as well as by Golgi cisternae was most pronounced in the cells undergoing rapid wall growth. The exact role of the associations of the wall material with the contents of the vesicles in the growth of the primary cell wall is not yet clear.

9:20 **Wilson, B. F.** Cabot Foundation, Harvard University, Petersham, Mass.—Mitotic activity in the cambial zone of Pinus strobus L.—Description of a technique for measuring mitotic activity from samples. Application of the technique to girdling experiments. Interpretation of results in terms of the control of cambial activity.

9:40 **Stebbins, G. L.,** and **Peter Jura.** Department of Genetics, University of California, Davis.—Differential synthesis of nucleic acids as a result of asymmetrical mitoses in the leaf sheath epidermis of barley.—Application of thymidine H^3 to developing leaf sheaths of barley at the time when asymmetrical mitoses are taking place and at various later stages showed that the nuclei of the larger cells which differentiate into normal epidermal cells do not incorporate thymidine, and measurements of nuclear DNA content at various stages after the final asymmetrical mitoses indicate that DNA content is not doubled at all in these cells. The short cells which later differentiate into siliceous-suberous pairs do not incorporate thymidine until just before they are ready to divide. An exception to the lack of replication in the nuclei of large cells occurs when these cells are immediately adjacent to a guard cell mother cell of the stomatal row at a stage just before subsidiary cells are formed. Under these conditions the nuclei of the long cell actively incorporate thymidine up to and into mitotic prophase, then divide to give rise to subsidiary cells. This indicates that GCMC's are the source of a stimulus which induces DNA replication and mitotic division in the nuclei of cells immediately lateral to them. Uridine incorporation takes place in the nuclei of both the long and the short cells produced by asymmetrical mitoses, but the timing and rate of incorporation are different. The significance of these results is discussed.

10:00 **Van't Hof, J.** University of Minnesota, Minneapolis.—Comparative studies on the relationship between cell population and growth kinetics and the parameters of the mitotic cycle of several plant root meristems.—The rate of root growth is a reflection of the average rate of cell proliferation and the average increase in cell size from birth to maturation. Therefore, it is possible to observe equal root growth rates in two different species which have a different mitotic cycle duration, a different number of proliferating cells and a different average cell size providing these variables are compensatory. The present experiments were performed with three varieties of *Pisum sativum* (Alaska, Weitor, and Witham Wonder), *Helianthus annuus* and *Vicia faba.* The duration of the mitotic cycle, DNA synthesis (S period), pre-DNA synthetic period (G_1), post-DNA synthetic period (G_2) and mitosis were measured by simultaneously marking meristematic cells with colchicine and H^3–thymidine. Autoradiography was used to distinguish the cells labeled with H^3–thymidine. The number of proliferating cells was estimated mathematically from cell population kinetic data and cell counts; the growth rate was measured once daily with a ruler. The results indicated that the mitotic cycle, S, G_1, G_2 and mitotic duration were very similar in all varieties of *Pisum* and that the number of labeled cells, root growth rate, and rate of cell proliferation differed. *Helianthus* roots had a mitotic cycle duration like that of *Pisum,* and unusual growth rate and a lower rate of cell proliferation. *Vicia,* on the other hand, had a longer mitotic cycle and S duration even though root growth rate and the rate of cell proliferation were similar to that of *Pisum.* These experiments indicated that the mitotic cycle and S period are a function of cellular DNA content and that neither cycle duration nor root growth rate nor cell counts nor mitotic indices exclusively measure the proliferative capacity of a tissue, but rather the combination of all four parameters is necessary for a proper estimation.

10:20 **Stewart, R. N.** U.S.D.A., Plant Industry Station, Beltsville, Md.—The contribution of five independent histogenic layers to the stem and leaf of English ivy.—Observation of plastid variegations in English ivy indicated there was tissue from five independent histogenic layers in the stem and leaves. One cultivar contained normal green plastids except in cells from the second histogen which carried only colorless plastids (GWGG). The leaves had a narrow white edge and the stems were reddish-green.

In several branches the second histogenic layer replaced the third layer (GWWG). On these branches the leaves were mostly white with only a reduced green area along the midrib. The stems were reddish-green. Several shoots of GWWG composition have given rise by replacement to GWWW branches whose leaves were white and stems red. Microscopic examination of fresh sections of the different variegations indicated five separate layers are often included in leaf formation. In another ivy cultivar a defective plastid type was found in tissue from the third histogenic layer. Apparently a diffusible substance from the defective plastids prevented development of pigment in plastids in adjacent cells so that a large central portion of the leaves on the GGW-- shoots were yellow, as were the stems. Some branches became GGGW- by replacement and the leaves showed only a small yellow area near the midrib and the stems were yellow. By further replacement an occasional GGGW- branch changed to GGGGW. The leaf blades were entirely green but the stems were red. Green stems on a few branches from the GGGGW shoots indicated further replacement had given rise to GGGGG branches.

10:40 **Recess.**

10:45 **Hayat, M. A.** North Dakota State University, Fargo. —THE QUIESCENT CENTER IN ROOTS OF EUPHORBIA ESULA L. —Primary roots of various developmental stages were examined, and several specimens of each developmental stage were used to ascertain whether or not any variations occurred. In the primary roots of a certain developmental stage the central cylinder, cortex and cap-epidermis have separate initial cells and the boundary between these histogens is fairly rigid. A hemispheric-shaped quiescent center is present and its size and degree of quiescence varies at different developmental stages of the root. When safranin-hematoxylin combination was used, the staining reaction of the ground substance of the cytoplasm as well as the nucleus in the cells of the quiescent center is different from that seen in the surrounding cells. The relatively deeply stained quality of the cells surrounding the quiescent center indicates that these cells are meristematic and are preparing for division. Feulgen reaction confirmed that the amount of DNA per nucleus in these cells is considerably less than that observed in the surrounding cells. This center is most prominent only at certain stages of development during the life of a root. The center at its maximum size contained approximately 40 cells. The cells in this center rarely divide and have definitely fewer and smaller nucleoli than the immediate surrounding cells. This indicates that relatively small amounts of RNA and proteins per cell are synthesized. However, some mitotic figures are seen in this center during the development of early lateral roots indicating that these cells function as a reserve.

11:05 **Williams, A. F.,** and **S. N. Postlethwait.** Purdue University, Lafayette, Ind.—STUDIES OF DEVELOPMENT IN MAIZE MUTANT, POLYTYPIC (PT).—The semi-dominant gene, Polytypic, affects ear and tassel development in a variety of ways, the most common of which is proliferation of sterile pistillate tissue from the lower, normally aborted floret of ear spikelets, and from the normally inactive pistil primordium of tassel florets. During the course of development, ear, tassel, and other tissues from mutant and normal sib plants have been compared using several methods including paper chromatography, disk electrophoresis, and immunoelectrophoresis in an attempt to detect biochemical differences which may be significant in development of the mutant.

11:25 **Gelinas, D. A., S. N. Postlethwait,** and **L. F. Bauman.** Purdue University, Lafayette, Ind.—DEVELOPMENTAL STUDIES IN THE ZEA MAYS MUTANT CLUMPED TASSEL (CT).—The morphological development of the maize mutant clumped tassel (Ct) is described. Preliminary linkage studies indicate that the dominant mutant gene is located on chromosome 8. Expression of the mutant gene results in alterations at several points in the normal developmental sequence of the tassel. Mature mutant plants exhibit varying degrees of dwarfing. Reduction in stature results from reduced internode elongation rather than a reduction in the number of nodes. The mutant tassel shows a reduction in the total number of spikelets produced. Individual staminate flowers, however, frequently show a proliferation of floral structures. Preliminary investigations with applied growth regulators and at the biochemical level are in progress.

11:45 **Hecht, Adolph.** Washington State University, Pullman.—INACTIVATION OF INCOMPATIBILITY.—Self-incompatibility in the genus *Oenothera* has proved stable to bud pollination and late season pollination. In previously reported experiments my students and I have demonstrated the breakdown of the incompatibility reaction in two species of *Oenothera* by exposure of the stigmas and styles to sublethal temperatures prior to pollination. By ultraviolet treatment of the tissues of one of these species we have obtained a similar breakdown of incompatibility. When styles were self-pollinated immediately after the high-temperature treatments, an appreciable improvement in compatibility was observed, but pollen tube growth was still considerably less vigorous than that observed following compatible pollinations. When pollination with otherwise incompatible pollen was delayed 24 hr, pollen tube growth was observed to compare favorably with that of genetically compatible pollinations. We have assumed that the heat treatment triggered the breakdown of a hypothetical incompatibility substance, but that its complete inactivation requires a number of hours to reach completion. The fact that styles stored at essentially room temperatures (27 C) showed this response, whereas those kept in a refrigerator (4 C) for the 24-hr period showed little if any difference in incompatibility from their response immediately after the heat treatment, has led us to conclude that the degradation of the incompatibility substance probably involves a chemical change. We hope to be able to show some of the chemical differences before and after the 24-hr period following treatment in an attempt to relate these differences to the vastly changed response to the growth of selfed pollen tubes.

12:05 **Ascher, Peter D.** University of Wisconsin, Madison.—A GENE ACTION MODEL TO EXPLAIN GAMETOPHYTIC SELF-INCOMPATIBILITY IN FLOWERING PLANTS.—A workable model to explain the mechanism of the gametophytic type of self-incompatibility reaction in flowering plants can be constructed from the Jacob-Monod regulator-operon model for gene action. The incompatibility (S) alleles fulfill the role of regulator genes governing two systems of operons within the pollen tube which control pollen tube metabolism. One operon concerns a metabolism using pollen reserves and simple stylar components and results in the limited growth characteristic of incompatible pollen tubes; the second involves utilization of a different metabolic path and yields the high-velocity growth typical of compatible tubes. The product of the stylar regulator genes, a monomer, moves into the pollen tube where it meets the monomer product of the pollen regulator gene. Similarity of monomers results in a functional dimer repressor which inhibits the high growth rate operon. Continued functioning of the low-velocity growth system until pollen reserves have been depleted yields an inhibited pollen tube. No repressor forms when monomers are different. The presence of proper stylar substrates induces the high-velocity growth system into operation resulting in a compatible pollen tube. Evidence supporting this model may be had from several lines of experimentation in *Lilium longiflorum.*

GENERAL SECTION

Session 2. Monday Afternoon. W. F. MILLINGTON, *presiding.*

2:00 **Kozlowski, Theodore T.,** and **Ray F. Evert.** University of Wisconsin, Madison.—EFFECT OF PHLOEM BLOCKS ON CAMBIAL ACTIVITY OF POPULUS TREMULOIDES.—Studies were made of cambial activity of *Populus tremuloides* following phloem interruption during the dormant season and at various times during the growing season. Phloem blocks were applied by isolating patches of bark (cambium plus external tissues) in the lower stem by cutting concentric circles 4 and 4.5 inches in diameter into the xylem and removing all tissues between the two circles. When phloem blocks were applied during the dormant season (November, February, or March) cambial activity and phloem differentiation took place in the spring in the isolated tissues. However, xylem differentiation did not occur. If phloem blocks were applied after cambial activity was initiated, secondary wall formation ceased prematurely in both xylem and phloem. The first formed xylem elements of such an increment had secondary walls of normal thickness. Cells formed subsequently had progressively thinner secondary walls, and most of the last formed cells (parenchyma strands) lacked secondary walls. Interspersed among the parenchyma strands were short vessel elements with walls of normal thickness. Following phloem severance all of the cells of the cambial region eventually were subdivided anticlinally. This phenomenon took place whether the phloem blocks were applied during the dormant or growing seasons.

2:15 **Tamulevich, S. R.,** and **R. F. Evert.** U.S. Forest Products Laboratory and University of Wisconsin, Madison.—ASPECTS OF SIEVE ELEMENT ULTRASTRUCTURE IN PRIMULA OBCONICA.—The mature, enucleate sieve element of *Primula obconica* is lined with a parietal layer of cytoplasm consisting of plasmalemma, one or more cisterna-like layers of endoplasmic reticulum, numerous mitochondria and plastids, and a membrane which apparently separates these cytoplasmic components from a large central cavity. The central cavity contains numerous longitudinally oriented slime tubules. We believe these tubules normally form strands which run the length of the cell and traverse consecutive cells through the sieve-plate pores. Developmental aspects will be discussed

2:30 **Davis, J. D.,** and **R. F. Evert.** University of Wisconsin, Madison.—PHLOEM DEVELOPMENT IN CELASTRUS SCANDENS.—Studies based on collections made over a 1-year period (November 1964–December 1965) reveal that no functional sieve elements overwinter in the phloem of *Celastrus scandens.* The first functional sieve elements and companion cells of a new growing season differentiate in late April from sieve-element and companion-cell precursors which overwintered on the outer margin of the cambial zone. Soon after, cambial activity (division) begins and gives rise to new phloem and xylem initials. In most stems about ⅔ of the new phloem increment is laid down by the time early-wood formation is completed. Phloem and xylem differentiation cease simultaneously in mid-August. Cessation of function of sieve elements begins in mid-October. By mid-December all sieve elements are nonfunctional.

2:45 **Murmanis, L., R. F. Evert,** and **I. B. Sachs.** U. S. Forest Products Laboratory and University of Wisconsin, Madison.—ULTRASTRUCTURE OF TRACHEARY ELEMENTS IN CUCURBITA MAXIMA.—Young tracheary elements are thin-walled and contain an extensive system of endoplasmic-reticulum membranes, mostly rough-surfaced. Many ribosomes, mitochondria and dictyosomes are present. Some plastids are also present, and many of them contain starch granules. With the beginning of secondary wall formation, dictyosomes become associated with a great many vesicles, which were not present before. These vesicles show different degrees of association with plasmalemma and often fuse with it. Concentric layering of microfibrils in the secondary thickenings suggests that some type of synchronous incorporation of wall material occurs. Mitochondria often show intimate associations with plasmalemma bounding the secondary thickenings. Microtubules run parallel to the secondary thickenings. Packets of membrane-bound fibrils are present, but with no orientation to the secondary thickenings. For a time after deposition of secondary walls, tracheary elements have normal-appearing nuclear and cytoplasmic components. Degeneration of cellular components occurs after perforation of the end wall.

3:00 **Evert, R. F.** and **L. Murmanis.** University of Wisconsin and U.S. Forest Products Laboratory, Madison.—ASPECTS OF ULTRASTRUCTURE OF SIEVE ELEMENTS IN ROBINIA PSEUDOACACIA.—At maturity the enucleate sieve elements in *Robinia pseudoacacia* are lined with a plasmalemma and one or more cisterna-like layers of endoplasmic reticulum. Numerous mitochondria and proplastid-like structures with electron-dense bodies (some crystal-like) are present in the parietal layer of cytoplasm. Slime plugs, but not "persistent slime bodies," were found in many elements. In others, fibrillar slime was more or less evenly distributed throughout the central cavity of the cell. Some micrographs suggest that normally the fibrillar slime forms fine strands, which traverse the cells and run from cell to cell through the sieve-plate pores. Pores of lateral sieve areas are similar to those of sieve plates, that is, they are lined with cytoplasm and traversed by slime. Sieve elements are connected with companion cells by plasmodesmata.

3:15 **Recess.**

3:30 **Ervin, E. L.,** and **R. F. Evert.** University of Wisconsin, Madison.—ASPECTS OF SEASONAL PHLOEM DEVELOPMENT IN PERENNIAL MONOCOTYLEDONS.—Seasonal collections have been made of *Typha latifolia* and *Polygonatum pubescens* rhizomes and of *Smilax hispida* aerial stems. Living sieve elements are present year-round in all three species, but most sieve-area pores appear occluded with dormancy callose in winter. Sieve elements of all three species contain slime. Other aspects of phloem development and structure will be discussed.

3:45 **Alfieri, F. J.,** and **R. F. Evert.** University of Wisconsin, Madison.—SEASONAL PHLOEM DEVELOPMENT IN PINUS RESINOSA.—Judged by collections made between July, 1963, and September, 1964, the seasonal cycle of phloem development in *Pinus resinosa* is as follows. During the latter half of April cells in the outer margin of the cambial zone begin to differentiate into sieve cells. Shortly afterwards (about a week) cambial activity (division) commences. Most sieve-cell differentiation is completed by late August. By late September all sieve-cell differentiation is completed. In a year's growth increment all but the last-formed sieve cells (2–5 rows) cease functioning the same season they are derived from the cambium. These overwintering sieve cells are functional when new sieve-cell differentiation begins in April and are the first sieve cells to become nonfunctional during the new growing season. Cessation of function begins in late May or June. By mid-December all but the last-formed sieve cells (i.e., those which will overwinter in a functional state) are nonfunctional. Phloem differentiation precedes xylem differentiation by approximately a month; cambial activity and xylem and phloem differentiation cease almost simultaneously.

4:00 **Shobe, W. R.,** and **N. R. Lersten.** Iowa State University of Science and Technology, Ames.—TRANSFUSION TISSUE: A CONFUSING CONCEPT IN GYMNOSPERMS.—Transfusion tissue and accessory transfusion tissue in gymnosperm leaves consist largely of tracheid-like cells which are not organized into discrete vascular bundles. Since their original descriptions, about a century ago, there has been considerable controversy concerning the ontogenetic and phylogenetic origin and the possible function of these peculiar tissues. An extensive literature has accumulated, replete with numerous hypotheses and a mass of confusing terminology. A critical review of the previous work on these tissues has been made and will be summarized. A broad survey of transfusion tissues in gymnosperms is currently in progress, using a modified clearing technique with safranin-fast green staining. These cleared preparations are supplemented by selected microtome sections. Such a survey is essential for a unified morphological concept necessary for future physiological investigations. So-called "transfusion tissue," described in certain angiosperms, has been examined and will be compared with the transfusion tissues in gymnosperms.

4:15 **Chen, C. L.** Yale University, New Haven, Conn.—FOLIAR IDIOBLASTIC SCLEREIDS OF THE SAPOTACEAE-MIMUSOPOIDEAE.—The abundance of idioblastic sclereids is one of the most striking features in the laminar histology of a number of taxa of the Sapotaceae. These cells are not only enormous in quantity but extremely bizarre in form and intricate in arrangement. In all taxa of the tribe Manilkareae except *Letestua,* the sclereids in the palisade tissue are diffusely distributed. *Letestua* is unique in its absence of diffuse sclereids. In *Faucherea* the sclereids generally occur inside the mesophyll, whereas in other taxa they are commonly subepidermal or subhypodermal. Developmental studies are needed for a clear picture of the origin and growth of these idioblasts in various species. The mature foliar sclereids are profusely ramified, the branches being greatly elongated and fiber-like. These filiform sclereids extend along the paradermal plane. Overlapping of the branches of neighboring sclereids forms a network of idioblasts in the lamina. The sclereids may abut upon vascular sheaths and bend their course to follow the bundles to a certain extent. Some of the sclereids extend vertically or obliquely into the spongy parenchyma. The distribution of the sclereids in the spongy parts of mesophyll resembles that of the sclereids occurring in the palisade parenchyma. The filiform branches, however, tend to be shorter. The sclereids at the terminations of the veinlets are much ramified. The branches vary in length from very short to moderately long. Diffuse idioblastic sclereids are lacking from *Mimusops* and *Butyrospermum*—the two main genera of the tribe Mimusopeae. The idioblastic sclereids of the Sapotaceae are not only of morphogenetic interest, but they are also of diagnostic value in some of the taxonomically difficult groups of the family.

4:30 **Mia, A. J.,** and **G. Setterfield.** Carleton University, Ottawa, Ontario.—FINE STRUCTURE AND DEPOSITION OF SECONDARY WALL IN RAUWOLFIA SCLEREIDS.—In the electron microscope the thick secondary walls in sclereids of *Rauwolfia* show a complex multi-layered structure. The outermost layer is usually thicker than the inner ones and possesses cellulose microfibrils which lack obvious concentric order. Each inner layer displays two parallel rows of cellulose microfibrils (approximately oriented 45° to the vertical axis of the sclereid) intercalated with non-cellulosic wall matrix. The regular layers of microfibrils are often less obvious or inconspicuous near the lumen. Pulse-labelling experiments using H^3–glucose indicate that this layered structure is built up by apposition. Studies of sclereids fixed in glutaraldehyde and osmium tetraoxide revealed a conspicuous Golgi- and vesicular activity in the sclereids compared to activity in the ordinary pith parenchymatous cells.

Session 2. Tuesday Morning. S. N. POSTLETHWAIT, *presiding.*

9:00 **Huether, Carl A. Jr.,** and **G. Ledyard Stebbins.** University of California, Davis.—THE EXTENT OF GENETIC VARIABILITY FOR A CANALIZED CHARACTER (COROLLA LOBE NUMBER) IN NATURAL POPULATIONS OF LINANTHUS.—Constancy in numbers of floral parts within taxa is well-documented by their widespread use in taxonomic classification. One clear example of this constancy is found in the Polemoniaceae where the normal number of corolla lobes is five. A survey of more than 40 natural populations of several closely related species in the genus *Linanthus* across a transect of Northern California revealed the presence in every population of only 1 to 4% of flowers deviating from normality. When seed from these populations was harvested at random and the plants grown under environmental stress conditions of high temperature and long day length, a nine-fold increase in percentage of flowers deviating from the pentamerous condition was obtained, as well as a significant amount of variability between genotypes. A second method of finding genetic variability was also used; selection experiments for increase and decrease in lobe numbers have produced some lines in which over 50% of the flowers have more than five lobes after five generations of selection. These two separate lines of evidence reveal a vast amount of natural genetic variability for a character which presumably has undergone long-continued natural selection for phenotypic constancy.

9:15 **Uhl, C. H.** Cornell University, Ithaca, N. Y.—CHROMOSOMES OF ARTIFICIAL HYBRIDS OF MEXICAN CRASSULACEAE.—More than 500 different interspecific hybrid combinations have been produced, involving five genera and about 100 different species. About 200 of these hybrids also are intergeneric, and about 30, by the usual taxonomy, involve parents belonging to different subfamilies. The relative ease of interspecific and intergeneric crossing raises questions concerning the role of hybridization in the evolution of the group and also the degree to which the present taxonomy reflects the genetic relationships. As an extreme case, *Echeveria linguaefolia* and *Sedum cremnophila,* both $n = 33$, closely resemble each other vegetatively and give a technically intersubfamilial hybrid with normal meiosis and more than 95% normal pollen, suggesting very close genetic relationship. Chromosome numbers range from $n = 12$ to $n = 240+$. Hybrids generally resemble more closely the parent with the higher chromosome number and, where the numbers differ greatly, the more numerous genome often "swamps" the other, with the hybrids closely resembling that parent only. Synapsis of the chromosomes in such hybrids often shows an intermediate number of bivalents, indicating that autosyndesis occurs and suggesting strongly that polyploidy, rather than fragmentation, is responsible for the evolution of the higher numbers. Many hybrids show a pattern of chromosome pairing in which the number of bivalents and multivalents is equal to the gametic number of the parent with fewer chromosomes, with the rest of the chromosomes represented by a variable number of univalents.

9:30 **Hollenback, J. G.,** and **C. A. Hollenback.** St. Norbert College, W. DePere, Wis., and University of Wisconsin Green Bay Center.—FRUIT- AND SEED-SET IN SEVERAL COMBINATIONS OF TEMPERATURE AND MOISTURE.—Various combinations of temperature and moisture during the summer of 1964 in which haploid Tuberosum-Phureja F_1 hybrid families were growing, permitted observations of the influence of temperature and moisture on fruit and seed-set after sibbing and outcrossing. The number of fruit/pollination and the average number of seeds/fruit were found to be low if temperature was high (average five-day

high of 85 F and low of 63 F) or if moisture was low. The number of seeds/fruit was quadrupled if the temperature was low (average five-day high of 71 F and low of 55 F) when the moisture was adequate.

9:45 **Shilling, Paul R.** Hartwick College, Oneonta, N. Y.—MECHANICAL DISEASE RESISTANCE IN WOOLLY TOMATOES.—A strain of tomato (*Lycopersicon esculentum*), isogenic except for the woolly locus, has been investigated. Leaves have been removed and dusted with pulverized, diseased leaves from field-grown tomato plants. Intact plants have similarly been dusted. The number of lesions which developed were recorded. Data indicate a significantly reduced number of lesions developing on woolly leaves as compared with non-woolly leaves.

10:00 **Stewart, R. N.,** and **T. Arisumi.** U.S.D.A., Plant Industry Station, Beltsville, Md.—GENETIC AND HISTOGENIC DETERMINATION OF PINK BRACT COLOR IN POINSETTIA.—Three independent somatic mutations from red to pink bract color in poinsettia resulted from loss of pigment formation in the epidermis. In red bracts, red pigment was present in vacuoles of epidermal and internal cells. Epidermal cells of the three pink sports were colorless but internal spongy parenchyma cells were pigmented as in red bracts. The pink appearance was apparently due to dispersion of pigment in the small, spongy parenchyma cells. The pink sports were periclinal chimeras with only the epidermis (L-I) changed. They produced genetically red gametes, indicating that the second histogenic layer (L-II) was red. Small streaks and flecks of red appeared on pink bracts where normal L-II cells displaced the mutant L-I. All three sports produced red-bracted shoots from adventitious buds, proving that L-III was red. One pink sport produced several branches with bracts having a white margin around a central pink area, the result of non-pigmented L-I's replacing normal L-II. Furthermore, the white-edged, pink-centered form changed to all white several times, again by replacement. Recently, seed collected in Mexico produced poinsettias with pink bracts quite similar to the pink sports. However *pink* pigment was found in both epidermal and internal tissues. No red streaks or flecks were pink. This pink color was determined by a single, recessive chromosomal factor found in all three histogenic layers.

10:15 **Recess.**

10:30 **Paddock, Elton F.,** and **Baldev, K. Vig.** Ohio State University, Columbus.—LEAF SPOTTING IN GLYCINE MAX.—Of the 11 alleles known at the Y locus in *Glycine max,* only one, Y, results in normal chlorophyll development. Plants having Yy_{11} differ from those with YY in having lighter green leaves. Plants with $y_{11}y_{11}$ are yellow due to near-complete lack of chlorophyll. In leaves of Yy_{11} plants, there are dark green spots and yellow spots which are, respectively, apparently YY and $y_{11}y_{11}$ in constitution. These spots usually appear singly, but occasionally a dark green spot and a yellow spot of same size and shape are adjacent (twin-spots). Spots appear most frequently on the simple leaves and in progressively decreasing frequency but increasing size on the first and second compound leaves. Spots are exceedingly rare on subsequent leaves. No such spots appear on YY or $y_{11}y_{11}$ plants; therefore, the spots are probably not due to simple mutation. Presoaked seeds were treated with dilute solutions of Mitomycin-C which is known to induce somatic crossing-over in other organisms. Spot frequency, especially of twin-spots, increased proportionately to the concentration and duration. Spots continued to be confined to the simple and first and second compound leaves in Yy_{11} plants. Mitomycin-C was also applied as a lanolin paste to stem tips of plants in the third compound leaf stage of growth. Spots appeared in the next up to three leaves emerging beyond the point of application. In mitosis in primary roots of untreated seeds, chromosome elimination, endoduplication and other abnormalities were seen, but only in the early stages of germination. In secondary (lateral) roots mitosis was essentially normal. Mitomycin-C appears capable of enhancing these phenomena during germination and in meristems during subsequent seedling growth, but only in those leaf primordia present at the time of application.

10:45 **Pratt, Charles,** and **Odessa Williams.** Savannah State College, Savannah, Ga.—ACTIVITY STUDIES OF COTTONSEED PROTEOLYTIC ENZYMES BY PAPER CHROMATOGRAPHY.—The commercial preparation of the proteolytic enzyme, pepsin, was found to be effective in degrading a protein isolated from cottonseed, but this commercial preparation was found to contain at least seven enzymic polypeptides. The active fractions of the enzyme were determined by a modification of two-dimensional paper chromatography. A streak of enzyme solution, 3 inches long, was placed on a sheet of Whatman #1 chromatography paper. After development in a butanol–acetic acid–water (6:1:2 v/v) solvent system, a strip one inch wide was cut from the sheet and sprayed with ninhydrin to locate the components of the enzyme mixture as they had separated in a vertical position. The sprayed strip was laid back in place and the unsprayed portion was marked. A sample of cottonseed protein solution was superimposed on each of the enzyme fractions and allowed to stand for three days. A blank strip of chromatography paper was sewed on the chromatogram in order to replace the strip which had been removed, and the whole sheet was chromatographed in a second direction. The dried chromatograms were sprayed, the final spots located and further identification work done with the active fractions of the enzyme and cottonseed protein.

11:00 **Desborough, S. L.,** and **S. J. Peloquin.** University of Wisconsin, Madison.—ESTERASE ISOZYMES FROM SOLANUM TUBERS.—Patterns of soluble proteins from tubers of *Solanum* species have been characterized by disc electrophoresis. Esterases present in tubers appear suitable for chemical and genetical analyses. Esterase patterns of (1) 53 *Solanum* species, (2) 32 interspecific hybrids, (3) 8 cultivars of *S. tuberosum,* (4) 114 haploids ($2n = 24$) and 156 selfs ($2n = 48$) from four cultivars, and (5) 56 hybrids between haploids and 24-chromosome species were determined. The number of esterase isozymes that hydrolyse alpha naphthyl acetate at *p*H 7.0 varies from one to nine. Species and interspecific hybrids possess more complex patterns, in number and distribution, than either selfs or haploids. A few species have nine isozymes. In general the isozymes in haploids and selfs appear similar, but some haploids have only one isozyme. A hypothesis based on the active enzyme being a tetramer adequately accounts for the results. These tetramers are composed of three types of monomers which combine with equal frequency to give the nine esterases if the relative mobility of A monomer is 1, of B is 2 and of C is 3. Assuming that allele E^A controls the production of monomer A, E^B of B and E^C of C, the simplest genetic hypothesis consistent with the results is that these three alleles are independent. However, chemical data from rupturing tetramers and recombining the monomers and artificial mixture experiments along with appropriate genetic analysis are necessary for verification of this hypothesis.

11:15 **Chattopadhyay, S. K.,** and **H. D. Brown.** The University of Texas Medical Branch, Galveston.—OUABAIN-INHIBITED ATPASE FROM BARLEY ROOT.—A membrane preparation from 3-day barley (*Hordeum vulgare* 'Cordova') seedlings exhibits an adenosine triphosphatase activity. Endoplasmic reticulum isolated from root homogenates by differential centrifugation catalyzed the hydrolysis of

adenosine triphosphate (9.5 mμmoles Pi/mg Protein/min [based upon a 60-min incubation]). The enzyme is inhibited by high concentrations of metals; unaffected by lower concentrations of Mg^{++}, Ca^{++}, Na^{+}, and K^{+}, as chloride salts. Its *p*H optimum is 6.8. Thus several of the criteria by which the presence of an ion-transport enzyme is recognized (Skou, J. C., 1965, Physiol. Rev. 45: 596) have not been demonstrated. Despite this, a characteristic considered by many authors to be solely the specific property of $Na^{+} + K^{+}$-transport enzyme is present. That is to say, these preparations respond in a most pronounced way to the presence of the cardiac glycoside, ouabain. 10^{-4}M ouabain inhibits 97% of ATP hydrolysis. Thus in a typical series of experiments, at 42 C the ATPase hydrolyzed 159 mμmoles of Pi/h, while in the presence of 10^{-4}M ouabain 4.76 mμmoles of phosphate were hydrolyzed during the same one-hour incubation period. Our study leads us to question the meaning and mechanism of cardiac glycoside inhibition and to question the significance of the inferential criteria now widely employed for recognition of on ion-transport enzyme.

11:30 **Postlethwait, S. N.** Purdue University, Lafayette, Ind.—SPACE-LAPSE PLANT ANATOMY.—This paper will report the structure of an automated device for cinematography of sequential microscope sections. It will include the showing of several loop films produced by the machine. The subject matter of films will be a corn node, a clover flower, a *Coleus* stem tip, a lily type flower and perhaps others.

Session 1. Tuesday Afternoon. SHIRLEY TUCKER, *presiding.*

2:00 **Bierhorst, D. W.** Cornell University, Ithaca, N.Y. —GAMETOPHYTES OF SCHIZAEA AND ACTINOSTACHYS.—More than 100 schizaeaceous gametophyte collections from New Caledonia are reported. These include at least four species of *Actinostachys* (the digitate species of "Schizaea"), three of the dichotoma type *Schizaea* spp. and at least two of the simple leaf, pinnate *Schizaea* spp. All of the now known *Actinostachys* spp. have subterranean, fleshy cylindrical gametophytes which become large and tuberous with age. All of the known *Schizaea* spp. with simple leaves and pinnate fertile leaf segments have uniseriate, branched filamentous gametophytes which are either surface living and green or subterranean and non-green Species of *Schizaea* of the dichotoma type which are known have subterranean gametophytes which are ontogenetically modified filaments. Their growing ends are simple filaments. Cells some distance from the apex divide and redivide to form packets of cells which may give a distinctly jointed appearance to the multiseriate, cylindrical and fleshy older axes. Each joint which may be several cells long and several cells in thickness is referable to a single cell cut off by a tranverse wall from the apical cell of the filament.

2:15 **Steward, F. C., H. W. Israel,** and **Marion O. Mapes.** Cornell University, Ithaca, N. Y.—BIOCHEMICAL DIFFERENTIATION AND MORPHOGENESIS IN CARROT CULTURES: A UNIQUE CASE.—A strain of cultured carrot cells was established from a carrot root which had a high chlorophyll content in its secondary phloem. The resultant free cells formed abundant chloroplasts and were unusually green. These free cells gave rise to small clusters with nodules which readily formed root tips. Although they were only microscopical in size, these colonies possessed the equivalent of a light-grown shoot in their dark green cells, and they also had access to all the stimuli that normally emerge from a root. Cells which were appropriately placed along this gradient became bright orange to an extent that normally does not occur in growing carrot cells or explants but only when storage roots are developed on plants grown from them. The contrast between the green pigmented, the orange pigmented, and the colorless cells in these cultured "plantlets" shows how the expression of their gene-determined biochemical potentialities is controlled and regulated by the factors that also control differentiation and morphogenesis. Evidence on the microscopical and electron microscopical features observed will be presented.

2:30 **Jensen, L. C.** University of Minnesota, Minneapolis.—APICAL STUDIES IN THE CRASSULACEAE, SUBFAMILIES KALANCHOIDEAE, COTYLEDONOIDEAE, AND SEDOIDEAE.—An examination of the adult vegetative shoot apex of 36 species representing six genera revealed dimensional and organizational variation. All but four *Kalanchoe* species have 2–3 tunica layers and a corpus width of 2–3 cells during all plastochron stages. In three closely related *Kalanchoe* species the upper part of the corpus is stratified during the minimal plastochron stage, superficially resembling the lower tunica layers; such stratification is not characteristic of the maximal stage. What appears to be a "central mother cell zone" can be distinguished in *K. beharensis* but not in other species. Below this region there is a broad arc of dividing cells resembling the cambium region in the shoot apex of *Opuntia.* Apical width of decussate plants was calculated from sections made perpendicular and parallel to the youngest leaves. The apex is oval in shape, being wider in a plane parallel to the youngest leaves. Most decussate *Kalanchoe* species have apical widths measuring 80–140 $\mu \times$ 120–190 μ during maximal area, and 30–80 $\mu \times$ 70–160 μ at minimal area. Three decussate species of this genus, all with stems of large diameter, have apices measuring 200–300 $\mu \times$ 300–500 μ at maximal area and 100–150 $\mu \times$ 180–400 μ at minimal area. Decussate species of *Sedum* and *Cotyledon* tend to have width measurements similar to those of the majority of decussate *Kalanchoe* species. Species with spiral phyllotaxy from all genera have small apices, ranging from 60 to 130 μ in width at maximum area. Height measurements for all genera seldom exceeded 50 μ and revealed no correlation with varying width dimensions.

2:45 **Tucker, Shirley C.** University of California, Davis. —DETERMINATE APICAL MERISTEMS.—Although apical meristems are theoretically immortal, many in fact are determinate. Three examples will be considered: two types of floral apex, and the tendril apex of *Vitis vinifera.* As the apex is considered a heterogeneous population of cells, it is of interest to consider which apical components cease cell division first, and which ones begin differentiation first. In the *Michelia* flower the activity of the central initial zone determines the longevity of the entire apex. When cell division lessens in that region, no replacements are provided for maturing cells in the surrounding zones, and the entire apical meristem becomes differentiated. In the female flower of *Drimys lanceolata* the components of the apex undergo re-orientation and produce a massive terminal carpel, leaving no apical residuum. A third type of apical cessation occurs in the tendril of *Vitis vinifera.* Here the central initial zone and overlying tunica increase their rate of cell division, and produce a highly specialized tissue (the epithem), and the tendril tip forms a terminal hydathode of short active life. Other determinate apices such as thorns, adhesive-disc tendrils, and those of determinate herbaceous stems display still other patterns of apical cessation.

3:00 **Greathouse, D. C.,** and **W. M. Laetsch.** University of California, Berkeley.—BRANCH DIMORPHISM IN THEOBROMA CACAO: ANATOMICAL AND HISTOCHEMICAL STUDIES ON THE SHOOT APICES OF THE DIMORPHIC BRANCHES.—The seedling of *Theobroma cacao* L. has an orthotropic shoot with alternate leaves of ⅜ phyllotaxy. Under our growing conditions the branch dimorphism is generally initiated in the second year of growth when the apical meristem aborts and axillary bud primordia develop into a "fan" of 3–5 plagiotropic branches. These fan branches are characterized by leaves with short petioles and

a ½ phyllotaxy. Subsequently, an axillary bud below the point of origin of the plagiotropic branches develops into a new orthotropic shoot. The apical meristem of this shoot eventually aborts and another set of plagiotropic branches is initiated. Preliminary to a detailed morphogenic analysis of the branch dimorphism a comparative study of the orthotropic and plagiotropic shoot apices has been made. This has involved both standard histological procedures and histochemical techniques. The results will be described and their implications with regard to the morphogenic problem of branch dimorphism will be discussed.

3:15 **Recess.**

3:30 **Nolan, J. R.** Antioch College, Yellow Springs, Ohio.—PROMERISTEM BIFURCATION OF THE ASCLEPIADACEAE SHOOT TIP.—The promeristem of *Asclepias syriaca* (and related taxa) has been studied with reference to the origin of the lateral, non-axillary peduncles. The species has an erect, single stem with decussate leaves and with axillary buds arising no earlier than the fourth plastochron. With the onset of peduncle growth the vegetative promeristem bifurcates into two approximately equal members at the same nodal level as a pair of leaf primordia. In a transverse view the bifurcation is oblique to these primordia, with the smaller member nearer to the leaf that later subtends a strong axillary bud. This smaller member is the peduncle promeristem, rapidly becoming larger than and overtopping the other member which continues as the vegetative promeristem. The vegetative promeristem then produces a pair of opposite leaves while again bifurcating into two members, duplicating the above pattern, and duplicated at every node thereafter. An abaxial bract early appears on the peduncle, but this is seen as a product of the peduncle promeristem, subtending the first bifurcation of the peduncle itself. There is no evidence to support the premise of either the vegetative or peduncle promeristem being a displaced axillary bud. The system, therefore, does not conform to typical angiospermous monopodial or sympodial axes. An evolutionary interpretation is offered, with the suggestion that the behavior of the asclepiad promeristem be assigned the term secondary dichotomy.

3:45 **Nolan, J. R.** Antioch College, Yellow Springs, Ohio.—ENANTIOMORPHIC SYMMETRY IN THE ASCLEPIADACEAE.—Enantiomorphic symmetry refers, in this paper, to the serial production of asymmetric organs that are, with alternating regularity, mirror-images of each other. This phenomenon, to which little mention is given by the botanical literature, is found to be a constant morphological feature in the Asclepiadaceae, expressed most strongly in the early development of the peduncle system. In a typical asclepiad, the peduncles occur laterally and singly at each node. A given peduncle early becomes an asymmetric body of sub-units whose order of development can be assigned as clockwise (or right-handedness). The next peduncle expresses a similar asymmetry but in a mirror-image order of development, counterclockwise (or left-handedness). The third peduncle reverts to the clockwise order, the fourth peduncle has counterclockwise order . . . and so on, for the entire peduncle complement. The actual structures involved in the enantiomorphic pattern include peduncle sub-heads, subtending bracts, ultimate pedicels, and quincuncial sepals. Depending on genus and species, one of these units tends to display the enantiomorphism more graphically than the others. In the simple *Ampelamus albidus*, for example, the first peduncle produces a clockwise helicoid cyme of pedicels; the second peduncle produces a counterclockwise order. The intriguing suspicion is that enantiomorphic symmetry may be a common tendency in many plant groups. Extensive analyses of other families, therefore, could lead to enantiomorphism becoming a legitimate tool for determining evolutionary relationships and physiological pathways.

4:00 **Morrow, L. O.** Richmond Professional Institute, Richmond, Va.—SOME ASPECTS OF GYNOECIAL STRUCTURE IN CORYPHOIDEAE (PALMAE).—A comprehensive study of the structure of flowers of 28 genera of coryphoid palms has been made. Aside from the unexpectedly complex vascular anatomy of the flowers, one of the most interesting features is the apparent transition series in the gynoecium. An apocarpous tricarpellate gynoecium is the basic type. The beginning of syncarpy is seen in some genera where only the styles are connate, whereas connation of both styles and ovarial regions can be shown in other genera. A solid trilocular pistil appears to be the endpoint of the transition series. Six genera have a unilocular, uniovulate pistil, derived from the tricarpellate condition, apparently by loss of the ovarial portion of two carpels.

4:15 **Macdonald, A. D.,** and **R. Sattler.** McGill University, Montreal, Canada.—DEVELOPMENT OF THE FEMALE REPRODUCTIVE STRUCTURES IN MYRICA GALE.—The reproductive apex, the inception and development of the lateral appendages ("bract," "bracteole," "carpel," and "integument") and the terminal nucellus are described. Histogenesis and the development of procambium strands are emphasized. Organogenesis is described in terms of differential growth. On this basis *Myrica* can be compared with the Gnetales without the use of insinuative categories such as "phyllome," "caulome," "sporophyll," and "integument." Phenetic and phyletic considerations are distinguished and on this basis the relationship of *Myrica* and the Gnetales are discussed.

4:30 **Jensen, Lawrence C.** University of Minnesota, Minneapolis.—ANOMALOUS GROWTH IN KALANCHOE (CRASSULACEAE).—An examination of shrub and sub-shrub members of the genus *Kalanchoe* was undertaken to determine the nature of secondary tissues. Secondary growth is anomalous, with external derivatives of the vascular cambium following one of two courses of development: (1) A derivative may undergo several successive longitudinal divisions, followed by similar divisions in some of the surrounding cells, producing bundles of phloem; (2) Other derivative cells elongate slightly and may divide transversely one or two times. These become parenchyma cells and constitute the bulk of secondary tissues external to the vascular cambium. They have thin walls with primary pit fields, tapering ends, 0–2 transverse septa, and living protoplasts. In some species they become modified by thick deposits of cellulose on walls facing intercellular spaces. These cells resemble lacunar collenchyma but fail to yield positive histochemical tests for pectin. Many species have secondary xylem consisting mainly of extremely short, lignified fibers and vessels. Fibers have living protoplasts and simple pit-pairs with linear inner apertures. Vessels are in groups of 3–7 elements with perforation plates at approximately 45° angles. Lateral walls of vessels are commonly sclariform-reticulate with vertical strands connecting the reticulations. Perforation plates consist of one large subterminal pore. Wood rays are absent. Wood parenchyma is usually paratracheal, varying from scanty to vasicentric. Species having large amounts of secondary xylem composed primarily of parenchymatous tissue will also be discussed. The size of the cortex and pith relative to that of vascular tissue will be discussed. In most instances periderm seldom consists of a significant amount of tissue except in *K. beharensis* where there is an unusually large amount of phelloderm.

4:45 **Brennan, James R.** Massachusetts State College, Bridgewater, Mass.—ANATOMICAL STRUCTURE OF THE TWO ABSCISSION ZONES IN THE PETIOLE OF PARTHENOCISSUS TRI-

CUSPIDATA.—The simple trilobate leaf of Boston ivy possesses two abscission zones in its petiole and leaf fall in the autumn results from breakage in either or both of these zones. One zone develops in typical fashion at the base of the petiole, whereas the other is located at the base of the lamina. Although lamina and petiole may abscise while still connected the laminae often abscise prior to the petioles and it is quite common to find petioles attached to the stems some time after the laminae have fallen. Eventually, the petioles also abscise; thus, detached petioles and laminae are often found on the ground below the vines, as well as intact leaves. In the abscission zone at the base of the petiole, a separation layer is distinguished by the presence of parenchymatous cells smaller than those of the rest of the petiole. Abscission is accomplished through the separation of cells from each other in this layer, while protection of the resultant exposed surface of the stem is provided by the development of a primary protective layer and a periderm that is continuous with the stem periderm. In the abscission zone at the base of the lamina, a separation layer develops in a similar manner to the separation layer at the base of the petiole; however, no primary protective layer or phellogen is produced in this abscission zone.

Session 3. Wednesday Afternoon. D. J. PAOLILLO, JR., *presiding.*

2:00 **Spink, G. C.,** and **G. B. Wilson.** Michigan State University, East Lansing.—ULTRASTRUCTURE AND MICROANATOMY OF THE FIRST HALF MM OF THE ROOT TIP OF PISUM SATIVUM.—A descriptive study of the ultrastructure and microanatomy of the first ½ mm of the root tip of *Pisum sativum* has been completed. The areas to be reported here are the columella, tip-cells and the epidermis. The tip-cells are those at the very apex of the root tip and appear to be the acropetal termination of the columella cells. The epidermal cells in this area appear to be closely related to both columella and tip-cells. These areas will be discussed and illustrated with slides.

2:15 **Jones, D. D., D. James Morré,** and **H. H. Mollenhauer.** Purdue University, Lafayette, Ind., and Charles F. Kettering Research Laboratory, Yellow Springs, Ohio.—SLIME SECRETION BY OUTER ROOTCAP CELLS OF ZEA MAYS.—In maize rootcap cells secretion is accompanied by hypertrophy of dictyosome cisternae forming large vesicles. Vesicle contents are subsequently released from the protoplast by fusion of the vesicle membrane with the plasma membrane (Mollenhauer, H. H., W. G. Whaley and J. H. Leech, *J. Ultrastruct. Res.* 5: 193–200, 1961). The secreted material gave a positive periodic acid–Schiff reaction providing a means of localization. The secretion moves outward, following the free space of the cell wall after discharge from the protoplast and appears as a slime droplet adhering to the root tip. By following droplet formation, secretion was found to be influenced by temperature (Q_{10} of about 2) and characterized by a temperature independent periodicity (ca. 3 hr). Secretion was enhanced by supplying mono- and disaccharides to the growth medium. Sucrose (0.04 M) doubled the amount of slime produced. No correlation was found between the amount of slime and root growth. Outward movement was favored by a water-saturated environment. With roots grown in air and under water stress, secretory product accumulated at the inner wall surfaces (no external secretion). Chemical analysis of the secreted polymer after isolation and purification yielded the empirical formula $C_6H_{10}O_5$. The complex acid hydrolysis pattern resembles that of a difficultly hydrolyzable polysaccharide.

2:30 **Paolillo, D. J., Jr.,** and **J. A. Reighard.** University of Illinois, Urbana.—SOME ASPECTS OF THE ULTRASTRUCTURE OF MOSS LEAVES.—Leaves of *Polytrichum ohioense, P. juniperinum* and *Atrichum angustatum* were examined in thin sections with an electron microscope. No qualitative differences were found in cell organelles among the three species examined. The morphological differentiation of the terminal row of cells in each lamella (used for species identification in *Polytrichum*) is not associated with cytological differentiation from the other cells of a lamella. Protoplasmic connections among the cells of the lamellae are of small diameter, widely scattered, and few in number. This situation is in marked contrast to what is found in the presumed "conducting" tissue of the leaf, where numerous large protoplasmic connections perforate the crosswalls. The chloroplasts from our field- and greenhouse-grown leafy gametophytes contained many grana. The three-dimensional structure of these grana is probably different from what we have observed in higher-plant chloroplasts, because certain frequent configurations found in the moss grana do not occur with any significant frequency in the grana of higher plants.

2:45 **Paolillo, D. J., Jr.,** and **J. A. Reighard.** University of Illinois, Urbana.—COMMENTS ON THE QUESTIONABLE RELATIONSHIP BETWEEN STRUCTURE AND ONTOGENY IN CHLOROPLASTS.—Recent reports on chloroplast ultrastructure have emphasized interconnections among the compartments of a granum. These interconnections occur in two generalized patterns: (1) connectives that span compartments more or less vertically at the margin of the granum yield sectional views that show several successive loculi connected to a common electron-transparent space at the margin of the granum, and (2) connectives that are helically arranged at the margin yield median sectional views that show the loculi of two successive compartments to merge in a Y-shaped configuration at the margin of the granum. These two patterns of interconnections have been associated with theories of morphogenesis of grana stacks. The occurrence of *multiple* helices on the grana of higher plants obscures the ontogenetic significance of the helical pattern. The discovery of both patterns in the liverwort *Marchantia* further obscures the ontogenetic significance of the arrangements of intercompartmental connections. It may be suggested that the relationship between mature form and ontogenesis is more complex than has been alleged, and that a broadening of our concepts of ontogeny of grana is required.

3:00 **Thomson, W. W.** University of California, Riverside.—SOME OBSERVATIONS ON THE ULTRASTRUCTURE OF THE SALT GLANDS OF TAMARIX.—Thin sections of the salt gland of *Tamarix* leaves were studied with the electron microscope. The gland consists of a complex of cells which contain numerous large mitochondria with many cristae. Small vacuoles are generally present near the periphery of the gland cells and many of these vacuoles contain aggregates of electron-dense material. The hyaloplasm is a dense matrix containing ribosomes and membrane elements. The walls between the cells of the gland are thin and electron dense, and there is protoplasmic continuity between the gland cells through plasmodesmata. This electron-dense wall layer surrounds the cells and in many places is folded and projects inward forming a labyrinth-like structure. Outside the electron-dense wall layer on the lateral sides of the cells and on the surface of the outer gland cell there is another wall layer which is thick and electron translucent. The wall between the internal vacuolated cells and the lower gland cells is thick and electron dense.

3:15 **Recess.**

3:30 **Lersten, N. R.,** and **H. T. Horner, Jr.** Iowa State University, Ames.—THE ANATOMY AND FINE STRUCTURE OF BACTERIAL NODULES AND MESOPHYLL CELLS IN LEAVES OF PSYCHOTRIA BACTERIOPHILA (RUBIACEAE).—Bacterial nodules in roots of angiosperms are fairly common but are rare

in leaves. Such nodules are characteristic of some species of *Psychotria*, as well as a few other Rubiaceous genera. Some studies have been made on various anatomical and physiological aspects of these leaf nodules, but a comprehensive investigation combining bacteriological, histochemical and correlated light and electron microscopic techniques has not been attempted. In this initial phase of such a study the anatomy and fine structure of the bacterial nodules and associated leaf tissues in mature leaves will be presented.

3:45 **Gee, M. M., C. N. Sun,** and **J. D. Dwyer.** St. Louis University, St. Louis.—SUBCELLULAR OBSERVATIONS ON SUNFLOWER CROWN GALL INDUCED BY AGROBACTERIUM TUMEFACIENS.—The present study aims at a subcellular study on the inception and developmental phases of crown gall tumor induction on common sunflower petioles by *A. tumefaciens*. For the inception phase tissues were fixed in Dalton's chrome osmium solution (*p*H 7.6) for 2 hr and embedded in Epon-812 every 12 hr after bacterial inoculation, up to the 72nd hr. For the developmental phase, 5-, 7-, 14-, 24-day-old crown gall tissues were fixed and embedded as above. During the inception phase, numerous bacteria appeared both within the host cytoplasm and in the intercellular spaces of the host tissues. Most of the bacterial cells observed had their outer envelopes fallen apart from the cytoplasm and the latter, containing a mass of fibril-like substances, diffused in the host cytoplasm. Most chloroplasts showed radical disintegration of the lamellae systems and swellings of the grana and the plastid itself. Ribosomes increased considerably. In the next phase bacteria were absent. Here the contents of chloroplasts showed greater disintegration with large vacuoles appearing within the swollen plastids first and gradually, in 24-day-old tumor tissue, the grana and lamellae systems being replaced by a number of big round inclusions. Very many ribosomal particles appeared in this phase. Mitochondria remained more or less unchanged.

4:00 **Smith, Kenneth M., R. M. Brown, Jr., P. L. Walne,** and **D. A. Goldstein.** University of Texas, Austin, and University of Pittsburgh, Pittsburgh.—ELECTRON MICROSCOPY OF THE INFECTION PROCESS OF THE BLUE-GREEN ALGA VIRUS (BGAV).—In a previous communication a preliminary account was given of the infection process of the blue-green alga virus first isolated by Safferman and Morris (1963). It was shown that the most characteristic sign of infection was the lateral displacement of the photosynthetic lamellae. In addition it was shown that the virus particles were closely associated with the photosynthetic lamellae and remained attached to them even after the whole cell is completely lysed. In the present study the virus was propagated in algae growing on agar and portions of the plaques were removed and fixed in acrolein-glutaraldehyde followed by post-fixation in osmium tetroxide. Unequivocal evidence of a virogenic stroma in the nucleoplasmic region of cells of *Plectonema boryanum* has been obtained, and large numbers of virus particles are seen developing in this region. Further characterization of the virus particles themselves has shown them to possess a long "tail," much like that of some bacteriophages. Sections of cells with the virus particles in situ have shown the tails penetrating the wall of the cell, and numerous empty virus particles or "ghosts" remaining attached to the cell walls. These facts suggest the tentative conclusion that the virus particles inject their DNA into the cell in the manner of certain 'phages.

4:15 **Hindawi, I. J.** Division of Air Pollution, Public Health Service, and Taft Sanitary Engineering Center, Cincinnati, Ohio.—NODULES AND SWELLING ACTIVITY IN GRAPEVINE AND BROCCOLI LEAVES IN RESPONSE TO AUTOMOBILE EXHAUST.—Broccoli and three varieties of grape vine—grenache, mission, and zinfandel—were exposed to irradiated automobile engine exhaust for several 4-hr periods. Numerous outgrowths or proliferations of tumor-like tissue appeared, mostly on the lower surface of the leaves. The injured broccoli leaf tissue became brown and then started to swell. Small brown, cone-shaped nodules developed in the grape leaf on the grenache variety. Microscopic examination of fresh sections of the injured tissue indicated that a pattern of growth in the mesophyll layer developed independently of that of the normal leaf. The spongy cells elongated, the nucleus enlarged, the cytoplasm divided by a new cell wall, and small nodules developed. In broccoli the spongy cells expanded and enlarged, the chlorophyll bleached out and disappeared, and cell division did not occur.

4:30 **Piehl, Martin A.** The University of Wisconsin, Milwaukee.—THE ROOT PARASITISM OF CORDYLANTHUS AND SOME OF ITS ECOLOGICAL IMPLICATIONS.—Observations of several species of *Cordylanthus* (Scrophulariaceae) in their natural habitats have provided information on the parasitic behavior of this genus, which is of particular interest since there appears to be no record of actual observation of its parasitism in the literature. The haustorial roots are somewhat distinctive from those of the Santalaceae and Scrophulariaceae which have been investigated in that they show a strong tendency to grow along host roots for considerable distances and produce numerous haustoria in close succession. They appear to be generally non-specific as to hosts, since angiosperms from a wide variety of families as well as gymnosperms are invaded. By July in the dry chaparral and woodland-savanna in which some species occur, *Cordylanthus* is conspicuous among annuals in being green and just coming into flower, while the other annuals have fruited and dried. The evidence strongly suggests that it is the hemi-parasitic existence of these plants which permits them to thrive at a time when most annuals have ceased to grow. Among root parasites in similar dry environments, other annuals, e.g., species of *Orthocarpus*, differ in that they complete their growth and fruit early in the season, while still others, such as certain species of *Castilleja*, are perennials.

4:45 **Rasmussen, Reinhold A.,** and **Lois E. Rasmussen.** Walter Reed Army Institute of Research, National Institutes of Health.—CORRELATION OF PINUS PONDEROSA FOLIAGE ODOR CONSTITUENTS WITH NEEDLE AGE.—Ultrasensitive gas chromatographic analysis has made possible the direct measurement of the volatile materials emitted by plants (PNAS 53: 215–220, Jan. 1965). The volatile compounds, from the flowers, leaves, and bark of many species of plants, have been separated and quantitatively resolved into several discrete components by this technique. Preliminary analysis of the volatiles released by *P. ponderosa* foliage at different physiological ages, namely 1–3 years (living foliage), the fourth year (yellow-brown) and the fifth year foliage (dead) have shown that the foliage volatiles for each individual year are characterized by distinctive terpene profiles. The volatiles from needle ages 1, 2, and 3 years were resolved by GLC analysis into three terpene components while the volatiles from 4- and 5-year foliage resolved as many as five components. The terpene profile for each year's foliage was distinct. In the 1–3-year foliages a very volatile component with a retention time similar to a hemiterpene, probably isoprene, was resolved. However, the hemiterpene component was not resolved from the dead foliage. Comparison of the terpene percentages in the foliage volatiles with published *P. ponderosa* oleoresin terpene values (Sci. 143: 1337–37, Feb. 1964) showed little resemblance. The different chemical composition of each year's foliage volatiles may be interesting in view of the differential susceptibility of various ages of pine foliage to insect attack. Extending these studies to large populations of pine, firs, and other conifers may offer a new approach for studying the orientation of insects to conifer foliages.

HISTORICAL SECTION

Session 3. Monday Afternoon. CONWAY ZIRKLE, *presiding.*

2:00 **Business Meeting of the Section.**

2:20 **Zirkle, Conway.** University of Pennsylvania, Philadelphia.—CHAIRMAN'S ADDRESS: THE PROPHASE AND METAPHASE OF THE HISTORY OF BOTANY.

2:45 **Leech, James H.** University of Texas, Austin.—REPORT ON THE ARCHIVES, BOTANICAL SOCIETY OF AMERICA.

3:00 **Ewan, Joseph.** Tulane University, New Orleans.—CURRENT RESEARCH IN THE HISTORY OF AMERICAN BOTANY.

3:15 **Recess.**

3:30 **Van Stee, Suzanne M.** University of Colorado, Boulder.—T. D. A. COCKERELL: NATURALIST OF OLD COLORADO.—T. D. A. Cockerell (1866–1948) arrived in Colorado in 1887. For the next 60 years, Cockerell studied the flora and fauna, recent and fossil, of his adopted state. His extensive correspondence, his unpublished MSS, and his 3,904 publications supply a picture of a now nearly extinct breed, the all-round naturalist.

3:45 **Shetler, Stanwyn G.** Smithsonian Institution, Washington, D. C.—HIGHLIGHTS IN THE HISTORY OF THE KOMAROV BOTANICAL INSTITUTE, LENINGRAD.—The Botanical Institute of the Academy of Sciences of the USSR, named in honor of V. L. Komarov (1869–1945) in 1940, was created in 1931 by the merger of the Principal (formerly "Imperial") Botanic Garden and the Botanical Museum in Leningrad. Both institutions were founded about 1714 by Peter the Great. The merger was an integral aspect of the general "sovietization" and subsequent "bolshevization" of the Imperial Academy of Sciences. Among the outstanding botanists of the former institutions were F. E. Fischer (1782–1854), K. B. Trinius (1778–1844), C. A. Meyer (1795–1855), E. L. Regel (1815–92), E. R. Trautvetter (1809–89), F. J. Ruprecht (1819–70), and C. J. Maximowicz (1827–91). The new Botanical Institute undertook many large-scale collective researches in botany, epitomized by the recently completed *Flora SSSR* (1934–64), one of the most ambitious floristic endeavors of all time. Traditional strengths have been taxonomy and geobotany. Today the Institute embraces all branches of botany and employs more than 700 persons. Chief resources include a botanical library of about 400,000 volumes and an herbarium of more than 5,000,000 specimens. Komarov's dogmatic taxonomic philosophy has gradually lost its grip since his death. The Institute stands at the center of Russian botanical institutions in research, education, and publication. Many international tropical expeditions have been undertaken in postwar years, and a large role in the International Biological Programme is anticipated. The list of the Institute's renowned botanists is long.

4:00 **Stannard, Jerry.** University of Colorado, Boulder.—THE RENAISSANCE HERBAL: ITS PAST AND ITS FUTURE.—Two classes of herbals existed in the Renaissance. The first class, typified by the *Herbarius Latinus* (1484), was anonymous and is characterized by stylized woodcuts of those plants known in Graeco-Roman times. The second class, represented by the writings of Brunfels, Bock and Fuchs, may be dated by the publication in 1530 of Brunfels' *Herbarum vivae eicones.* Despite naturalistic illustrations of plants and an increased floristic range, the text of these later herbals exhibits the difficulties of trying to break away from the beliefs inherited from ancient and medieval botanists.

MICROBIOLOGICAL SECTION

Session 4. Monday Afternoon. C. W. HESSELTINE, *presiding.*

1:15 **Business Meeting of the Section.**

1:45 **Recess.**

2:00 **Harrington, Brian J.,** and **Kenneth B. Raper.** University of Wisconsin, Madison.—THE USE OF A FLUORESCENT BRIGHTENER TO DEMONSTRATE CELLULOSE IN CELLULAR SLIME MOLDS.—The presence and location of cellulose during the life cycles of several species of the cellular slime molds have been demonstrated using the disodium salt of 4,4′-bis(4-anilino-6-bis(2-hydroxethyl) amino-s-triazin-2-ylamino)-2-2′-stilbene-disulfonic acid, a fluorescent brightener, known as Biofluor. It has been applied as a vital stain incorporated in growth media at a concentration of 0.0025%, and as a direct stain as a 0.1% solution in N/2 saline at *p*H 6.0. The formation of the stalk and the spores has been followed by staining pseudoplasmodia and sorocarps at various stages in development. Vegetative myxamoebae, grown in the presence of the brightener, show no fluorescence until they produce cellulose in the slime material covering the aggregating streams and the pseudoplasmodia, in the sorophore sheath, in the walls of the stalk cells and spores, and in the walls of microcysts if these are formed. The brightener appears to be a sensitive stain for cellulose and has the advantages over such cellulose stains as congo red and zinc chloriodide in that the staining reaction (fluorescence) is very intense and is not obscured by unstained material, in this case, cellulose-free myxamoebae.

2:15 **Toama, M. A.,** and **K. B. Raper.** University of Wisconsin, Madison.—INDUCTION OF MICROCYST FORMATION IN POLYSPHONDYLIUM PALLIDUM.—Microcyst formation in *Polysphondylium pallidum,* strain Pan-17, can be induced by increased osmotic pressure and the presence of certain ions. Maximum encystment depends upon the growth conditions and the inducing agent(s) used. In shaken suspensions of pregrown, washed myxamoebae, there is a 4-hr lag before encystment starts. The average maximum encystment was 77% in 0.08 M KCl solution at 25 C, while the percentages in isoosmotic solutions of sucrose and glucose were only slightly less. Isoosmotic solutions of $CaCl_2$ and $MgCl_2$ gave less encystment, while that of NaCl did not induce encystment. The addition of K^+, Ca^{++} or Mg^{++} at a concentration of 2 mM to NaCl led to the induction of encystment. Anions of potassium other than chloride having the same osmolarity produced either less encystment or completely destroyed the myxamoebae. The addition of trace elements to KCl produced partial or complete inhibition of encystment, depending upon the concentrations used. The optimum *p*H for encystment was *p*H 6.0, while lower and higher *p*H levels either destroyed the myxamoebae or decreased the percentage of encystment. This may have resulted from the formation of insoluble complexes at the higher *p*H, or to toxicity of the buffer system. The addition of divalent ions to KCl solution increased the rate of encystment; however, compounds which formed chelates or complexes with divalent ions either partially or completely inhibited microcyst formation.

2:30 **Reinhardt, D. J.,** and **A. Mancinelli.** Department of Botany, Columbia University, New York.—LIGHT AND THE DEVELOPMENT OF THE CELLULAR SLIME MOLD ACRASIS

ROSEA.—The time at which fruiting occurs in the NC-18 isolate of *Acrasis rosea* can be regulated by administering stimulatory light followed by a dark period. Mature sorocarps form 14 hr after the termination of light and the start of darkness. Within this 14-hr interval, aggregation and sorocarp development occur. Weak aggregation centers are detectable after 4–6 hr of dark incubation. Aggregations continue to increase in size, and between 12 and 14 hr late aggregation stages, sorogens and finally mature fruiting bodies are formed. Low energies of light in the blue region were highly stimulatory to fruiting. A comparison of energy input versus fruiting response at 420, 450 and 475 mμ indicates that 450 mμ is the most efficient wavelength for fruiting. Wavelengths tested at 537–790 mμ, at 2 to 3 times the energy input in the blue, are only weakly stimulatory. At higher energies red, but not far-red, induced good fruiting responses. The minimum dark period, i.e., the minimum time needed in darkness (by cultures previously stimulated in light) to obtain some fruiting within the 14-hr developmental period, was found to be 7 to 8 hr for NC-18 and 5 to 6 hr for Tu-26. Maximal numbers of sorocarps form when these cultures are given 10 to 11 hr of uninterrupted dark. Light-stimulated cultures of NC-18 placed in darkness and interrupted an hour earlier than the minimal dark period by short exposure to blue or fluorescent light exhibit a 4 to 5 hour delay in fruiting. Low energies of blue light and high energies of red effectively delay fruiting. Light-stimulated NC-18 can fruit in continuous far-red. No red–far red interaction similar to that reported in higher plants was found.

2:45 **Koch, William J.,** and **Linda B. Bernstein.** Department of Botany, University of North Carolina, Chapel Hill.—EXPERIMENTAL STUDIES OF PLANONT VARIATION IN CHYTRIDIAL FUNGI.—Planonts or flagellated spores and gametes are of outstanding use in gaining deeper insight into the phylogenetic meaning of aquatic phycomycetes. Not much is known about the value of planonts for making immediate taxonomic decisions and resolving phyletic relationships at the species and genus levels. Through a study of several genera and species at the light microscope level of observation, we have come to recognize the following potentially useful features: modes of swimming and flagellar withdrawal; flagellar length and position of attachment; body size, shape, and plasticity; and the organelles and inclusions within the planont body. In some cases certain features of the planont were observed to be conspicuously different among different single spore isolates of a species. Also, the planonts of some isolates growing on different substrata were quite different. In order to explore these observations more thoroughly and to put them on a more valid quantitative basis, special experiments were conducted with several isolates of *Phlyctochytrium punctatum* Koch and *Rhizophlyctis rosea* (de Bary and Woronin) Fischer. The results of these experiments reaffirm the validity of inherent planont differences among isolates of a species and the importance of nutritional effects upon the response of the organism.

3:00 **Lessie, P.,** and **J. S. Lovett.** Purdue University, Lafayette, Ind.—A FINE STRUCTURE STUDY OF ZOOSPORE FORMATION IN SYNCHRONIZED CULTURES OF BLASTOCLADIELLA EMERSONII.—Large populations of late exponential-phase *Blastocladiella* plants can be induced to differentiate their zoospores in a synchronized fashion (Murphy and Lovett, Dev. Biol., in press). When induced at 15½ hr, the plants form discharge papillae at 17–18 hr, undergo visible cleavage at ca. 18 hr, 50 min, and discharge zoospores between 19 hr and 19 hr, 30 min. Ten-ml samples were removed every 12 or 15 min, starting at 16 hr, and were fixed and embedded for electron microscopy. The following sequence of intracellular events, starting with the coenocytic plant and ending with the production of ca. 256 zoospores, will be described: nuclear division without dissolution of the nuclear membrane or nucleolus, and with intranuclear spindle fibers and paired extra-nuclear centrioles; extensive cytoplasmic vacuolization, and prominent bundles of macrotubules (ca. 400 A diam) some of which connect to irregular cisternae; papilla formation; septation; flagellum formation by one of the centrioles which elongates to form the basal body (kinetosome); rootlet formation and vesicles which surround the elongating flagellum; formation of cleavage planes by means of vesicles that appear identical to those associated with flagella; completion of cytoplasmic cleavage to produce uninucleate cells; ribosome localization to form the nuclear cap; cap membrane development and organization of the "side body" complex with a single mitochondrion and associated granules. The cytological pattern will be briefly discussed in relation to the previously established physiological changes in the same system.

3:15 **Recess.**

3:30 **Nolan, Richard A.** University of California, Berkeley.—NUTRITIONAL STUDIES WITH THE AQUATIC PHYCOMYCETE CATENARIA ANGUILLULAE.—With the extensive studies which have been conducted on the aquatic phycomycetes *Allomyces, Blastocladia,* and *Blastocladiella,* nutritional studies on closely related organisms, such as *Catenaria,* will help to complete our knowledge of the nutritional patterns within this group of fungi. An isolate of *Catenaria anguillulae* has been studied using shake cultures and a standardized zoospore inoculum. A requirement for a reduced sulfur source (ex. methionine) was established. Inorganic sources of nitrogen are not utilized; and of the 23 organic nitrogen sources tested, only five (L-asparagine, L-ornithine, DL-citrulline, L-arginine, and L-glutamic acid) are utilized. The optimum level of nitrogen, when supplied by vitamin-free casamino acids in the presence of 0.5% glucose, is 0.16 grams N/liter. The optimum *p*H range for growth is 8.2 to 8.7 and presents a very interesting feature of this organism. The optimum temperature for growth is 25 C. All of the work has been conducted using *p*H indicators with the daily adjustment of *p*H where necessary; and in conjunction with this aspect of the study, the toxic effects of 10 *p*H indicators have been assessed. The optimum level of various micronutrients has been determined using several chelators (EDTA, DPA, and NTA). The vitamin requirements of this isolate will be discussed in relation to the key position which some workers believe this organism occupies between the members of the Chytridiales and the members of the Blastocladiales.

3:45 **Goldstein, S., S. Sesnowitz,** and **M. Belsky.** Brooklyn College, City University of New York.—ENDOGENOUS RESPIRATION OF A BIFLAGELLATE MARINE FUNGUS.—Thalli of the nonfilamentous phycomycete *Thraustochytrium aureum* were used to determine the manner in which endogenous respiration may be altered by the presence of exogenous oxidizable substrate and by 2,4-dinitrophenol. Glucose did not stimulate oxygen consumption in starved or unstarved cells and the specific activity of $C^{14}O_2$ evolved from the respiration of uniformly labelled cellular reserves was reduced by less than 10% by exogenous nonisotopic glucose. The bulk (99%) of the entering sugar was assimilated during the 1-hr experimental period. In contrast glutamate (an optimal source of nitrogen but inadequate as a sole source of carbon for growth) exerted a marked stimulatory effect on overall oxygen consumption but sharply curtailed the oxidation of cellular reserves. Oxygen uptake was also increased by 2,4-dinitrophenol. It was a point of interest that this uncoupler increased respiratory activity specifically by stimulating the oxidation of reserve material. However, as with glutamate, 2,4-dinitrophenol did not influence the quantity of glucose taken up or respired.

4:00 **Griffin, D. H.** University of Iowa, Iowa City.—THE EFFECT OF ELECTROLYTES ON REPRODUCTION IN ACHLYA SP.—

Replacement culture experiments show a non-specific salt stimulation of gemma formation. Optimum salt concentration is about 0.08M. Zoospore formation occurs at or below 0.02M salt. Calcium is required for zoospore formation and cannot be replaced by sodium, potassium or magnesium. Optimum calcium concentration for zoospore formation is about 10^{-3}M. At about 10^{-5}M calcium, zoospore behavior is like *Protoachlya*. At less than 10^{-6}M, sporangium primordia are found, but zoospores are usually not cleaved.

4:15 **Gleason, F. H.** University of California, Berkeley.—COMPARATIVE STUDIES ON LACTIC DEHYDROGENASE ACTIVITY, CYTOCHROME CONTENT, AND ULTRASTRUCTURE OF MITOCHONDRIA IN LEPTOMITUS AND RELATED FUNGI.—The capacity for carbohydrate respiration and fermentation varies significantly in the seven genera of the Leptomitales. The metabolic behavior of these fungi can be correlated with lactic dehydrogenase activity, cytochrome content, and the number and size of mitochondria in each cell. An NAD dependent D(-)-lactic dehydrogenase with appreciable activity is present in those fungi which ferment glucose. The highly aerobic genera have a complete cytochrome spectrum; but *Mindeniella*, a strongly fermentative genus even under aerobic conditions, is deficient in cytochrome a–a_3. Finally, the mitochondria are numerous and well-developed in the aerobic group but are scarce and smaller in the fermentative group.

4:30 **Held, A. A.** University of California, Berkeley.—NUTRITION AND METABOLISM OF A FACULTATIVELY ANAEROBIC, FERMENTATIVE WATERMOLD.—A phycomycete representing a new genus of the order Leptomitales (Oomycetes) has been studied in pure culture. It exhibits a combination of metabolic and nutritional characteristics which has not been described before among the fungi. It is facultatively anaerobic; the gaseous environment has no effect on the energy metabolism, which is purely fermentative. Anaerobic conditions appear to enhance vegetative growth of the thallus, whereas the presence of oxygen tends to enhance zoosporangium formation and proliferation. A high atmospheric CO_2 content is required for growth; the fungus thrives under 20% CO_2 and will tolerate 100% CO_2. Nutritional aspects involving adaptation to anaerobic growth will be discussed, with special reference to lipid requirement.

4:45 **Bonitati, J. P., W. B. Elliott,** and **P. G. Miles.** State University of New York at Buffalo.—RESPIROMETRY OF FILAMENTOUS FUNGI.—Techniques have been developed for measuring the respiration of filamentous fungi under a variety of experimental conditions. The methods include the use of tantalum grids for supporting layers of mycelium sufficiently thin to permit free diffusion of respiratory gases during respirometry. The grids also ensure quantitative recovery of the respiring material for sample-mass determinations. Because of the inertness of tantalum, dry weight or protein assays may be performed while samples are on the grids. A special volumetric-type respirometer was developed for use with the grids and will be discussed. Some results of the effects of cultural conditions on the respiration of *Schizophyllum commune* will be presented to illustrate the methods developed.

Session 3. Tuesday Afternoon. Symposium.

FINE STRUCTURE OF FUNGI: SPORE FORMATION AND STRUCTURE. Co-sponsored by the Mycological Society of America. M. S. FULLER, *presiding*.

2:00 **Fuller, M. S.** University of California, Berkeley.—INTRODUCTORY REMARKS.

2:10 **Aldrich, H.** University of Texas, Austin.—ULTRASTRUCTURAL STUDIES ON THE LIFE HISTORY OF THE MYXOMYCETE PHYSARUM FLAVICOMUM.

2:50 **Reichle, R.** University of California, San Diego.—ZOOSPORES AND THEIR FORMATION IN THE AQUATIC PHYCOMYCETES.

3:30 **Carroll, G. C.** University of Texas, Austin.—SOME ASPECTS OF THE ULTRASTRUCTURE OF ASCOSPOROGENESIS IN ASCODESMIS SPHAEROSPORA AND SACCOBOLUS KERVERNI.

4:10 **Burge, Harriet P.** University of Michigan, Ann Arbor.—COMPARATIVE ULTRASTRUCTURE OF ASTEROSPORES OF THE BASIDIOMYCETES.

Session 3. Wednesday Morning.

PETER DAY, *presiding*.

9:00 **Collins, O. R.,** and **J. Clark.** Wayne State University, Detroit.—A PLASMODIAL COLOR MARKER IN A SLIME MOLD, DIDYMIUM IRIDIS.—The brown plasmodial pigment in *Didymium iridis* is apparently inherited on a 1-locus, 2-allele basis. The homozygous dominant (BB) and the heterozygous (Bb) conditions result in production of a brown plasmodium, whereas the homozygous recessive (bb) condition brings about development of a cream-colored plasmodium. In all 714 crosses studied, the pigment was inherited in this straightforward fashion without exception. Single-spore clones from 3 isolates (Honduran, Panamanian, and Costa Rican) were used. All of these clones displayed the dominant allele except those from the Panamanian isolate. The usefulness of the color marker as a genetic tool in possibly refining our concept of the mating locus in *D. iridis* and in investigating the plasmodial incompatibility system in this organism will be discussed. This is believed to be the first report on pigment inheritance for any species of true slime molds (Myxomycetes).

9:15 **Collins, O. R.,** and **J. Clark.** Wayne State University, Detroit.—ON THE GENETIC BASIS OF PLASMODIAL COMPATIBILITY IN DIDYMIUM IRIDIS.—In a recent article in *Mycologia*, Collins asserted that a plasmodial incompatibility mechanism operates in certain heterothallic isolates of *D. iridis*. Based on evidence available at that time, a tentative genetic explanation of how the mechanism might operate was offered. The hypothesis presented implicated 2 loci in addition to the mating locus. With much more data available now, the original hypothesis has been modified to include 3 loci, plus the mating locus. The present tentative model proposes that any 2 plasmodia of the same isolate (= strain) will show compatibility if they are genotypically identical at the 4 loci, or even if they are only "phenotypically" alike at these loci. Since the plasmodium is a diploid structure, examples of pairs of compatible plasmodia can be represented as follows:

$$\frac{CDE}{CDE} \times \frac{CDE}{CDE}; \quad \frac{CDE}{cDE} \times \frac{CDe}{cdE} \text{ and } \frac{cDE}{cDE} \times \frac{cDE}{cDE}.$$

On the other hand, examples of incompatible pairs would include:

$$\frac{CDE}{cDE} \times \frac{cDE}{cDE}; \quad \frac{CDe}{CDE} \times \frac{Cde}{Cde}; \text{ and } \frac{CDE}{cde} \times \frac{cde}{cde}.$$

The implication is that two plasmodia must produce the same compatibility substance(s) if they are to be compatible. Because we have never encountered compatibility between two plasmodia which carry different pairs of alleles at the multiple allelic mating locus, we believe this locus, in addition to its mating function, may possibly play a role in determining vegetative, plasmodial compatibility. Finally, utilizing our recently discovered plasmodial color markers, heterokaryons between brown (Bb) and cream-colored (bb) plasmodia were obtained, thus allowing for immediate and direct observation on the effect of this heterokaryotization process.

9:30 **Mullins, J. T.** University of Florida, Gainesville.—HETEROTHALLISM IN THE BIFLAGELLATE WATER MOLDS: PRELIMINARY GENETIC ANALYSIS.—The heterothallic members of genera such as *Achlya* and *Dictyuchus* are sexually dimorphic, but the potentialities for differentiation as male or as female appear to be labile at the level of the individual. These species typically consist of a linear series of sexual strains, each of which, with the possible exception of the two terminal strains, interacts as male or as female, depending upon its position in the series relative to that of its mate. The sexual reproductive process is initiated and coordinated throughout its entire course by a series of specific diffusible hormones. Information from genetic analysis of progeny and mutagenic studies which indicates a diploid life cycle will be presented. Possible models for the genetic system which controls mating competence will be discussed.

9:45 **Epstein, Ephraim,** and **Philip G. Miles.** State University of New York at Buffalo.—INDOLE METABOLISM IN SCHIZOPHYLLUM COMMUNE.—Some mutant strains of *Schizophyllum commune* produce the pigment indigotin. The same strains also produce indirubin, isatin, anthranilic acid and indole-3-acetic acid. Addition of indole-2-C^{14} to a culture medium of such strains brings about the formation of labeled indigo, indirubin, isatin and IAA, and unlabeled anthranilic acid. Of all these compounds only IAA is formed after the addition of indole to non-pigmented strains of this fungus, but other unknown indolic compounds are produced. The reaction, indole ——→ IAA, is reversible since the addition of indoleacetic acid-2-C^{14} to a culture medium of a pigmented strain brings about the formation of labeled indole together with labeled indigotin and isatin and unlabeled anthranilic acid. It is postulated that a genetic block in the pigmented strains brings about the accumulation of indole which is oxidized to indoxyl and further to isatin. Two molecules of indole will form an indigotin molecule while a molecule of isatin and a molecule of indoxyl will produce indirubin. On the other hand, this indole may be converted to indole-3-acetic acid or broken down to anthranilic acid. Non-pigmented strains do not accumulate indole but possess the enzyme which converts indole to indole-3-acetic acid and other indolic compounds.

10:00 **Miles, Philip G.** State University of New York at Buffalo.—INHIBITION OF THE GROWTH OF SCHIZOPHYLLUM COMMUNE SPORE GERMLINGS BY THE AMMONIUM ION.—It has been observed that spore germlings of *Schizophyllum commune* fail to develop into mycelia when isolated onto a semisynthetic medium which supports the growth of established mycelia. The cause for this failure of growth has been investigated. Spores were collected from fruit bodies formed from several different dikaryons and, after the spores germinated, the germlings were isolated. It was determined that the inhibition of growth of the germlings upon this medium is of common occurrence in *S. commune*. Experimentation has implicated the ammonium ion as the responsible component in the medium for the failure of the germlings to develop into mycelia. These studies emphasize that the germling is a distinct developmental stage between spore and mycelium.

10:15 **Recess.**

10:30 **Schwalb, Marvin N.,** and **Philip G. Miles.** State University of New York at Buffalo.—THE GROWTH AND METABOLISM OF MUTANT AND NORMAL STRAINS OF SCHIZOPHYLLUM COMMUNE UNDER MICROAEROPHILIC CONDITIONS.—An apparatus is described which allows the observation of multiple samples of fungi under oxygen tensions of < 1 mm Hg or larger. Various strains of *S. commune* show definite changes in growth, extracellular polysaccharide production and hyphal morphology under microaerophilic conditions. In addition, the metabolic products which accumulate in the medium were examined and suggestions as to the mode of energy production under these conditions are made.

10:45 **Lemke, P. A.** Harvard University, Cambridge, Mass.—THE GENETICS OF DIKARYOSIS IN A HOMOTHALLIC BASIDIOMYCETE, SISTOTREMA BRINKMANNI.—The genetic evaluation of the interrelationship of homothallism to heterothallism in the higher basidiomycetes has awaited the confirmation of primary (homokaryotic) homothallism in a system (a) amenable to genetic analysis and (b) related to experimentally adequate heterothallic forms. The fungus *Sistotrema brinkmanni*, as a nomenclatural entity, is a composite of homothallic (I), bipolar (II), and tetrapolar (IV) counterparts—all previously subjected to extensive cultural analysis by Biggs (1937). Three further contributions to the system can now be mentioned. These are (1) the enhancement of fruiting competence in culture for the heterothallic as well as the homothallic forms, (2) the confirmation of homokaryotic dikaryosis as well as meiosis in homothallic strains of the system by the use of mutation kinetics and biochemical (auxotrophic) mutations, and (3) the demonstration, through biochemically forced heterokaryosis, that genetic isolation between homothallic and heterothallic counterparts of the complex is not complete. Indicative evidence for the role of incompatibility factors in the genetic regulation of dikaryosis is implicit in the interactions between homothallic and heterothallic strains. Certain of these interthallic heterokaryons ($I \times II$) are dikaryotic in phenotype and sporulate to yield recombinant progeny. Initial genetic analyses suggest that a modification, rather than the total absence, of incompatibility control may account for dikaryotic sexual progression in a homothallic basidiomycete.

11:00 **Yu, Jean Lee,** and **Philip G. Miles.** State University of New York at Buffalo.—STRUCTURAL AND FUNCTIONAL COMPLEXITY OF THE INDIGOTIN LOCI OF SCHIZOPHYLLUM COMMUNE.—Indigotin mutants are characterized by deposition of crystalline indigotin in the medium. Several of these mutant strains have been studied genetically. The time of appearance of pigmentation is clearly different, and the intensity of pigment production is extremely variable. In crosses between wild type and mutant the progeny of some crosses segregate for indigotin and non-indigotin production in a 1:1 ratio, whereas in other crosses the ratio differs from 1:1. The majority of the mutant strains are unilateral dikaryotizers, and in most cases the mutants bear a morphological aberrancy which is inseparable from pigmentation. Problems imposed by tetrapolarity and unilateral dikaryotization have been responsible for the attempts to develop special methods for allelism and linkage studies of the indigotin mutants.

11:15 **Stamberg, Judith,** and **John R. Raper.** Harvard University, Cambridge, Mass.—GENETIC RECOMBINATION IN SCHIZOPHYLLUM COMMUNE.—Use of a "high recombination" strain has shed some light on the control of recombination between the α and β loci of both incompatibility factors. Intra-A-factor recombination frequencies are not determined solely by map distance or specific A factor combinations (Raper et al., PNAS 46: 833, 1960); intra-B-factor recombination frequencies vary in the same manner as the A. Control of intrafactor recombination appears to reside in a polygenic system. Genetic markers linked to the incompatibility sites are being utilized to determine whether recombination control (a) is specific for a particular chromosome; (b) is specific for a particular segment of a particular chromosome; (c) is nonspecific and affects the entire genome.

11:30 **Raudaskoski, Marjatta,** and **John R. Raper.** Harvard University, Cambridge, Mass.—THE ORIGIN OF NEW INCOMPATIBILITY ALLELES IN SCHIZOPHYLLUM.—A new $B\beta$

incompatibility allele, generated via two successive mutations in the $B\beta$ locus (Raper, Boyd, and Raper. PNAS, 53: 1324–1332, 1965), calls attention to two significant questions: (a) is the new allelic specificity endowed in the primary or in the secondary mutation? and (b) can this origin of new alleles account for the extensive multiple-allelic series in nature? Answers to these questions have been sought in the determination of the specificities of secondary mutations induced in three independent primary mutations of $B\beta 2$ and in a single primary mutation of a different $B\beta$.

11:45 **Koltin, Y.,** and **John R. Raper.** Harvard University, Cambridge, Mass.—THE GENETIC STRUCTURE OF THE INCOMPATIBILITY FACTORS OF SCHIZOPHYLLUM COMMUNE: THE B FACTOR.—The study of the B incompatibility factor revealed the existence of three distinct types of B factors, distinguished on the basis of the presence or absence of intrafactorial recombination and through functional tests involving mating interactions. Among intrafactor recombinants, no exception to the 2-locus model (Raper et al. PNAS 46: 833–842, 1960) has been detected. Identification of the different alleles of the α and β loci has demonstrated the existence of a series of 7 alleles at the α locus and 9 alleles at the β locus. Recombination frequency in the B factor ranged from 0.006 to 0.084.

Session 3. Thursday Morning. F. V. RANZONI, *presiding.*

9:00 **Zimmerer, R. P., R. H. Hamilton,** and **Christine Pootjes.** Pennsylvania State University, University Park.—ISOLATION AND MORPHOLOGY OF TEMPERATE AGROBACTERIUM TUMEFACIENS BACTERIOPHAGE.—Lysogenic bacteriophage were detected in 15 strains of *Agrobacterium tumefaciens* out of a collection of 135 strains using strain B-6 as the sensitive host. Thirteen additional strains showed partial lysis with B-6. Bacteriophage isolated from five different strains showed similar morphological features. A typical bacteriophage (lv-1) had a polyhedral-shaped head approximately 71 mμ (length) $\times$ 63 mμ (width), and a tail approximately 211 mμ $\times$ 9.5 mμ. The bacteriophage have been designated by using l (for lysogenic) followed by the bacterial strain designation in lower case letters.

9:15 **Lippincott, Barbara B.,** and **James A. Lippincott.** Northwestern University, Evanston, Ill.—REDUCED INFECTIVITY OF NUTRITIONALLY DEFICIENT MUTANTS OF A. TUMEFACIENS.—Mutants of *A. tumefaciens* strain B6 which require adenine, methionine or asparagine for growth on a minimal medium have been isolated following ultraviolet light or heat treatment. They vary in specific infectivity (number of tumors initiated per viable bacterium inoculated) from $<$ 1 to about 30% that of the wild type. The mutants fulfill two basic tests relating nutritional requirements to loss of infectivity: (1) reversion to a wild type nutritional state is accompanied by an increase in specific infectivity; and (2) addition of the specific compounds required by the mutants to the infected leaf results in increased infectivity. Comparison of the rate of tumor appearance on leaves infected with mutant and wild type bacteria using different carborundum sizes shows the mutants can initiate tumors only at large wound sites. When the specific infectivity of the mutants is compared with that of B6 on several successive days following inoculation, the resulting curve may be extrapolated to show that the mutants are potentially as infectious as the wild type. These results show the reduced infectivity of the mutants to depend on their metabolic requirement and not on direct alteration of the ability to produce a tumor-inducing principle. They indicate that *A. tumefaciens* becomes competent to initiate tumors only after inoculation and following a period of metabolic activity normally supported by wound juices and the synthetic capacities of the wild type strain. The wound juice growth medium is limiting for nutritionally deficient mutants, allowing them to develop competence only at large wound sites.

9:30 **Ranzoni, F. V.** Vassar College, Poughkeepsie, N. Y.—SOIL FUNGI OF THE SONORAN DESERT.—Soil samples were taken from widely diversified and distributed sites in the Sonoran Desert. Intensive sampling was done in Organ Pipe Cactus National Monument, Arizona, and in the Grey's Wells region and near Desert Center, Calif. Soil temperature measurements were made only in Organ Pipe Cactus National Monument. Soil temperature, in general, were high, particularly in the summer months when most of the samples were taken. One or two inches below the surface temperatures as high as 61 C over a period of 2 hr were recorded. Investigations were confined to the surface and the upper 2 inches of the soil, and as far as possible from the root system of surrounding plants. Nearly all groups of fungi from the myxomycetes through the basidiomycetes were represented in Sonoran Desert soil. Demateaceous organisms predominated. Among the commonest organisms found were unidentified species of the Phoma-Phyllosticta complex. *Curvularia* spp., *Alternaria* spp., *Sirosporium mori, Aspergillus fumigatus, Macrophoma* spp., *Rhizopus chinensis, Rhizophlyctis rosea* and several unidentified sclerotial-forming fungi were to be found in the majority of samples.

9:45 **Furman, T. E.** Forest Physiology Laboratory, Beltsville, Md.—SYMBIOTIC RELATIONSHIPS OF MONOTROPA.—The achlorophyllous flowering plant *Monotropa* has been known since Kamienski (1885) as completely dependent on an enveloping fungus and has been shown by Björkmann (1960) to be an epiparasite on tree roots. Studies of *Monotropa uniflora* in Catoctin Mountain Park, Maryland, have shown its root system to be interpenetrated with roots of several angiosperm tree species with which it seems to form a three-phase symbiotic structure of mycorrhizae. Injected ^{32}P passed from *Monotropa* stems into both ectotrophic mycorrhizae of *Quercus* and endotrophic mycorrhizae of *Acer*. The *Monotropa* in the study locale is consistently ectotrophic with a septate mycelium lacking clamp-connections. That such a widespread species should be eclectic in its partners explains its distribution range but appears anomalous to the usual specificity of ectotrophs and endotrophs. Dry matter production and nutrient contents have been compared in the *Monotropa* populations of the forest floor and the surrounding photosynthesizers. If the epiparasite produces more respiring tissue than could be maintained by nutrients translocated through the fungus acting as a litter-decomposer, then it must perforce be sustained through carbohydrate flow from roots of green plants in the common mycorrhizal symbiosis.

10:00 **El Ani, A. S.** Division of Laboratories and Research, New York State Dept. of Health, Albany.—NUCLEAR DIVISION IN THE ASCUS OF NECTRIA CINNABARINA AND THE GENERIC CONCEPT IN THE HYPOCREALES.—*Nectria cinnabarina* was collected on oak twigs from Southern California in March, 1954, and the ascus development was followed with the aid of the aceto-orcein technic from crozier formation to ascospore maturation. The haploid complement was found to be five. The nuclear condition in the ascospore will be discussed relevant to the generic concept in the Hypocreales.

10:15 **Recess.**

10:30 **Kowalski, D. T.** Chico State College, Chico, Calif.—MORPHOLOGY AND CYTOLOGY OF PREUSSIA ISOMERA.—The cells of the vegetative mycelium are mainly uninucleate, but it is not uncommon for them to contain two or three nuclei. Nuclear division appears to occur by the

nuclei elongating slightly and then simply pulling apart. No typical mitotic stages were observed. Ascocarp development is ascostromatic. Formation begins from a spherically swollen, multinucleate cell. Cell division proceeds in a single plane and at a faster rate than nuclear divisions, producing a chain of predominantly uninucleate cells. Cell divisions then occur in three planes to form a globose mass of homogeneous, uninucleate cells, the ascostroma. The cells in the middle of the centrum become binucleate and may give rise to asci very early in development. As the ascocarp enlarges, the cells lining the entire locule give rise to hyphae which resemble paraphyses. These hyphae, however, grow toward the center of the locule and there form enlarged binucleate cells which are ascogenous. This causes the asci to form at a central point and they can grow in all directions. The majority, however, are directed upwards. Ascus formation is by the typical crozier method. The haploid chromosome number is $n = 6$ and centrioles are present at each metaphase stage. The spore walls form at the eight-nucleate stage. The nuclei then undergo two divisions and three septa are laid down forming four-celled spores. Near maturity, there is an additional nuclear division so that each spore cell is binucleate. The cells of the spores are weakly held together, fragmenting easily into separate cells.

10:45 **Schaeffer, Harold, P. Jr.,** and **R. P. Collins.** University of Connecticut, Storrs.—DEVELOPMENTAL STUDIES IN COPRINUS LAGOPUS.—*Coprinus lagopus* was grown and fruited in a simple, defined medium. Carbon, nitrogen, and phosphate utilization were studied in both culture filtrates and mycelial extracts. The free amino acids found as a result of the autodigestion of gills as well as the free amino acids of gills not undergoing autolysis were studied and compared.

11:00 **Collins, R. P.,** and **K. Kalnins.** University of Connecticut, Storrs.—KETO ACIDS PRODUCED BY CERATOCYSTIS VARIOSPORA.—Culture filtrates and cell extracts of *C. variospora* were analyzed for the presence of keto acids. The keto acids were separated as their 2,4-dinitrophenylhydrazones by means of thin-layer chromatography. Seven α-keto acids were separated and tentatively identified by comparing R_F values of known 2,4-dinitrophenylhydrazone keto acids with the unknown keto acid 2,4-dinitrophenylhydrazone derivatives. As a further proof known and unknown 2,4-dinitrophenylhydrazone derivatives were reduced to their corresponding amino acids. Identification of the reduced keto acid derivatives was made by means of thin-layer chromatography. All of the amino acids identified corresponded to previously identified keto acid 2,4-dinitrophenylhydrazones.

11:15 **Northen, Henry T.** University of Wyoming, Laramie.—EFFECTS OF TERGITOL, A BIODEGRADABLE DETERGENT, ON THE GROWTH OF 40 GENERA OF FUNGI.—Fungi were grown on an agar nutrient medium containing 0, 10, 100, or 1000 ppm Tergitol Anionic 15-S-3A sulfate. Concentrations as low as 100 ppm prevented growth of *Saprolegnia* sp., *Nocardia* sp., *Ashbya gossypii*, and three species of *Streptomyces*. Most resistant to Tergitol are *Serratia marcescens* (a bacterium), and two yeasts, *Hansenula anomala* and *Saccharomyces cerevisiae*, which species grew as well on 1000 ppm as in the controls. Species exhibiting reduced growth on 100 ppm and no growth on 1000 ppm include *Aspergillus ornatus, Chaetomium olivaceum, Circinella*, sp., *Mycotypha africana, Phycomyces blakesleeanus, Polysphondylium pallidum*, and *Streptomyces griseus*. Among the species whose growth was reduced 50% or more by 1000 ppm Tergitol are *Absidia orchidis, Alternaria* sp., *Cladosporium herbarum, Curvularia* sp., *Hormodendrum* sp., *Mucor hiemalis, Pseudoeurotium zonatum*, six species of *Penicillium*, and three species of *Aspergillus*. Within a genus, species differ in their sensitivity to the biodegradable detergent. For example, *Streptomyces venezuelae, S. viridochromogenes*, and *S. rimosus* are more sensitive than *S. griseus*. In *Rhizopus stolonifer* sensitivity varies with sex, the minus being more sensitive than the plus. Several species growing on 1000 ppm Tergitol exhibited reduced sporulation, altered rhythms of growth, and change in pigmentation. Tergitol at a concentration of 1000 ppm prevented zygospore formation of *Mucor hiemalis*.

11:30 **Peterson, J. E.,** and **C. C. Cohrs.** University of Missouri, Columbia, and Woodland Hospital and Clinic, Moberly, Mo.—PRELIMINARY CLINICAL EVIDENCE FOR MYXOMYCETE SPORES AS HUMAN ALLERGENS.—Although myxomycete spores might be expected to be components of the atmospheric flora, they have never been reported as such. Since they have not, neither have they been considered as possible allergens. On the basis of very preliminary clinical tests, it appears that myxomycete spores may, indeed, be human allergens. An extract was prepared from fresh *Stemonitis fusca* Roth spores in routine fashion for intradermal use, and a nine-step dilution series was made from the concentrate. These preparations have been used on four "problem-allergy" patients with dramatic results. In two of the cases, injection with moderate dilutions of the extract provoked immediate severe asthmatic attacks. Subsequent continued treatment with dilute concentration of the extract gives promise of ultimate desensitization for both patients. The other two cases were both showing allergic symptoms when treated with dilutions of the allergen extract. In both instances striking relief from the symptoms was immediate. Desensitization of both patients is continuing with apparently good results. It is especially interesting that no skin reactions have been seen in any of these cases.

11:45 **Walker, Alma Toevs.** University of Georgia, Athens.—STRUCTURE AND LICHEN SUBSTANCES OF CORNICULARIA NORMOERICA.—Within the cortical and medullary tissues of the arctic-alpine lichen, *Cornicularia normoerica* (Gunn.) Du Rietz, are deposited and secreted a number of compounds. Light microscope studies of the lichen structure, crystalline compounds isolated and their chromatographic separations will be illustrated and their chemical properties discussed. Particular emphasis is placed upon the methanol extracts affecting specifically the fungus-alga association.

PALEOBOTANICAL SECTION

Session 5. Monday Afternoon. FRANCIS M. HUEBER, *presiding.*

2:00 **Banks, H. P.** Cornell University, Ithaca, N. Y.—ANATOMY OF A HOSTIMELLA.—Specimens of *Hostimella* sp., similar to those described by Halle from the Lower Devonian of Roragen, Norway, have yielded structure. The specimens were collected and loaned by Dr. Olof Selling, Director, Paleobotanical Department, Swedish Museum of Natural History. The xylem strand is solid, round in cross section, and appears to have a central protoxylem area. This is comparable to the *Rhynia*-type of psilophyte and different from the *Psilophyton*-type. The latter has a solid strand, but it is elliptical in cross section and is exarch in maturation.

2:10 **Schmid, Rudolf.** University of Michigan, Ann Arbor.—ELECTRON MICROSCOPIC STUDIES OF CALLIXYLON WOOD.—Replicas were prepared of silicified wood of *Callixylon newberryi*, and ultrathin sections were prepared of non-mineralized wood of an undetermined species of *Callixylon*. The fine structure of the wall corresponds closely

to that in living plants. In sections the tracheid walls exhibit an electron-dense compound middle lamella markedly thickened at the cell corners, a thin electron-transparent S_1 layer in the secondary wall, and a thick electron-dense and perhaps partially decomposed S_2 layer. No S_3 layer is evident. Both sections and replicas of the bordered pit-pairs show pit membranes lacking tori. Microfibrillar structure is not very discernible in either sections or replicas. Crassulae have not been detected with the electron microscope.

2:25 **Bonamo, P. M.,** and **H. P. Banks.** Cornell University, Ithaca, N. Y.—A STUDY OF THE FERTILE BRANCHES OF TETRAXYLOPTERIS.—The specimens of *Tetraxylopteris schmidtii* Beck (1957) which form the basis of this investigation are from the Oneonta Formation of lower Upper Devonian age (Frasnian) in New York State. They are predominantly fertile axes. The sporangia are borne on systems of fertile branches arranged on a main axis in an opposite, decussate manner. Each of these systems dichotomizes twice resulting in four major axes. Each major axis bears three orders of pinnate, alternate subdivisions, the final divisions terminating in one or a pair of sporangia. The final divisions are so short that they are often completely obscured by the sporangia which they bear. Thus the second order pinnate branches appear to bear terminal clusters of sporangia along the length of the first order of branches. The fertile system as a whole, and each of its subdivisions, is curved upward and inward so that the sporangia are perpendicular to the main axis. The sporangia are elongate, oval with an acute tip. The walls seem to be composed of elongate cells and dehiscence was longitudinal. Many spores were obtained from the sporangia of several specimens. All are spherical, trilete and pseudosaccate. The bladder is attached to the body only in the proximal area and thus is usually much folded. The exoexine displays a very fine granular ornament. The spores are identical to the dispersed spore genus *Rhabdosporites* Richardson (1960).

2:35 **Beck, Charles B.,** and **Robert E. Bailey.** University of Michigan, Ann Arbor.—A LYGINORACHIS-LIKE SPECIMEN FROM THE NEW ALBANY SHALE.—A specimen from the Falling Run Formation of the New Albany Shale, interpreted as possibly part of a large compound leaf or leaf-like branch system, is characterized by a branching vascular system. In the base of the specimen, the primary xylem strand is papilionoid and surrounded by considerable secondary xylem and phloem. The stele first branches into two equal parts, followed immediately by an unequal branching of each part in a plane at right angles to the first. Assuming this specimen to be part of a lateral branching system, the larger product of one of the two secondary divisions is adaxial whereas that of the other is abaxial. In the two larger of the four resulting stelar columns, the primary xylem maintains the butterfly shape, whereas in the two smaller, it becomes narrowly elliptical in transverse configuration. Development of primary xylem is mesarch. Traces arise from stelar columns with elliptical as well as from those with papilionoid primary xylem strands. Secondary xylem decreases in amount in successively higher orders of stelar branching. The large amount of parenchyma within and surrounding the primary xylem strand in the basal part of the specimen provides it with a distinctly calamopityean aspect, but the papilionoid primary xylem strand resembles that of *Lyginorachis* and the basal part of the petiole of *Tetrastichia*.

2:50 **Phillips, T. L.,** and **G. A. Leisman.** University of Illinois, Urbana, and Kansas State Teachers College, Emporia.—PAURODENDRON FRY, A RHIZOMORPHIC LYCOPOD.—From middle Pennsylvanian coal balls collected in Kansas and Illinois the ligules and rhizomorph of *Paurodendron* are illustrated. Assignment of *Paurodendron* to the Lycopsida is corroborated. Discovery of the root-bearing portion of this Carboniferous lycopod establishes a diminutive, phyletic line in the Paleozoic with rhizomorphs smaller than many species of *Isoetes*. *Paurodendron* resembles the selaginelloid line more closely than other rhizomorphic types. Anatomical comparisons of *Paurodendron* with roots and root-bearing structures of lycopods are made; the root-bearing and a representative leaf-bearing portion of *Paurodendron* are reconstructed. The three species described by Fry are reduced to one.

3:05 **Recess.**

3:20 **Taylor, T. N.** University of Illinois at Chicago Circle, Chicago, Ill.—LOWER PENNSYLVANIAN COAL BALL PLANTS: CALAMOSTACHYS BINNEYANA.—The discovery of specimens of *Calamostachys binneyana* in Lower Pennsylvanian petrifaction material in North America has provided additional information about the structure of this calamitean fructification. The cones consist of regularly spaced alternating whorls of bracts and sporangiophores. Bracts are fused in a disc except at the margin where the individual units become free. Sporangiophores are inserted at right angles to the cone axis and bear four axially directed sporangia. The vascular system of the North American specimens differs from that in other reports of the taxon in the presence of 12 vascular bundles in the cone axis. Each sporangiophore is supplied by a single vascular trace that departs from one axile bundle. There appears to be no constant relationship between the number of vascular bundles and the number of bracts. Spores are spherical, thin-walled, and of the *Calamospora* type. Relationships with other structurally preserved members in the genus are discussed in light of the diversity in structure demonstrated by the new specimens.

3:35 **Bucher, J. L.,** and **G. A. Leisman.** Kansas State Teachers College, Emporia.—OBSERVATIONS ON SOME PENNSYLVANIAN CALAMITE CONES.—New information concerning *Calamocarpon insignis* includes variability in number of appendages, size and development of the microspores, and bract anatomy. *Paleostachya decacnema* exhibits a solid medulla, a 4- or 5-lobed stele and, correspondingly, 8 or 10 sporangiophores. The bract to sporangiophore ratio may be less than 2 to 1. New anatomical data on the bract is given. Specimens of *Paleostachya andrewsii* show considerable variation in sporangiophore and bract number. Microspores are described. Reasons are advanced for considering *P. andrewsii* as being conspecific with *P. vera*. Only slight differences exist between *P. vera* (= *P. andrewsii*) and *Calamostachys americana*. A new genus is described in which 14 bracts are fused to form a disc with a downward projecting edge. Fourteen superposed sporangiophores arise in a mid-internodal position and are fused to the bracteate disc below by thin lamellae. Each sporangiophore bears four sporangia. There is a suggestion of heterospory.

4:00 **Baxter, Robert W.,** and **G. A. Leisman.** University of Kansas, Lawrence, and Kansas State Teachers College, Emporia.—A NEW EQUISETALEAN CONE WITH ELATERITES TRIFERENS SPORES.—In 1943 L. R. Wilson described some scattered elater-bearing spores found in a middle Pennsylvanian coal ball from What Cheer, Iowa, as *Elaterites triferens*. The spores, averaging 60μ in diameter, with a trilete scar on the proximal surface and three conspicuous elaters attached to their distal surface, have now been found in a nearly intact cone from the same locality. The cone is similar to *Calamostachys* in having whorls of peltate sporangiophores, each with four sporangia, and some secondary xylem at the nodes, but it apparently differs in lacking sterile bracts. The distinctive characteristics of both the spores and the cone give added weight to the contemporaneous existence of the Equisetales and Calamitales in the Pennsylvanian Period.

Session 3. Tuesday Morning. FRANCIS M. HUEBER, *presiding.*

9:00 **Phillips, T. L.** University of Illinois, Urbana.—UPPER CARBONIFEROUS SPECIES OF BOTRYOPTERIS.—The known stratigraphic occurrences of American specimens of *Botryopteris* largely complement those occurrences of the genus known from western Europe and the Donetz Basin of the U.S.S.R. Three new American species, representative of three proposed phyletic lines in the Upper Carboniferous, are described from Lower and Middle Pennsylvanian coal balls. The laminate foliage of two of the new species is partially described. Ascertained from organic connections, three previously established American species, *Botryopteris trisecta, B. globosa* and *B. americana,* are parts of a single species which has, in turn, been referred to *Botryopteris forensis. B. forensis* is one of the few coenopterid species with representative portions of all sporophytic organs described and reconstructed. The discovery of a new species, in the oldest coal balls known from North America, serves more clearly to relate the generotype, *B.* forensis, to *B. hirsuta* in one phyletic line. The evolution of a siphonostele is evident in a second phyletic line including *B. ramosa* and *B. tridentata.* The third group of species includes the European forms, *B. mucilaginosa* and possibly *B. renaulti.* Trace formation, emission and branching are compared in the proposed phyletic line culminating in *Botryopteris forensis.*

9:15 **Phillips, T. L.,** and **H. N. Andrews.** University of Illinois, Urbana, and University of Connecticut, Storrs.—BISCALITHECA (COENOPTERIDALES) FROM THE UPPER PENNSYLVANIAN OF ILLINOIS.—In 1957 Mamay described some well-preserved sporangia from the Upper Pennsylvanian of Illinois under the name *Biscalitheca musata.* They are distinguished by their large size (3–4 mm long) and complex wall structure. His collection consisted of a concentration of hundreds of sporangia suggesting an aggregate comparable to that of *Botryopteris.* Our account is based on specimens from the same locality and it includes parts of the branch system that bore the sporangia. That part of the branch system preserved is a bipinnate frond with the sporangia, in soral groups of about seven, borne along the trailing edge of the ultimate branch order. The general organization seems to be quite like that of Grand 'Eury's "*Androstachys frondosus*" and we are inclined to believe that *Biscalitheca* is closely allied to the *Zygopteris* complex.

9:30 **Eggert, D. A.,** and **T. N. Taylor.** University of Iowa, Iowa City, and University of Illinois at Chicago Circle.—A FERTILE ETAPTERIS FROM THE MIDDLE PENNSYLVANIAN OF ILLINOIS.—Numerous frond axes referable to the coenopterid fern genus *Etapteris* have been found both in attachment and in association in two Middle Pennsylvanian petrifactions from Illinois. These axes include petioles, primary pinnae, and secondary pinnae upon which planated foliar areas are present. Two rows of sori occur along the secondary pinnae. These sori are radially symmetrical and are composed of relatively few (approximately 5–7) individual sporangia that are attached about a common stalk. The sporangia are elongate, curved, and have two lateral multiseriate annular zones. The sporangial walls are one cell layer in thickness, and have a histology that is closely comparable to that described for the genera *Biscalitheca, Monoscalitheca,* and *Notoschizaea.* Spores within the sporangia are radial, trilete, and measure approximately 55 μ in diameter. The spores are further characterized in having extremely long rays and an exceptionally thick spore wall. A re-evaluation of the supposed natural relationships of forms included within the family Zygopteridaceae is based upon the specimens of *Etapteris* and recent information obtained concerning the fertile parts of other zygopterid ferns.

9:45 **Stidd, B. M.** University of Illinois, Urbana.—MORPHOLOGY AND ANATOMY OF THE FROND OF PSARONIUS.—Several small, relatively well-preserved axes of the genera *Stipitopteris* and *Stewartiopteris* indicate a more complex frond than has been shown in previous reconstructions. The presence or absence of the internal trace as well as its configuration seems to be quite variable. Also, an additional manner of trace emission has been found. The distal portion of the frond is elucidated by an excellent, circinnately coiled specimen which shows in cross section many scales and multicellular epidermal hairs. This feature, observed in petrifaction material, may make possible a correlation with certain compression fossils of the genus *Pecopteris.* The problem of distinguishing between ontogenetic variation in the frond and bona fide species is discussed.

10:05 **Recess.**

10:20 **Gray, L. R.** Chicago City Junior College, Chicago, Ill.—PALYNOLOGY OF THE MIDDLE KITTANNING COAL IN OHIO.—The Middle Kittanning Coal was collected from seven localities in eastern Ohio and from the type area in western Pennsylvania. At seven of the eight localities, the coal was sampled in two, three, or four intervals, while at one, seven intervals were sampled. The evidence indicates that the small spore assemblages generally are uniform in composition and relative abundance, although the vertical distribution of some forms appears to vary geographically. Seventy-two kinds of small spores have been observed, including the following taxa: *Alatisporites* (*A. trialatus* and *A. varius*); *Calamospora* (*C. breviradiata, C. hartungiana,* and *C. straminea*); *Cirritriradites* (*C. annulatus* and *C. annuliformis*); *Crassispora plicata*; *Cyclogranisporites* (*C. aureus* and *C. pergranulus*); *Densosporites* (not observed in the Ohio samples); *Endosporites* (*E. ornatus* and *E. plicatus*); *Florinites antiquus*; *Granulatisporites* (*G. granularis, G. levis,* and *G. spinosus*); *Laevigatosporites* (*L. desmoinensis, L. globosus, L. medius, L. minutus, L. ovalis, L. pseudothiessenii, L. punctatus* and *L. robustus*); *Lophotriletes*; *Lycospora* (*L. brevijuga* and *L. granulata*); *Murospora kosankei*; *Punctatisporites* (*P. minutus, P. obliquus* and *P. sulcatus*); *Raistrickia* (*R. crocea* and *R.* cf. *grovensis*); *Reinschospora*; *Schopfites* (*S. colchesterensis* and *S. dimorphus*); *Torispora securis*; *Triquitrites* (*T. additus, T. bransonii, T. exiguus, T. inusitatus,* and *T. spinosus*); *Vesicaspora wilsonii*; *Vestispora* (*V. fenestrata, V. laevigata,* and *V. quaesita*); and *Wilsonites.*

10:35 **Langenheim, Jean H., Betty L. Hackner,** and **Alexandra Bartlett.** Harvard University, Cambridge Mass.—MANGROVE POLLEN AT THE DEPOSITIONAL SITE OF OLIGO-MIOCENE AMBER FROM CHIAPAS, MEXICO.—Pollen from 12 rock samples from Chiapas, Mexico, either from strata containing amber or immediately adjacent to them, were studied. These samples are primarily calcareous siltstones or silty shales and considered, from fossil marine invertebrate evidence, to be latest Oligocene or ealiest Miocene in age. The pollen indicates development of mangrove vegetation of considerable complexity at or close to the site of deposition of the amber. The most important elements of the vegetation suggested by the pollen record were members of *Rhizophora,* probably representing several species of different ecological preferences. Despite the fact that paleoecological conclusions must be tentative until more careful studies of both the delimitation of different modern mangrove species and of pollen sedimentation along the Pacific coast of Central America are made, certain environmental conditions are suggested for the depositional site. At some sites the beds from which the samples came apparently were deposited under brackish conditions with a predominance of *Rhizophora*; some in a more coastal, saline mixed *Rhizophora* vegetation; others near a backswamp forest adjacent to *Rhizophora* or possibly in foreshore con-

ditions in the vicinity of mangroves. These palynological data likewise support the geological conclusions that deposition of the amber-bearing beds generally took place along the coastline of a shallow, tropical sea with occasional shoreline fluctuations. Evidence from comparative infra-red spectra and inclusions that the amber was produced by possible ancestral populations of *Hymenaea courbaril* also receives corroboration as this species today commonly occurs in habitats in which accumulated resin could easily enter mangrove deposits.

SYSTEMATIC SECTION

Session 1. Monday Morning. QUENTIN JONES, *presiding.*

11:00 **Stuckey, Ronald L.** The Ohio State University, Columbus.—TAXONOMIC AND GEOGRAPHICAL RELATIONSHIPS IN NORTH AMERICAN RORIPPA (CRUCIFERAE).—The species of *Rorippa* native to North America fall within two groups, the annuals and the perennials. The annual species are considered to be the most recently evolved in that they possess derived characters such as taproots, thin leaves, petals shorter than the sepals, and short anthers. Within these species, or among several closely related species, there are often well-defined centers of morphological diversity—that is, geographical areas in western United States where nearly all of the variations in certain morphological characters may be found. The perennial species are considered to have primitive characters such as horizontally spreading roots, thick leaves, petals longer than the sepals, and elongate anthers. These species are well-defined morphologically and are isolated in geologically old areas. They are believed to be relic species representing fragments of a former widespread population. In a series of six morphologically similar species which have geographically adjacent distributions, we can follow the changes in several morphological characters beginning with *R. sinuata,* a primitive species, and culminating in *R. sessiliflora,* a highly derived species. These morphological trends are (1) a gradual reduction in size of the petals, (2) shortening in the length of the anthers, styles, pedicels, and seeds, and (3) an increase in the numbers of seeds per silique. We may look to the more recently evolved annual species with centers of diversity still evident in order to understand what has happened in the past to produce those species which are morphologically similar and are now adjacent or isolate geographically. Whereas morphologically similar and related species are adjacent or isolated geographically, morphologically diverse and unrelated species are sympatric.

11:15 **Bobear, Jean B.** State University of New York, Brockport.—VARIATION IN THE IRISH EUPHRASIA.—Taxonomic treatment of the Irish *Euphrasia* has followed the pattern common to genera designated as critical. The variation within the genus is typified by a lack of discrete characters or rather by an overlap of ranges for morphological characters with a resulting separation of species which is based on small differences. Barriers to hybridization are weak or non-existent and intermediate populations are of frequent occurrence. Populations selected as representative of homogeneous morphological types were sampled and subjected to simple biometric analysis of 35 morphological characters. Some structuring of the variation resulted. All characters except one, glandular hairs, were found to be continuously variable, and were also inconsistently variable within each species. Some vegetative characters proved efficient in distinguishing species. The majority of characters were stable in cultivation. For most species habitat appeared to be an important factor in speciation and is often an aid in identification. Continuous variation of morphological characters is typical of the Irish *Euphrasia,* yet there is clustering of morphological types which are of frequent occurrence.

11:30 **Terrell, Edward E.** New Crops Research Branch, Crops Research Division, U.S.D.A., Beltsville, Md.—A CONSPECTUS OF THE GENUS LOLIUM.—The genus *Lolium* (tribe Festuceae) consists of eight tentatively recognized species, all of which are diploid ($2n = 14$). The genus is most closely related to *Festuca,* with which it forms natural and artificial hybrids. Artificial interspecific crosses in *Lolium* have succeeded in nearly all possible combinations. Natural interspecific hybridization has been partly responsible for the continuous nature of the variation and for the difficulty of separating taxa. The species are indigenous to Europe, the Atlantic Islands, northern Africa, and western Asia, and have been widely introduced on all continents. The center of variation is in the Mediterranean–southwestern Asia region, one which has been greatly disturbed by human activity in historical times. Certain problems in species indistinctions are more understandable when viewed in the light of man's disturbance of the habitat. The taxonomy has been further obscured by the chaotic state of the nomenclature. There are about 440 names in existence for taxa of various ranks in the genus, the result of the tendencies of many European botanists of the eighteenth and nineteenth centuries to give a new name to every local, minor variant.

11:40 **Smith, Dale M.,** and **Donald A. Levin.** University of California, Santa Barbara, and University of Illinois, Chicago.—THE CHROMOSOMES OF EASTERN NORTH AMERICAN PHLOX.—The karyotypes of 32 *Phlox* taxa were studied in many plants representative of populations found throughout eastern North America. Most plants were diploid with $2n = 14$, but a few tetraploids and plants with B-chromosomes were also observed. Some species were virtually indistinguishable karyotypically, while others deviated strikingly. Within and between the Subsections *Speciosae, Divaricatae,* and *Subulatae,* strikingly similar karyotypes were observed. Other Subsections differed significantly, with the *Ovatae* showing strong intra-subsectional variation. Karyotype asymmetry is correlated with morphological specialization. Where polyploidy was observed, discordant chromosome sets indicated allopolyploidy.

Session 7. Monday Afternoon.

1:30 **Clewell, Andre F.** Florida State University, Tallahassee.—EVOLUTIONARY BRINKMANSHIP IN LESPEDEZA.—Native American lespedezas (Leguminosae) are perennial herbs with long-lived seeds (55 yr). Dispersal is by animals passing seeds in their feces. Eleven species have been delimited by field, herbarium, and garden studies. Plants of all species have 20 somatic chromosomes. Most populations consist of 2–7 species and occur on dry, open sites. The species are taxonomically difficult, because nearly all populations contain some hybrids. Thirty-three hybrid combinations have been identified; two hybrids have been synthesized; and widely segregating offspring were obtained in progeny tests on 26 spontaneous hybrids representing 9 hybrid combinations. Most hybrids are partly or fully fertile, and pollen stainability in hybrids is generally only 20% lower than in plants belonging to the species. How the species have retained their identities in light of this degree of hybridization is open to question. The species seem to be continually on the brink of hybridizing themselves into a single polymorphic taxon. Seven interacting barriers causing reproductive isolation are operative: (1) limited ecogeographic isolation; (2) constancy of pollinating insects; (3) high degree of autogamy, primarily via cleistogamy; (4) plant succession—habitats invaded by lespedezas become consolidated before many seeds of hybrids can form

and germinate; (5) genic sterility via univalents and lagging bivalents which are not incorporated into microspores; (6) chromosomal sterility via translocations; and (7) partial inviability of the F_2 generation. Viable F_2's, which mostly form via self-pollination, often closely resemble plants of their parental species. Introgression is thereby accomplished without backcrossing.

1:45 **Clewell, Andre F.** Florida State University, Tallahassee.—FIRE AND THE PRE-COLUMBIAN DISTRIBUTION OF LESPEDEZA.—Plants of the 11 native American species of *Lespedeza* (Leguminosae) occur on dry, open sites, roughly within the eastern half of the United States. Present distributions of species indicate that in pre-Columbian times lespedezas were primarily distributed along the border between the Deciduous Forest Formation and the Prairie Formation, and also between the deciduous forest and the southeastern pine savannahs. These regions were subjected to frequent lightning-set and Indian-set fires. The adaptation of lespedezas to fire habitats and the necessity of frequent fires for the survival of *Lespedeza* in pre-Columbian times have been demonstrated at the Tall Timbers Research Station, Leon Co., Fla., and in several virgin savannahs in southern Georgia and elsewhere. Road building and other disturbances account for the abundance of the genus in the Deciduous Forest Formation today. Cultivation has probably reduced the numbers of plants in the Prairie Formation; however, in the Southeast cultivation has probably increased the numbers of lespedezas. The reason for this increase is that cultivation has destroyed much of the wiregrass, *Aristida*, which covered vast areas and which provides severe competition for *Lespedeza*. Wiregrass does not invade old fields, even in old fields which have been kept open by annual burning for 60–100 years. Such fields contain lespedezas abundantly.

1:55 **Raven, Peter H.,** and **David P. Gregory.** Stanford University, Stanford, Calif.—THE EVOLUTION OF POLLINATION SYSTEMS IN GAURA (ONAGRACEAE).— *Gaura* comprises about 19 species. The greatest representation of species and of morphologically diverse sections is in west Texas. Most species of *Gaura* are self-incompatible perennials, have white flowers that open near sunset, and are visited and pollinated by small or medium-sized moths. One section of *Gaura*, of which the best known species is *G. biennis* L., is characteristic of the eastern United States. This section includes the only two species of *Gaura* in which the flowers open in the morning. One of these, *G. lindheimeri* Engelm. & Gray, of east Texas and adjacent states, grows on black prairie soil. It occurs sympatrically with another, evening-opening species of the same section, but it is predominantly pollinated by bumblebees in the morning and thus highly isolated reproductively, with F_1 hybrids very rare. It also blooms earlier in the season. A second morning-opening species occurs locally in the vicinity of Hot Springs, Arkansas. This undescribed species occupies an enclave in the range of the evening-opening ones and does not occur sympatrically with them. It is less morphologically differentiated than is *G. lindheimeri*, although clearly distinct. Taken together, the two species illustrate stages in the evolution of new entities through divergence in pollination systems, at first accompanied by little morphological change.

2:10 **Klein, William M.** Colorado State University, Fort Collins.—THE ORIGIN OF OENOTHERA CALIFORNICA WATSON.—*Oenothera californica* occurs in small scattered colonies on disturbed sites throughout the coast ranges of southern California extending into northern Baja California. Meiotic observations of plants in populations scattered over this range have established the tetraploid nature ($2n = 28$) of this species. The typical chromosome configuration observed in pollen mother cells is five quadrivalent and four bivalent associations although cells with seven quadrivalent associations have been observed. Morphologically this species is most similar to a contiguous, polytypic diploid species ($2n = 14$), *Oenothera avita* (Klein) Klein, which occurs in the Great Basin region. *Oenothera avita* is chromosomally polymorphic with structurally homozygous, seven-paired, and translocation heterozygotes, usually rings of four chromosomes and five pairs, present in the same population. Through a series of crosses and analysis of the hybrids it was determined that the seven-paired configuration was common to all populations tested. Crosses were made between plants bearing the characteristic arrangement of *O. avita* and *O. californica* and chromosome pairing determined in the triploids. A maximum of seven trivalent associations were observed in these hybrids. The high frequency of quadrivalent associations in natural populations, and trivalent associations in artificially produced hybrids support the hypothesis that *Oe. californica* originated through the doubling of the characteristic chromosome end-arrangement of *O. avita*. The morphological and ecological similarities of these species and their distribution patterns also suggest such a derivation. Studies are now in progress attempting to synthesize *Oe. californica* and obtain biochemical evidence bearing upon its origin.

2:25 **Maze, J., N. G. Dengler, W. R. Hildreth,** and **R. Myatt.** University of Toronto, Ontario, and University of California, Davis.—THE REDUCED AWNS OF SOME MEMBERS OF THE GENUS STIPA AND THEIR POSSIBLE RELATIONSHIP TO DISPERSAL MECHANISMS.—The genus *Stipa* is characterized, in part, by well-developed, persistent, terminal awns on the florets. There are, however, some species of *Stipa* with reduced, deciduous awns. Two examples of such species are *S. webberi*, a species of western North America, and *S. ichu*, a species of Central and South America. Information from morphological and cytological data indicates that these species of *Stipa* may represent two lines of evolutionary awn reduction. *Stipa webberi* is similar to *S. pinetorum*, differing primarily in its reduced awn. *Stipa ichu* is somewhat different from *S. webberi* and *S. pinetorum*. These two trends toward awn reduction seem most logically explained as a result of evolutionary modification of part of the dispersal mechanism. In some of the species of *Stipa* that have well-developed awns, the awn is pubescent and may be an adaptation for dispersal by wind or by adhering to the fur of mammals (Stebbins, 1956). The change in dispersal mechanism leading to the weakening of the awns of *S. webberi* and *S. ichu* may have been a transfer of the adaptation for dispersal from the awn to the floret. The florets of *S. webberi* are densely pubescent with long hairs and may serve as a means of dispersal. The florets of *S. ichu* are small and light in weight and bear at their apex, a group of long hairs. This small, light floret and long hairs combine to make an effective unit for wind dispersal, more effective than that found in many other species of *Stipa*.

2:40 **Long, Robert W.** University of South Florida, Tampa.—INTER- AND INTRASECTIONAL ARTIFICIAL HYBRIDS IN RUELLIA AND THEIR TAXONOMIC SIGNIFICANCE.—Interspecific pollinations between and within sections *Dipteracanthus*, *Euruellia*, and *Physiruellia* of *Ruellia* (Acanthaceae) have resulted in the synthesis of 22 different F_1 hybrids. Plants could be classified as vigorous and fertile, vigorous with reduced fertility, weak and partially fertile, and sterile. Intersectional crosses regularly yielded partially or completely sterile hybrids. The tropical American species *R. brittoniana* (sect. *Physiruellia*) was successfully crossed with Mexican-Texan *R. occidentalis* (sect. *Euruellia*) to produce vigorous, partially fertile hybrids that were morphologically similar to *R. malacosperma* (sect. *Physiruellia*). All intersectional hybrids and many intrasectional hybrids showed meiotic irregularities during microsporogenesis: univalents, chains, precocious separation of bivalents, laggers, non-disjunction, multiple spindles, and micronuclei. Parental taxa are interpreted in genecological terms to be groups of polytypic ecospecies or of cenospecies.

2:55 **Crovello, Theodore J.** University of Kansas, Lawrence.—QUANTITATIVE TAXONOMIC STUDIES IN THE GENUS SALIX.—Section *Sitchenses* of the genus *Salix* contains from one to three taxospecies depending on the particular taxonomic treatment at hand. Techniques of numerical taxonomy were employed to provide information as to how many formal, taxonomic entities should be recognized within the Section, using the criterion of the uniform taxospecies concept. Estimates of phenetic distance between closely related species of the 31 species in California recognized by Munz were obtained. These served as a context in which decisions within the Section *Sitchenses* were made. A coefficient of distance was used in the calculation of the Basic Similarity Matrix, an OTU $\times$ OTU table from which the similarity between any two OTUs could be read. Various methods of factor analysis and of Robert C. Tryon's cluster analysis were used to cluster the OTUs in hyperspace. In the first stages there were over 550 OTUs, each plant scored for 149 characters being an OTU. In later stages, clusters of individuals were treated as OTUs. The results differed with the use of different methods.

3:10 **Recess.**

3:20 **Mueller, Sabina.** University of North Carolina, Chapel Hill.—THE TAXONOMIC SIGNIFICANCE OF CUTICULAR PATTERNS WITHIN THE GENUS VACCINIUM (ERICACEAE).—Since macroscopic leaf morphology has been found inadequate in characterizing the species of *Vaccinium*, the microscopic structure of leaf surfaces was investigated by using a specially developed plastic replica technique in order to determine the relative taxonomic value of cuticular characters. A survey of the cuticular patterns of various species showed that the pattern was different for each species examined, although more ornate patterns were more difficult to distinguish. A study of variation within an individual plant, its year-to-year variation, and its ontogenetic variation showed that within a given genotype the pattern is recognizably the same, although density and prominence of the cuticular ridges appears to be environmentally influenced. In a study of populations of individuals suspected of being genetically homogeneous compared with populations containing presumed hybrids, the populations containing the suspected hybrids were found to be quite variable as to cuticular pattern. In these populations the presumed hybrids had cuticular patterns which always differed from the suspected parental species, but the patterns of the hybrids were not alike from one population to another, nor were they always intermediate. Therefore, it is suggested that the cuticular pattern for a species is under rather strong genetic control, and with hybridization the specific pattern breaks down and results, as expected, in the appearance of a pattern different from, or modified from, the original pattern. Hence the use of cuticular patterns as a species-specific character may have its greatest value in population studies for assessing the degree of genetic contamination from other species.

3:35 **Tessene, Melvern F.** University of Michigan, Ann Arbor.—THE ENDEMIC PLANTAGOS OF MT. WAIALEALE, HAWAII.—The summit area of Mt. Waialeale, Hawaii, difficult of access and one of the wettest spots in the world, supports four endemic plantains traditionally named *Plantago krajinai, P. glabrifolia, P. grayana* var. *pusilla* and *P. grayana* var. *grayana*. Except for the last all are confined to the alpine bog which is about one-half of a square mile in area. Here each taxon occupies a different ecological position: *P. krajinai* occurs only along the edge of the ancient volcano's crater, *P. glabrifolia* only in standing or running water. *P. grayana* var. *pusilla* forms pure stands on the tops of ridges and *P. grayana* var. *grayana* occurs in the ecotone between the swales and the ridges. That the four taxa are closely related is shown by reproductive morphology and chromosome numbers ($n = 12$ in all cases) but they show considerable difference in their general habit. Ecological variation results in some of the taxa appearing superficially similar under certain conditions. No indication of hybridization has been found. The problem of how these isolated *Plantago* species evolved to their present form is discussed in light of systematic, ecological and geological factors. Because of the uniqueness of the habitat and the narrow restriction of these plantains both geographically and ecologically, it is possible that this *Plantago* flora represents the coming together of previously differentiated forms into a refugium where additional divergence has occurred.

3:50 **Levin, Donald A.,** and **Harold W. Kerster.** University of Illinois, Chicago.—INTERSPECIFIC POLLEN FLOW IN PHLOX.—Differences in the floral morphology of *Phlox* species include those of style length and pollen size. Species with long styles produce pollen which has a diameter nearly twice that of pollen of short-styled species. Such distinctiveness permits one to determine the direction and extent of interspecific pollen flow within and between populations. Contraspecific pollen is readily discernible on stigmas stained with a solution of aniline-blue in lactophenol. Interspecific pollen flow was assessed in a population comprised of *P. pilosa* and *P. glaberrima*. The pollinators of these taxa, primarily Lepidoptera, show a high degree of discrimination and relatively little interspecific pollination occurs. Less than 25% of stigmas of both species carried contraspecific pollen, and when such pollen was present it was very sparse. Pollen flow was primarily in the direction of *P. glaberrima* whose stigmas contained 8 times the load of contraspecific pollen as did the stigmas of *P. pilosa*. There is little correlation between spatial association and the extent of interspecific pollination. This is ostensibly due to the behavior of the Lepidoptera pollinators which are strong fliers and typically do not move from a plant to one of its nearest neighbors.

4:05 **Duncan, Wilbur H.** University of Georgia, Athens.—DISJUNCTS IN THE SOUTHEASTERN UNITED STATES, ADVENTIVES OR RELICS.—Some species of vascular plants which are well represented in the southeastern United States also have one or more disjunct populations in the area. Information has been obtained concerning the nature of some of the disjunct populations, and especially on the manner in which they were established and how long they have been in existence. Analyses of the data indicate that some naturally reproducing disjunct populations were introduced by man intentionally or accidentally, some are recent natural adventives, others are probably older natural adventives, and others may be relics. The recent natural adventives generally, but not unexpectedly, have windborne propagules, whereas the suspected older adventives may have heavier propagules. The relic populations may have been established since the "ice age" (e.g., *Trientalis borealis*) or much longer (e.g., *Quercus margaretta, Leitneria floridana*). Isolation has been sufficiently long for development of measurable differences between population components of certain species. Some may not deserve taxonomic recognition (e.g., *Lyonia mariana*). Others do (e.g., *Rhododendron minus* var. *chapmanii*).

4:20 **deVlaming, Victor L.,** and **Vernon W. Proctor.** Texas Technological College, Lubbock.—DISPERSAL OF AQUATIC ORGANISMS: VIABILITY OF SEEDS RECOVERED FROM THE DROPPINGS OF CAPTIVE KILLDEER AND MALLARD DUCKS.—Seeds of aquatic and semiaquatic angiosperms were fed to two representative waterbirds: killdeer (*Charadrius vociferous*) and mallard ducks (*Anas platyrhynchos*). The viability and maximum period of retention for seeds recovered from the droppings were determined. Results indicate that resistance of the seeds to avian digestive processes depends both upon the nature of the seed coat and the species of bird through which the seeds pass. Periods of maximum retention were greater in killdeer than in mallard ducks. Plants with highly resistant seeds are

for the most part of wide geographic distribution, suggesting that the extensive range of many aquatic plants can be accredited at least in part to their adaptation to internal transport by birds.

4:35 **Clayberg, Carl D.** Connecticut Agricultural Experiment Station, New Haven, Conn.—STUDIES OF INTERSPECIFIC HYBRIDIZATION IN SINNINGIA AND RECHSTEINERIA (GESNERIACEAE).—Eight *Sinningia* species representing six sections and seven *Rechsteineria* species from three sections have been crossed in all but two of the 210 possible combinations. Hybrids were obtained for 52 of the combinations, 20 of these being reciprocals. The hybrids ranged from complete fertility to complete sterility. Examination of meiosis in pollen mother cells indicated that in most instances sterility was due to post-meiotic breakdown resulting from asynapsis or cryptic structural hybridity. Chromosome counts established that $2n = 26$ for all 15 species, eight of which had not been previously reported. In the usage of Clausen, Keck, and Hiesey, the two genera constitute a single comparium divided into distinct coenospecies. Primary evolutionary divergence of the two genera appears to have been caused by adaptation to different principal pollinators.

Session 5. Tuesday Morning. Symposium. DIVERSE APPLICATION OF PLANT TAXONOMY. Organized by LORIN I. NEVLING. Harvard University, Cambridge, Mass. JOHN M. FOGG, *presiding*.

9:00 **Gentry, Howard S.** United States Department of Agriculture, Beltsville, Md.—TAXONOMY SERVING PLANT EXPLORATION AND INTRODUCTION.

9:25 **Jones, Quentin.** U.S.D.A., Beltsville, Md.—BOTANICAL AND CHEMICAL SCREENING PROGRAMS: CHEMOTAXONOMY IN ACTION.

9:50 **Critchfield, William.** Pacific Southwest Forest and Range Experiment Station, Berkeley, Calif.—THE INTERACTION OF TAXONOMY AND FOREST BIOLOGY.

10:15 **Recess.**

10:30 **Patrick, Ruth.** Academy of Natural Sciences, Philadelphia, Pa.—DIATOMS AS INDICATORS OF CHANGE, PAST AND PRESENT.

10:55 **Gates, David M.** Missouri Botanical Garden and Washington University, St. Louis.—ENERGY EXCHANGE AS RELATED TO PLANT MORPHOLOGY AND TAXONOMY.

11:20 **Fogg, John M.** Morris Arboretum and University of Pennsylvania, Philadelphia.—SUMMARY AND COMMENTS.

Session 6. Tuesday Afternoon.

1:30 **Kane, J. M.** University of Wisconsin, Madison.—BIOSYSTEMATICS OF THE GENUS ACTAEA IN NORTH AMERICA (RANUNCULACEAE).—Two morphologically distinct species of *Actaea* occur in North America. *Actaea rubra* is restricted to glaciated eastern North America, while in the West it is found north and south of the glacial line. *Actaea pachypoda*, the white-fruited eastern species, is found both north and south of the line of maximum glaciation and is sympatric with *A. rubra* over a large portion of glaciated eastern North America. Morphological variation patterns, hybridization and karyology are discussed. The limited hybridization, together with differences in morphology, ecology, and chromosomes suggest that the two species have been separated for a long time and have only recently (post-Pleistocene) come into contact. It is postulated that *A. pachypoda*, clearly associated with the eastern deciduous forest, is an old Arcto-Tertiary element. *Actaea rubra*, as evidenced by its present northern and western affinities, is presently viewed as an element that recently migrated into eastern North America.

1:45 **Iltis, Hugh H.** University of Wisconsin, Madison.—THE WESTERN ELEMENT IN THE EASTERN NORTH AMERICAN FLORA AND ITS PHYTOGEOGRAPHIC IMPLICATIONS.—Recognition of a large Western floristic element in northeastern North America, including many common species, is a key to many taxonomic, phytogeographic and evolutionary-historical problems. Species of western origin, with their eastern vicariad, include *Populus tremuloides-grandidentata, Actaea rubra-alba, Juniperus horizontalis-virginiana, Viola rugulosa-canadensis*, and many others without eastern counterparts. In the West, the western taxa range N-S across the glacial boundary with impunity, while in the East (rarely excepting taxa of cliffs, shale barrens, sands) westerners are *restricted to glaciated land*, as are any hybrids between the species of such pairs. On the other hand hundreds of eastern species of similar tolerances and climax vegetations have migrated north from Appalachia across the glacial boundary. This differential migration suggests that the Pleistocene eastern deciduous forests were essentially unchanged from those of today, did not undergo any major successional changes (except where subject to periglacial phenomena), and were therefore closed, uninvadable communities. On this and many other grounds E. L. Braun's views that effects of Pleistocene glaciers on southeastern vegetation were minimal, that southeastern plant ranges have changed but little, must be accepted. The view of major vegetational southward shifting and a broad band of coniferous forest in front of the ice must be rejected.

2:00 **Xavier, K. S.** Wayne State University, Detroit, Mich.—TAXONOMIC IMPLICATIONS OF ELECTRON AND LIGHT MICROSCOPIC STUDIES OF LINUM POLLEN.—Examination of 130 species of *Linum* by means of the light microscope and 32 species, representing the major subgroups of the genus, by means of the electron microscope, reveals that though the pollen characters within a species are without much variation, one can distinguish most species rather readily. Though the pollen of some of the closely related species are similar in morphology, the fine structure has been found to be different. The large amount of variation among pollen grains in the genus, especially since it appears to be correlated with differences in gross morphology of the plant, may indicate that the usual treatment of *Linum* as a single genus is too conservative. In any case it is believed that the new knowledge obtained from these microscopic studies will contribute substantially to our knowledge of the relationships of the various species of *Linum*.

2:15 **Ugent, Donald.** University of Wisconsin Herbarium, Madison.—SOLANUM × EDINENSE BERTH., A NATURALLY OCCURRING HYBRID OF S. TUBEROSUM.—Population analyses were undertaken in an effort to substantiate Hawkes' report of the hybrid origin of *S.* × *edinense* ($2n = 60$) from *S. tuberosum* ($2n = 48$) and *S. demissum* ($2n = 72$). Mass collections of *S.* × *edinense* from the Nevado de Toluca, Mexico, are morphologically intermediate between *S. tuberosum* and *S. demissum* in corolla diameter, anther length, and plant height. However, the majority of hybrid traits appear to result from the expression of recombined parental characters. Thus the putative hybrid resembles *S. demissum* in the shape of the corolla and calyx lobes, and the breadth/length ratio of its leaves, while it markedly approaches *S. tuberosum* in peduncle length, leaf dissection, and relative lengths of terminal and lateral leaflets. A statistical hybrid index

was devised as a means of assessing the intermediate nature of the leaf from the standpoint of character recombination. Index values were then utilized in the construction of conventional, pictorialized, scatter-diagrams. The results of such analyses agree with ecogeographical and cytological evidence and strongly substantiate the postulated *S. tuberosum* × *S. demissum* hybrid origin of *S.* × *edinense.*

2:30 **Reeder, John R.** Yale University, New Haven, Conn.—VALIDITY OF THE MONOTYPIC TRIBE JOUVEEAE (GRAMINEAE).—In 1956 Pilger described the tribe Jouveeae to accommodate the ditypic genus *Jouvea* Fourn., which is restricted to the seacoasts of Mexico and Central America. Stebbins & Crampton in 1961, however, included *Jouvea,* along with *Distichlis, Monanthochloë, Vaseyochloa,* and *Ectosperma* (= *Swallenia*) in the tribe Aeluropodeae, established by Nevski in 1937. They indicate that the grasses included here all have many-nerved lemmas. This disposition of *Jouvea* was followed by Soderstrom & Decker in 1964, who assigned their newly described genus *Reederochloa* to the Aeluropodeae. While indicating a close relationship among *Distichlis, Monanthochloë, Reederochloa,* and *Jouvea,* these latter authors raise some doubts as to whether *Swallenia* and *Vaseyochloa* belong to this alliance. Recent cytological studies of both species of *Jouvea* indicate that in this genus the chromosomes, although of the same basic number ($x = 10$) as those of *Distichlis* and *Reederochloa,* are very much larger and, indeed, appear to be unusually large for grasses of the eragrostoid alliance. This remarkable cytological difference, along with the unusual pistillate inflorescence, quite different caryopsis, 3-nerved lemmas, ligule consisting of a ring of hairs, and certain differences in the leaf anatomy and epidermis, suggest strongly that *Jouvea* is not closely related to *Distichlis, Monanthochloë,* and *Reederochloa.* The retention of the tribe Jouveeae Pilger for the single genus *Jouvea* appears, therefore, to be fully justified.

2:45 **Recess.**

2:55 **Webster, Grady L.,** and **Barbara D. Webster.** University of California, Davis.—THE MORPHOLOGY AND RELATIONSHIPS OF DALECHAMPIA.—The circumtropical but preponderantly American genus *Dalechampia,* comprising nearly 100 species of twining vines (or rarely subshrubs), is strikingly isolated within the Euphorbiaceae because of its distinctive bibracteate inflorescence. There has been considerable taxonomic controversy with regard to the relationships of the genus, and Croizat has revived the hypothesis of Jussieu and Muller that *Dalechampia* is allied to the Euphorbieae because of a supposed analogy between its inflorescence and the cyathium. Field and laboratory investigations of the common American species *D. scandens,* together with a comparative survey of related species, have thrown some light on these problems. The *Dalechampia* inflorescence seems best interpreted as consisting of a terminal male pleiochasium (with part of the lateral branches transformed for nectar production) juxtaposed to a 3-flowered female cyme. The bisexual inflorescences appear to be distinctly proterogynous, in contrast to the statement of Pax that they are proterandrous. The configuration of the inflorescence—a bilaterally symmetrical pseudanthium—suggests adaptation for cross-pollination, but the closing movement of the bracts makes self-pollination highly probable in the absence of visits by pollinators. The similarity of the *Dalechampia* inflorescence to the cyathium of the Euphorbieae appears to be entirely superficial, and both reproductive and vegetative evidence supports the suggestions of Baillon and of Bentham that *Dalechampia* is related to *Plukenetia* and *Tragia.*

3:10 **Eyde, Richard H., Dan H. Nicolson,** and **Priscilla Sherwin.** Smithsonian Institution, Washington, D. C., and Duke University, Durham, N. C.—FLORAL ANATOMY AND SYSTEMATIC POSITION OF ACORUS (ARACEAE).—A survey of floral anatomy of the Araceae has revealed that *Acorus* is not given sufficient distinction in current systematic treatments. Engler, monographer of the family, made the genus a member of his subfamily Pothoideae, but *Acorus* differs greatly from *Pothos* and related genera in microscopic characters of the gynoecium: (1) each carpel has its own stylar canal, and (2) no carpellary midveins or other bundles are present in the ovary wall. These same characters separate *Acorus* from *Gymnostachys,* a monotypic Australian genus with which it has been linked by generations of taxonomists. In addition, *Acorus* differs from all other Araceae in the introrse dehiscence of its stamens and from most other Araceae in the absence of raphides in floral and vegetative tissues. These differences, together with the ethereal oil cells emphasized by Hegenauer, justify the recognition of a subfamily Acoroideae, with *Acorus* the only genus.

4:00 **Business Meeting of the Section.**

Session 4. Wednesday Morning.

8:30 **Moore, Raymond J.,** and **Clarence Frankton.** Canada Department of Agriculture, Plant Research Institute, Ottawa, Ont.—CYTOTAXONOMIC STUDIES IN NORTH AMERICAN CIRSIUM.—*Cirsium* is native to all continents of the northern hemisphere. All Old World species have the basic chromosome number $x = 17$; the majority are diploids; polyploids ($4x$, $6x$) are common only in Japan. In North America, cytological evolution has produced series of reduced numbers, from $2n = 34$ to 18. Chromosome measurements indicate that the total amount of chromatin has remained constant and that the reduced numbers have been produced by translocations which have increased the asymmetry of the karyome. Reduction has occurred in several groups of related species. Most reduced-number species are in the Section *Onotrophe,* Subsection *Acanthophylla* of Petrak's monograph of North American *Cirsium* and it is in these that reduction to the lowest numbers (to $2n = 18$) is found. Minor reduction (to $2n = 30$), possibly a different process, is found in several other groups. Species-groups containing the lower numbers occupy extensive areas and are among the most widespread species of *Cirsium.* The ranges of the various species will be discussed.

8:45 **Haller, J. Robert.** University of California, Santa Barbara.—SYSTEMATIC AND EVOLUTIONARY RELATIONSHIPS OF PINUS TORREYANA.—*Pinus torreyana* is a narrow endemic of coastal southern California occurring in two small populations: one on the mainland of San Diego County, the other on Santa Rosa Island. Both populations show a considerable degree of morphological variability, much of which is apparently the result of direct modification by the environment. On the other hand, field studies and experimental plantings indicate that the mainland and island populations have diverged genetically to the point where they have become essentially distinct. Both populations of *P. torreyana* are very different from all other species in the genus. Their closest relative in California is *P. sabiniana,* with which artificial hybrids have been made. However, in some morphological features *P. torreyana* shows a striking resemblance to *P. oaxacana* of southern Mexico. The latter species occurs on moist, tropical highlands, associated with an ancient flora. A similar flora occupied much of southern California until the Pliocene. The mild, foggy climate of the sites where *P. torreyana* now occurs may rather closely approach the environmental conditions of the highlands of southern Mexico. The taxonomic isolation of *P. torreyana* and its occurrence in an area of relict subtropical climate together with other relict taxa of southern affinities suggest that the species is of very ancient, probably subtropical origin. With the additional consideration of morphological evidence, *P. oaxacana* appears to be a likely, although remote ancestor.

9:00 **Nelson, Andrew P.** Dartmouth College, Hanover, N. H.—SUBSPECIES AND ECOLOGICAL RACES IN PRUNELLA VULGARIS (LABIATAE).—A Eurasian subsp. *vulgaris*, an east Asian subsp. *asiatica* (Nakai) Hara, and a North American subsp. *lanceolata* (Bart.) Hulten are currently recognized within *Prunella vulgaris* L. The subspecies are differentiated by characters of foliar and floral morphology. European subsp. *vulgaris* contains a southern-lowland race which matures in one season in cultivation and a boreal-montane race which requires two seasons to come to flower. Californian materials of subsp. *lanceolata* include a first-year flowering race from lowland sites and a second-year flowering race of montane origins. Potential for perennation under various conditions of cultivation correlates with the amount of first-year flowering in Californian samples. Preliminary studies with subsp. *lanceolata* in eastern North America suggest a similar pattern of differentiation, and trials of a single population sample show that the potential for first-year flowering also exists in Japanese subsp. *asiatica*. Phytogeographic and morphological relationships between the subspecies suggest that subsp. *lanceolata* entered North America by way of the Bering Strait after establishment in northeastern Asia. It is most plausible to assume that this migration was accomplished by plants of a boreal-montane nature and that first-year flowering southern races have developed within each subspecies. Thus the species appears to carry an inherent differentiation potential which has been realized independently within each of its subspecies.

9:15 **Barker, William W.** University of Washington, Seattle.—APOMIXIS IN THE GENUS ARNICA.—Since Afzelius' report in 1936 of apomixis in *Arnica alpina, A. chamissonis,* and *A. diversifolia* there have been speculations that an apomictic behavior might be present in other taxa of the genus and that this might, in part, account for the taxonomic difficulty of the genus. In this study 19 taxa have been investigated in regards to reproductive behavior. Sexual reproduction is reported for *A. venosa, A. viscosa, A. cernua,* and *A. sachalinensis,* and for elements of *A. latifolia, A. fulgens,* and *A. sororia.* Autonomous apomixis is reported for *A. longifolia, A. mollis, A. parryi, A. lonchophylla,* and *A. lessingii.* The existence of both sexual and apomictic elements is reported for *A. alpina* and *A. amplexicaulis.* The possibility of pseudogamous apomixis is suggested for *A. cordifolia* and *A. spathulata.* Previous reports of apomictic reproduction in *A. chamissonis* and *A. diversifolia* and sexual reproduction in *A. montana* are confirmed. It is suggested that a previous report of sexuality in *A. longifolia* is incorrect. All of the elements for which sexual reproduction is known are diploid. All but one of the elements for which apomictic reproduction is known exhibit some degree of polyploidy. This seems to suggest that a reasonable approach to the taxonomy of the genus might be to clearly define the sexual diploid taxa where species in the biological sense may be presumed to exist. Once these species are clearly defined, it may be possible to determine their polyploid derivatives.

9:30 **Bogle, A. L.** University of Minnesota, Minneapolis.—NATURAL AND ARTIFICIAL HYBRIDIZATION BETWEEN PALMATE- AND SAGITTATE-LEAVED SPECIES OF PETASITES.—The systematics of the genus *Petasites* (Compositae; Senecioneae) in North America is based largely on leaf shape. Two species are recognized: *P. sagittatus* (Pursh) Gray, and *P. frigidus* (L.) Fries with three varieties, var. *frigidus,* var. *nivalis* (Greene) Cronq., and var. *palmatus* (Ait.) Cronq. Artificial hybridizations and studies of morphology, fertility, reproductive biology, and distribution indicate that the former species *P. warrenii* St. John (synonymous with *P.* f. var. *frigidus*) and *P. vitifolius* Greene (synonymous with *P.* f. var. *nivalis*) are merely phases of a large and variable group originating in hybridization between *P. sagittatus* and *P.* f. var. *palmatus.* Repeated interbreeding among natural hybrids and backcrossing to the parent stocks seem to have produced a polymorphic progeny. Artificial F_1 hybrids between the putative parents have leaf, anther, and style branch form comparing favorably with that of *P. warrenii* and many specimens relegated to *P. vitifolius.* Leaf form of the artificial hybrid *P. warrenii* × *frigidus* var. *palmatus* is similar to other variants of *P. vitifolius.* Artificial selfing of *P. vitifolius,* and crossing of it to the artificial F_1 hybrid, has produced progeny approximating still other phases of *P. vitifolius.* Pollen stainability indicates a high degree of fertility in F_1 hybrids, with continuing but decreasing fertility in more complex combinations. A formula designation is proposed to include the hybrids. The systematic position of *P. sagittatus* is discussed.

9:45 **Parks, C. R.,** and **Austin Griffiths, Jr.** Los Angeles State and County Arboretum, Arcadia, Calif.—EXPERIMENTAL TAXONOMIC STUDIES IN SECTION CAMELLIA OF THE GENUS CAMELLIA.—The type section of the genus *Camellia* has been so influenced by cultivation that probably two of the named species are products of cultivation. Cross-compatibility and chemotaxonomic data are available for seven taxa in this section—*C. japonica, C. hongkongensis, C. saluenensis, C. pitardii* var. *pitardii, C. pitardii* var. *yunnanica, C. reticulata* and *C. heterophylla.* Out of cultivation, only *C. japonica* and *C. hongkongensis* occur isolated from all others in this section. From both chemotaxonomic and cross-compatibility criteria, *C. hongkongensis* is apart; but with difficulty it has been crossed with the other diploid species, *C. saluenensis* and *C. japonica.* In all respects, *C. japonica* is most closely related to *C. saluenensis.* From chromatographic analysis, cultivated *C. saluenensis* shows *C. japonica* influence, while recent imports of *C. saluenensis* from China do not. On the basis of the data obtained here among the hexaploid species, *C. pitardii* and *C. reticulata, C. pitardii* var. *yunnanica* is more closely allied to the "wild form" of *C. reticulata* than to *C. pitardii* var. *pitardii*; however, these three types are all quite closely related. The evidence indicates that *C. saluenensis* is involved in an allohexaploid origin for the hexaploids mentioned here, and *C. reticulata* is a cultivated form of *C. pitardii,* escaped in one area. The tetraploid, *C. heterophylla,* known only from cultivation, is most likely a hybrid between the diploid and hexaploid species.

10:15 **Recess.**

10:25 **Bhatia, C. R., G. E. Hart,** and **H. H. Smith.** Biology Department, Brookhaven National Laboratory, Upton, L. I., N. Y.—ACRYLAMIDE GEL ELECTROPHORESIS OF LEAF PROTEINS IN NICOTIANA SPECIES.—Using the method of gel disc electrophoresis, it is possible to resolve soluble plant proteins into a number of fractions, based upon their electrophoretic mobilities and the molecular sieving action of the gels, with high reproducibility. The gels may be stained either for specific enzymes, by use of histochemical techniques, or for general proteins. We have applied this method to study the extent of protein and enzyme variation in certain species and some interspecific hybrids of the genus *Nicotiana.* Different selected genotypes of *N. tabacum* and *N. rustica* have also been studied to detect and specify intraspecific variation. In addition to observations on proteins that are stainable with Amido Black or Coomassie Blue, we have studied variation in the patterns of esterases, leucine amino peptidase and peroxidases. The results show a greater variability in the protein patterns between species than between different genotypes of the same species. Preliminary results suggest that specific enzymes may provide a more meaningful measure of genetic homology in evolutionary and taxonomic studies than unidentified proteins. The detailed results will be presented.

10:40 **Pickering, J. L.,** and **D. E. Fairbrothers.** Rutgers—The State University, New Brunswick, N. J.—

TAXONOMIC INVESTIGATION OF MAGNOLIA DENUDATA, M. LILIFLORA, M. × SOULANGIANA, AND M. × SOULANGIANA 'LENNEI' USING SEROLOGICAL AND ACRYLAMIDE GEL ELECTROPHORETIC METHODS.—Data obtained from photronreflectometer, double diffusion, immunoelectrophoresis, and acrylamide gel electrophoresis methods have been employed to investigate the two hybrids *M.* × *Soulangiana* and *M.* × *Soulangiana* 'Lennei', and the parental species *M. denudata* and *M. liliflora.* Results support the morphological and cytological diagnosis of the four taxa. The data also indicate a possible increase in the immunochemical complexity of seed proteins with an increase in polyploidy.

10:55 **Johnson, B. Lennart.** University of California, Los Angeles.—ANALYSIS OF GENOME AND SPECIES RELATIONSHIPS IN THE POLYPLOID WHEATS BY PROTEIN ELECTROPHORESIS.—Protein spectra from 4*n* and 6*n* species of *Triticum* were obtained by electrophoresis of seed extracts on polyacrylamide gels. All spectra were adjusted to a standard migration rate by a method whose error was much less than the width of the narrowest detectable band. Homologies among bands of the different spectra were then inferred from similarity in their migration velocity. These homologies were found to be consistent with evidence from conventional methods regarding genome relationships among the *Triticum* polyploids. *T. dicoccoides* and other known AABB tetraploids showed eight fast-moving albumin homologues, while *T. timopheevi* and other known AAGG tetraploids showed six. The two genomic groups had five albumin bands in common. Species differences within the AABB and AAGG groups were confined to the 6–9 slow-moving bands of the gliadin series. The hexaploid (AABBDD) subspecies showed 12 albumin homologues 8 of which were also homologous with the 8 of the AABB tetraploids, and 4 of which were attributed to the D-genome donor. Differences among the hexaploid subspecies were also confined to the gliadin series and were small compared with differences between the tetraploid species. The hexaploids resembled their presumed tetraploid progenitor, *T. dicoccum* with respect to the gliadin series.

11:10 **Seeligmann, Peter, Michael Thomas,** and **Ralph Alston.** University of Texas, Austin.—FLAVONOIDS OF HYMENOXYS SCAPOSA AND H. ACAULIS.—Rather extensive sampling of the flavonoid chemistry of *Hymenoxys scaposa* and *H. acaulis* throughout their ranges has disclosed a situation which is suggestive of either: (1) widespread interspecific hybridization; or (2) extreme chemical race development within a single taxon. By the latter interpretation, the two taxa would be regarded as a single biological entity having extreme differences in their flavonoid chemistry characteristics of large regions of distribution. Patterns within a particular region are quite consistent. The identification of these major flavonoids is in progress. Those characterized so far have proven to be the somewhat uncommon flavonol types such as quercetagetin glycosides, and quite interesting highly methylated flavone aglycones.

11:20 **Brehm, Bert G.,** and **David H. French.** Reed College, Portland, Ore.—CHEMICAL EVIDENCE FOR GENETIC EXCHANGE IN LOMATIUM (UMBELLIFERAE).—*Lomatium angustatum* varieties were collected from representative sites throughout the geographic range of this species in the Coast Range, Olympic Mts., and the Cascade Mts. of western Washington and Oregon. Two-dimensional chromatographic pattern comparisons were made with *L. martindalei.* The similarity of the patterns and their uniformity support a previous suggestion that these should be considered as one species. A significant variation in pattern components was found in local populations from the north-central portion of the Coast Range of Oregon where a specific combination of chemical characteristics, otherwise known only in *L. hallii,* was present. The current interpretation, based on geographic distributions and comparative chromatographic evidence, is that genetic exchange between the two taxa has occurred, despite the apparent lack of sympatry today. Although the possibility of such interchange has been suggested previously, definitive morphological evidence has not been presented. As of this time, hybridization, introgression, and other processes related to genetic exchange between species have not been reported in this genus.

11:35 **Murdy, W. H.** Emory University, Atlanta, Ga.—THE INHERITANCE OF PHENOLICS IN A MAIZE-TEOSINTE CROSS.—A chromatographic study of phenolic compounds in maize, teosinte, and their F_1 and backcross progeny was carried out. Extracts of plant material were made at frequent intervals throughout their period of development. Differences in the time of appearance and duration of various phenolics, as well as their specific location in the plant, were determined. When two different maize parents (with and without a genetic block for anthocyanin formation) were used in the cross, significant differences in the pattern of flavonoids were revealed. The phenolic constitution of maize and teosinte is discussed in relation to their taxonomic status.

Session 5. Wednesday Afternoon.

1:30 **Miller, H. E.,** and **T. J. Mabry.** The Cell Research Institute and Department of Botany, University of Texas, Austin.—SESQUITERPENE LACTONES OF AMBROSIA PSILOSTACHYA DC.: INTRASPECIFIC VARIATIONS.—It was hoped that a detailed analysis of the sesquiterpene lactones in the Compositae genus *Ambrosia* might resolve questions regarding its systematic position with respect to genera in the tribe Heliantheae. When, however, it was observed that populations of *A. psilostachya* DC. from the Gulf coast of Texas differed markedly in their sesquiterpene lactone content from that reported previously for Kansas and California collections of the species, we initiated a chemosystematic survey of a large number of populations of the species. Different populations of *A. psilostachya* have already yielded a total of fourteen sesquiterpene lactones. Three of the compounds were found to belong to a new class of sesquiterpene dilactones and were named psilostachyin (I), $C_{15}H_{20}O_5$, psilostachyin B (II), $C_{15}H_{18}O_4$, and psilostachyin C (III), $C_{15}H_{20}O_4$. The structures of I, II, and III, which were unique to the coastal populations, were determined by degradative reactions such as dehydrations, hydrogenations, ozonolyses, and metal hydride reductions. Spectral data (N.M.R., I.R., U.V., and mass spectra) and circular dichroism curves proved especially valuable in the structure determinations. Final proof of the structures of all the new compounds was provided by their synthesis from or conversion to sesquiterpene lactones of known structure. Some inland populations of the species contained only a new glycol lactone, which we named ambrosiol. Most of the inland collections (from Texas, Oklahoma, and Kansas) were found to contain mixtures of two or more of the following substances: coronopilin, parthenin, damsin, ambrosin, ambrosiol and six additional new substances whose structures are presently under investigation. Coastal populations of *A. cumanensis* were found to contain only I, II, and III, suggesting a close alignment of this species with the coastal variety of *A. psilostachya.* The peracetic acid oxidative conversion of coronopilin (IV) to psilostachyin (I) suggests the biogenesis of I from IV and experiments are presently under way to isolate the enzyme, a ketolactonase, that might be involved in the biogenesis of I from IV. The chemical and systematic implications of the data are discussed.

1:45 **Fairbrothers, D. E.** Rutgers—The State University, New Brunswick, N. J.—SEROLOGICAL CORRESPONDENCE OF THE GENUS COROKIA WITH TAXA OF THE CORNACEAE, NYSSACEAE AND GARRYACEAE.—The genus *Corokia* has been placed in the families Rhamnaceae, Saxifragaceae and

most often in the family Cornaceae. Melchior (1964) placed the genus in the tribe Corneae of the family Cornaceae in the 12th edition of *Engler's Syllabus der Pflanzenfamilien*. Eyde (1965) indicated it should not be included in the Cornaceae based upon data obtained from floral anatomy. Data obtained from quantitative (photronreflectometer) and qualitative (double-diffusion and immunoelectrophoresis) immunochemical methods indicate slight correspondence of *Corokia* with taxa belonging to the Cornaceae and Nyssaceae, and only negligible correspondence with Garryaceae taxa.

2:00 **Hillebrand, Gary R.,** and **David E. Fairbrothers.** Rutgers—The State University, New Brunswick, N. J.—PHYTOSEROLOGICAL SYSTEMATIC STUDIES OF SELECTED GENERA OF THE RUBIALES AND UMBELLALES.—Selected genera of the Araliaceae, Caprifoliaceae, Cornaceae, Nyssaceae, Rubiaceae, and Umbelliferae have been investigated by phytoserological techniques. Serological analyses of seed proteins by Ouchterlony double diffusion, immunoelectrophoresis, and photronreflectometer turbidity methods have provided an additional taxonomic criterion to be used in evaluating the taxonomic positions of these taxa. Studies of representatives of five tribes of the Caprifoliaceae indicated that the Lonicerae, Linnaeeae, and Diervilleae form a close serological unit, while the Viburneae and the Sambuceae are distinct from the other tribes and from each other. The data revealed greater serological correspondence between *Cornus* (Cornaceae) and the Caprifoliaceae than was illustrated between representatives of the Rubiaceae and the Caprifoliaceae. Representatives of the Araliaceae exhibited a relatively high degree of serological correspondence with the Caprifoliaceae, again higher than between the Caprifoliaceae and the Rubiaceae. These serological data support the classifications which indicate that the Araliaceae, Caprifoliaceae, Cornaceae, and Nyssaceae form a taxonomic unit but do not support classifications which place the Caprifoliaceae and the Rubiaceae in one order and the Cornaceae, Nyssaceae, Araliaceae, and Umbelliferae in another order.

2:15 **Bringhurst, R. S., Y. D. A. Senanayake,** and **Daud A. Kahn.** University of California, Davis.—FRAGARIA POLYPLOIDS, CHROMATOGRAPHIC ANALYSIS.—Chromatographic maps were developed (2-way paper method—phenolic compounds) for 11 *Fragaria* species or subspecies including: diploids ($2n = 14$) *F. nilgerrensis, F. nubicola, F. iinumae, F. viridis,* and European, California (American) and Japanese (= *F. yezoensis*) *F. vesca*; tetraploid ($2n = 28$) *F. orientalis;* hexaploid ($2n = 42$) *F. moschata;* and octoploids ($2n = 56$) *F. virginiana* and *F. chiloensis.* Many spots were common to all *Fragaria* species, but each map was distinctive because of unique spots and discriminative combinations of spots. The evolutionary significance of the compounds shared by a given diploid was studied. Based upon this, *F. orientalis* appears to have originated as an autotetraploid of European *F. vesca,* and the hexaploid *F. moschata* predominantly from *F. viridis* but also from European *F. vesca.* This is consistent with published results of cytogenetic analyses. Octoploid *F. virginiana* evidently is of complex origin involving *F. iinumae* as a major contributor, *F. viridis,* and European and American *F. vesca.* Octoploid *F. chiloensis* may have had a relatively simple origin involving American *F. vesca* and *F. viridis.*

2:30 **Stoutamire, W. P.** Cranbrook Institute of Science, Bloomfield Hills, Mich.—DISTRIBUTION OF SESQUITERPENES IN THE GENUS GAILLARDIA (COMPOSITAE).—Sesquiterpene lactones are present in all but one of the currently recognized *Gaillardia* species, some of these compounds also occurring in other genera and some apparently restricted to *Gaillardia* species. Plant material has been assayed chromatographically and the distribution of these compounds among species of the genus has been determined. The inter-specific distribution of sesquiterpenes closely parallels the cytologically circumscribed species groups. The intraspecific distribution of other sesquiterpenes within geographic races of the widely distributed and polymorphic *Gaillardia pulchella* Foug. has also been investigated. This taxon includes several chemical races in which the sesquiterpenes are geographically limited, their distribution closely paralleling the cytological differentiation which has occurred within the species.

2:45 **Little, Elbert L., Jr.** Forest Service, U.S.D.A., Washington, D. C.—DISTRIBUTION MAPS OF UNITED STATES TREES.—Revised maps of 124 important native tree species have appeared in "Silvics of Forest Trees of the United States," by the Forest Service (U.S. Dept. Agr., Agr. Handb. 271, 762 p., illus., 1965). Also, the 36 native species of *Pinus* have been mapped in "Geographic Distribution of the Pines of the World," by William B. Critchfield and the author (U.S. Dept. Agr. Misc. Pub. 991, 97 p., illus., 1966). Next will be an atlas with distribution maps of 200 tree species, including all native conifers and the important hardwoods. The base is a map of the United States, scale 1:10,000,000, with county boundaries. Any additional range will be shown also on a map of North America. A small preliminary edition is planned to provide an opportunity for review and revision before final publication. Similar maps are being prepared for the remaining native tree species.

3:00 **Recess.**

3:10 **Tryon, Rolla.** Gray Herbarium, Harvard University, Cambridge, Mass.—THE CLASSIFICATION AND EVOLUTION OF AMERICAN TREE FERNS (CYATHEACEAE).—A new classification and phylogeny, recognizing eight groups among the American species, is tentatively proposed for the Cyatheaceae. It is evident that the basic problems in the classification and evolution of the tree ferns are in the American tropics since this is the region of greatest diversity and the region in which the most primitive groups occur. Major evolutionary lines in the family have been in the specialization of the stem and petiole indument and minor ones have developed through the evolution of an indusiate sorus (from an exindusiate one) and of specialized types of petiole spines, venation and spores. The following groups are recognized on the basis of these characters: *Metaxya* and *Lophosoria* are monotypic genera with only trichomes on the stem and petiole; an endemic American group of 23 species, with undifferentiated stem and petiole scales; a group of 22 species with marginally setiferous scales; three groups, *Alsophila,* 55 species, *Cyathea,* 75 species, and *Cnemidaria* (sens. lat.), 40 species, with flabelloid scales; *Hemitelia* (sens. str.), 45 species with highly differentiated scales. This system must still be correlated with the classification of R. E. Holttum based on his extensive studies of the Old World species.

3:25 **Martin, G. W.** University of Iowa, Iowa City.—TAXONOMIC AND NOMENCLATURAL PROBLEMS IN THE MYXOMYCETES.—The Myxomycetes, a rather small group of controversial position, including about 500 species, is recognized by both botanists and zoologists. Since they have been studied mainly by botanists and are specifically recognized in the Botanical Code, it is appropriate to discuss them before a botanical group. There are special problems involved which are briefly noted. Others are common to many other groups, including delimitation of species, genera and higher taxa, overemphasis on single characters, incorrect citations in literature, and the application of the rules of nomenclature. Some are in process of resolution as the result of ultramicroscopic and genetic study. The possibilities of computer analysis are as yet undetermined. Nomenclature, with its static emphasis, and taxonomy, with its progressive and fluid approach, involve grave conflict, which is pointed out by the serious proposal to scrap traditional nomenclature and replace it by an entirely

different system. The results of such a fundamental change deserve serious consideration. A possible compromise is suggested.

3:40 **Ewan, Joseph.** Tulane University, New Orleans, La.—ANNALS OF "THE MOST WONDERFUL PLANT IN THE WORLD" (DARWIN) THROUGH TWO CENTURIES.—The discovery of Venus Fly-trap was announced in a letter from Governor Arthur Dobbs, of Brunswick, N. C., April 2, 1759, to Peter Collinson. John Bartram first sent dried specimens to England; William Young, the first living plants. Ellis sent description and figure of *Dionaea* to Linnaeus who replied that "certainly nothing more interesting was ever seen." In 1770 Ellis published the first color plate of *Dionaea* which was to be copied repeatedly. About 1773 William Malcolm wrote David van Royen at Leiden about sending a print of its leaf and commented that "at present (*Dionaea*) is in ye hands of only a very few persons who (hold) them very dear." Michaux saw feral Dionaeas in 1789 and two years later William Bartram published a description of the feral plants. The traveller Baron Albert von Sack inquired at Hosack's Elgin Botanic Garden in 1807 if *Dionaea* was to be found in its collections. In 1873 Darwin wrote Canby "I look at (*Dionaea*) as most wonderful plant in the world." The same year the French author Pouchet wrote that "according to an English savant, the Flytrap Dionaea does not close the panels of its trap merely to punish the insect which irritates it, but to suck out and feed on its juices, so that it would be a carnivorous plant." Two hundred years after Dobbs announced its discovery, P. L. Ricker reported endangered Venus Fly-trap was being sold in North Carolina for profit to "catch flies" and suckers.

3:55 **Johnston, Marshall C.** The University of Texas, Austin, and Texas Research Foundation, Renner.—SYSTEMATIC STUDIES IN KARWINSKIA (RHAMNACEAE).—This genus presents some of the same kinds of taxonomic problems as do mesquite (*Prosopis*, Leguminosae), granjeno (*Celtis*, Ulmaceae), huisache (*Acacia*, Leguminosae) and bisberinda (*Castela*, Simaroubaceae) in exhibiting little diversity and few morphic discontinuities over a very large arid-tropical and arid-subtropical distributional area. Some of the gradations can be interpreted as evidence of genetic intercontamination or even large-scale introgression. Introgression is particularly well illustrated in the vicinity of Zimapan, Hidalgo, between *K. Humboldtiana* and *K. subcordata* (*K. microphylla*). In the same vicinity *K. mollis* is quite distinct, though some of its same gene-combinations appear to be widespread (as contaminants?) toward the West and South. Maps showing a preliminary evaluation of variation in the genus are presented. Further work is projected.

4:05 **Shetler, Stanwyn G.** Smithsonian Institution, Washington, D. C.—GEOGRAPHIC VARIATION OF CAMPANULA ROTUNDIFOLIA IN NORTH AMERICA.—The circumpolar harebells are widely distributed in North America. Here as in Eurasia the complex constitutes a polyploid series that exhibits great morphological variation. This variation has defied ordinary methods of interpretation. As many as eight species have been recognized on morphological grounds. In this study an attempt was made to define a geographic pattern in the variation by means of parametric statistical procedures and population sampling techniques, using a pool of 3000 herbarium specimens. Four hypothetical regional populations were delimited by using morphotype frequency histograms, generated state by state from the herbarium specimens. These populations were then sampled randomly, and the four samples were analyzed for seven morphological characters, using analysis of variance. The F-tests showed significance at the 1% level in all seven cases, and Duncan's multiple range test was employed to isolate the specific mean differences. As a result of these statistical studies it is possible to distinguish four geographically correlated morphological tendencies. These correspond in general with other data. The conclusion is reached that the four regional morphotypes represent weakly differentiated geographic races of the single species *C. rotundifolia*. The races are being treated taxonomically as subspecies.

4:20 **Iltis, Hugh H.** University of Wisconsin, Madison.—AN AFRICAN ENDEMIC CLEOME (CAPPARIDACEAE) WITH SOUTH AMERICAN RELATIONSHIPS.—Abundant African material in European herbaria revealed the common tropical West African–Congolese *Cleome* previously referred to the neotropical "*C. spinosa*" to be an indigenous distinct species, closely related to several species of the endemic neotropical Section *Tareyana* Iltis. Until now believed a horticultural introduction, the many early collections (from 1816 onwards) and widespread distribution (swamps, wet forests) support morpho-taxonomic segregation of the African plants. The closest relative is the likewise pink-flowered Brasilian-Paraguayan *C. hassleriana* Chod. ("*C. spinosa*" auct. non Jacq.; "*C. pungens*" auct. non Willd.?), the commonly cultivated "Spider Flower," which has, but only very recently, been grown in Congolese gardens. As the only indigenous, spiny, Old World *Cleome*, and because of the above relationships, it represents another remarkable neotropical element in the African flora. Historical explanations for such disjunctions (continental drift, land bridges) are rejected. Avian long-range dispersal is indicated by semi-aquatic habitats of high ecological receptivity, annual habit, and self-compatibility of the group. Similar disjunctions occur in certain aquatic birds (tree ducks—*Dendrocygna*) and other neotropical plants of ecologically receptive "open" habitats. A re-evaluation of LRD in relation to ecological equivalence and differential ecological receptivity along a series of successional stages (i.e., that "openess" of habitat be viewed from the standpoint of invading individuals, and not the communities) is one of the great needs of plant geography. LRD has been continuously effective since life's beginnings, and must be accorded the important role in plant geography it deserves.

4:35 **Davidson, Robert A.** The Catholic University of America, Washington, D. C.—A CYBERNETIC VIEW OF CLASSIFICATION.—The success of classical taxonomy plus recent advances in computer simulations and cognitive psychology suggest that we examine organic classification from a viewpoint that is primarily cybernetic and only secondarily evolutionary in emphasis. The fundamentals of such an approach are briefly discussed.

Session 4. Thursday Morning. Symposium.

THE NATURE AND SIGNIFICANCE OF DIFFERENT BREEDING SYSTEMS. Co-sponsored by the American Society of Plant Taxonomists and the Society for the Study of Evolution. Organized by R. B. CHANNELL, R. C. JACKSON, *presiding*.

9:00 **Brewbaker, James L.** University of Hawaii, Honolulu.—SELF-INCOMPATIBILITY, POLLEN TYPE, AND SUPER GENES IN ANGIOSPERM EVOLUTION.

9:45 **Recess.**

10:00 **Vasek, Frank C.** University of California, Riverside.—ESTIMATION OF OUTCROSSING FREQUENCIES IN NATURAL POPULATIONS.

10:30 **Grun, Paul.** Pennsylvania State University, University Park.—UNILATERAL INCOMPATIBILITY IN THE EVOLUTION OF SOLANUM.

11:00 **Mulcahy, David L.** University of Georgia, Athens.—FLOWERING PATTERN IN SILENE ALBA AND ITS REPRODUCTIVE SIGNIFICANCE.

11:30 **Payne, Melissa Rose.** Belmont College, Nashville, Tenn.—REPRODUCTIVE BIOLOGY OF VIOLA RAFINESQUII.

Session 2. Thursday Afternoon. Symposium. THE NATURE AND SIGNIFICANCE OF DIFFERENT BREEDING SYSTEMS. Co-sponsored by the American Society of Plant Taxonomists and the Society for the Study of Evolution. Organized by R. B. CHANNELL, R. C. JACKSON, *presiding.*

2:00 **Cook, Stanton A.** University of Oregon, Eugene.—PATTERNS IN THE EVOLUTION OF FLOWERING PLANT GENETIC SYSTEMS.

2:30 **Ornduff, Robert.** University of California, Berkeley.—BREAKDOWN OF HETEROMORPHIC INCOMPATIBILITY.

3:00 **Macior, L. W.** Loras College, Dubuque, Iowa.—THE ROLE OF INSECT FORAGING BEHAVIOR IN ANGIOSPERM REPRODUCTION.

3:25 **Recess.**

3:35 **Dodson, Calaway.** University of Miami, Miami, Fla.—CHEMICAL BASES OF ATTRACTION AND THEIR INFLUENCE IN BREEDING SYSTEMS.

4:05 **Jackson, Raymond C.** University of Kansas, Lawrence.—SUMMARY.

TEACHING SECTION

Session 6. Tuesday Morning. PAUL VESTAL, *presiding.*

9:00 **Hollis, C. A.,** and **H. A. Miller.** Duquesne University, Pittsburgh, Pa.—A LABORATORY EXERCISE DEMONSTRATING MORPHOGENESIS.—An experiment for a freshman botany laboratory has been devised and tested, consistent with the modern trend of dynamic approach and student participation. The primary aims of the experiment are: (1) to involve students in problems of morphogenesis; and (2) to acquaint students with the effect of varying photoperiods upon the plant, *Silene pendula* var. *ruberrima.* The students make their own observations of morphogenic changes in vegetative growth; these changes, resulting from varying photoperiods, range from plants with rosette shoots to those with long internodes. They also observe changes in floral morphology ranging from perfect flowers to flowers with nonfunctional stamens and large functional pistils which also are a result of their photoperiodic treatment. Students are invited to correlate their observations with the published genetic and environmental data. Students are then encouraged to decide what new experimental evidence should be collected next, and to give reasons for their decisions.

9:15 **Voth, P. D.** The University of Chicago, Chicago, Ill.—SUITABILITY AND CULTURE OF BRYOPHYTES IN BASIC RESEARCH AND INSTRUCTION.—Increasing use of mosses and liverworts in laboratory investigations during the past 30 years is related, in part, to the development of new techniques and to the adaptation of older ones. Protonemal and leafy stages of mosses can be attained and their development traced using simple devices and expedients. Stock cultures of *Marchantia polymorpha* are maintained with minimum care in the greenhouse using soilless methods. Several factors controlling gemma-cup initiation are documented, assuring large numbers of gemmae at predictable times for experimentation and demonstration. Cup-induction under phytotron conditions and gemma-yield remain fruitful fields of inquiry. Biochemical mutations have been attained and the effect of exogenous growth regulators studied using gemmae as propagules. Enzyme characteristics of vegetative and gametic plants are now under investigation. Experimental and demonstration plants are grown at will by timing their exposure to the proper daylength. Axenic cultures of bryophytes are readily established and maintained in controlled environment rooms. Large masses of tissues have been produced on agar as well as in liquid culture. This has permitted analyses for endogenous growth substances. Methods of culture will be illustrated.

9:30 **Paddock, E. F.** Ohio State University, Columbus.—GOING MENDEL ONE BETTER, WITH SOYBEAN.—The phenotypically light green Yy_{11} genotype in *Glycine max* L. segregates 25% dark green, 50% light green, and 25% yellow seedlings. Self-pollination occurs. Only those pods containing three seeds were used. In greenhouse at about 75 F, most seeds germinated on the third day after sowing, but stragglers came along up to 20 days after the first to germinate. The lowest germination recorded in four annual sowings was 97.3%. The pooled average for the four years was 98.0%. Three relationships were tested for independence by chi-square using pooled data of the four years: (1) position of seed in pod versus phenotype of seedling emerging from that seed, (2) position of seed in pod versus days required for that seed to germinate, and (3) phenotype of seedling emerging from a seed versus days required for that seed to germinate. All three relationships were tacitly assumed by Mendel to be independent but were not actually tested by him. All three tests in soybean failed to reveal any significant departure from independence, thus confirming Mendel in these respects. The 1:2:1 ratio he assumed was obscured in his F_2 peas by dominance and tested in F_3; the ratio is revealed directly in F_2 in these soybeans.

9:45 **Eigsti, O. J.,** and **N. W. Eigsti.** Illinois Teachers College: Chicago-South, and Ball State University, Muncie, Ind.—OVERLOOKED PLANT MUTANTS FOR TEACHING.—Soybeans, waxy-albino maize, *Datura* phenotypes and triploid seedless watermelon offer excellent materials for teaching principles of genetics. Most of these plant representatives can be stored from one semester to the next and made available for classroom use without excessive hours of preparation by the teacher. Furthermore, the student need not waste hours in the laboratory before meaningful observations can be made. Lighting equipment for indoor laboratories eliminates the need for greenhouse facilities and a minimum of space is required for the materials suggested. The standard Mendelian principles, as well as modern concepts, can be illustrated in a number of ways. Some of the techniques used in teaching situations will be discussed in this presentation.

10:00 **Mentzer, L. W.** Illinois State University, Normal.—ASPARAGUS SPRENGERI: A USEFUL LABORATORY PLANT.—*Asparagus sprengeri* Regel, sometimes called asparagus fern, exhibits a wide variety of useful features. Its inflorescences are numerous and they illustrate a raceme. The flowers of this plant are representative of the Liliaceae, and this is important since flowers of this family are scarce at certain seasons of the year. Fruits in the form of berries often set and persist for many weeks. Structures often assumed to be leaves illustrate modified branches called cladophylls which carry on most of the photosynthetic activity of this drought-enduring plant. Branching tuberous roots grow in abundance, providing quantities of cortical tissue which has unusual water-holding capacity. These roots provide good material for dissection to trace branch roots into the pericycle. Individual hand-cut cross sections of the roots are easily made and stained to show detail of

a monocotyledonous root. Cells in the fleshy roots are easily plasmolysed. Besides being excellent for these observations, *A. sprengeri* provides well-developed root hairs noticeable even on mature roots. Excessive growth of the roots forces the soil above the top of the pots and frequently splits the pots, thus focusing attention on this attribute. The practicality of using this plant in the laboratory is enhanced by its simple culture. Vegetative propagation can be carried on rapidly and successfully even under adverse room conditions by splitting the root masses into clones. The extensive branching type of growth of both the stems and roots makes many specimens available from one plant.

10:15 **Recess.**

10:30 **Business Meeting of the Section.**

10:45 **Martens, J. Louis.** Illinois State University, Normal.—SOME ASPECTS OF THE 9:7 RATIO IN ALBINO MAIZE.—Two varieties of *Zea mays* L. were used to develop the ratio of nine green plants to seven albinos. Each was an unidentified variety of yellow field corn. One variety threw AC albinos (*a*lbinos with *c*arotin). The second variety threw AM albinos (*a*lbinos identified by an endosperm *m*arker). The leaves of the former were yellowish; those of the latter, "pure white." In 1964 both the AC and the AM lines were used as pollinators for the alternate line. No albinos occurred in the resulting generation, and in 1965 only seed from ears which were produced on alternate lines by heterozygous pollinators was planted. Individual plots were maintained and the plants selfed. Approximately 1/6 of the plots yielded the 9:7 ratio. From such a plot approximately ¼ of the plants threw no albinos, ¼ threw the AC albino, ¼ threw the AM line, and ¼ threw the 9:7 ratio. When an ear threw the 9:7 ratio, 3/7 of the albinos belonged to the AC line and 4/7 represented the AM line. Of the latter one of the four was presumed to be homozygous recessive for both pairs of alleles. Projects in physiology as well as genetics for which this corn is suited will be suggested.

11:00 **Hoshaw, R. W.** The University of Arizona, Tucson.—NEW LIFE IN TEACHING ORGANISMIC BIOLOGY.—In botany, organismic biology encompasses a variety of courses in the area of plant morphology. The use of *living* materials and the elimination of extensive memorization of subject matter can produce an improved climate for teaching and learning in these courses. Significant teaching of whole organisms and their life processes requires living material for laboratory studies rather than assorted forms of preserved specimens. It is relatively easy to grow, maintain and manipulate a variety of organisms including species from the lower plant groups. Thus, in the laboratory when the emphasis is on organisms, it is now easier to conduct experimental studies. For example, laboratory problems of several types can be designed with algal cultures which are readily available from the Culture Collection at Indiana University. Of special value are problems dealing with three or more cultures manipulated together as a group of unknowns. A number of questions can be asked to determine whether students really understand how living systems of these unknowns function under various experimental conditions. Methods of employing algal cultures in laboratory problems will be illustrated and discussed.

Session 1. Wednesday Afternoon. Symposium. BASIC CONCEPTS IN BOTANY—INITIAL COLLEGE COURSE. Co-sponsored by the Developmental Section, General Section, the American Society of Plant Physiologists, and The National Association of Biology Teachers. HELENA A. MILLER, *presiding.*

2:00 **Introduction.**

2:10 **BONNER, JAMES.** California Institute of Technology, Pasadena.

2:30 **STEBBINS, G. LEDYARD.** University of California, Davis.

2:50 **Recess.**

2:55 **STEWARD, FREDERICK C.** Cornell University, Ithaca, N. Y.

3:15 **THIMANN, KENNETH V.** University of California, Santa Cruz.

3:35 **Audience participation** (90 seconds per speaker).

Session 1. Thursday Afternoon. Panel Discussion CUEBS REPORT TO THE BIOLOGIC COMMUNITY. PAUL A. VESTAL, *presiding.*

2:00 **Scheim, Martin W.** Director, Undergraduate Education in the Biologic Sciences. **Andrews, T. F.** Associate Director, CUEBS.

3:15 **Recess.**

3:30 **Discussion continues.**