

BOTANY

Chairman: CHARLES T. HAMMOND

Department of Biology, St. Meinrad College, St. Meinrad, Indiana 47577

Chairman-Elect: KATHRYN WILSON

Department of Biology, Indiana University-Purdue University
at Indianapolis, Indianapolis, Indiana 46204

ABSTRACTS

Potassium Dependence in *Chlamydomonas reinhardtii*: Evidence for a transport Mutant. DOUGLAS D. DOCTOR and L. DAVID POLLEY, Crawfordsville, Indiana 47933.—The analysis of transport mutants in bacteria and fungi has provided considerable insight into the regulation and the molecular mechanisms of transport in those organisms. Despite the successes of this approach, genetic analysis of transport has not been undertaken in algae or higher plants. Here, we report the results of our initial efforts to isolate and to characterize mutants of *Chlamydomonas* defective for potassium transport.

Wild type cells of *Chlamydomonas* (R3 + NM) were mutagenized by ultraviolet irradiation. Survivors (approximately 5%) were plated on a modification of TAP medium, TAPM-4, containing 10 mM potassium. Surviving colonies were picked and screened indiscriminately by replica-plating to TAPM-4 containing only a trace amount of potassium. Out of approximately 3,000 colonies screened, two did not grow on the low potassium plates. These were selected as putative potassium transport mutants and one of them, laboratory strain NM1/92/22, was selected for further comparative studies with the wild type strain.

The transport of potassium by strains R3 + NM and NM1/92/22 was characterized by following the uptake of ^{86}Rb . Rubidium has been shown to be a suitable analog of potassium and its radioisotope has a more convenient half-life than does ^{42}K . Our studies show that rubidium uptake is energy dependent and that it is not inhibited by ouabain. In contrast to higher plants and algae which generally have complex transport kinetics, Rb transport in *Chlamydomonas* demonstrates simple Michaelis-Menten kinetics. A $V_{\max}$ of 28 nmoles Rb/hr/ 10^6 cells and a K_m of 0.8 mM were determined for Rb uptake by R3 + NM cells grown in TAPM-4 medium containing 10 mM K. When these cells were grown under potassium stress conditions, i.e. 0.01 mM K, or when cells were downshifted from 10 mM K to 0 mM K and incubated for 24 hours, the $V_{\max}$ increased 5-fold to 140 nmoles Rb/hr/ 10^6 cells, but there was little change in the affinity for Rb, $K_m = 1$ mM. The mutant exhibited slightly higher $V_{\max}$ of 40 nmoles Rb/hr/ 10^6 cells and a K_m of 0.8 mM. When these cells were downshifted, however, no change in the kinetic parameters was observed, $V_{\max} = 42$ nmoles Rb/hr/ 10^6 cells and $K_m = 1$ mM.

The observed shift in $V_{\max}$ may be the result of an allosteric change in the potassium pump, production of new pumps with increased capacity, or increased production in the number of pumps. The mutant is unable to increase the capacity of its potassium transport system. This defect may be, in part, the basis for its inability to grow in medium of low potassium concentration.

Growth and Extractable Carbohydrates of Red Oak Seedlings during the First Growing Season. D.S. EGEL and P.E. POPE, Department of Forestry and Natural Resources, Purdue University, West Lafayette, Indiana 47907.—There is considerable information concerning the seasonal distribution of carbohydrates in many tree species; however, little of this information relates to seedlings during the first growing season. Red Oak (*Quercus rubra* L.), an important species in hardwood regeneration, was used in this study to determine the methanol extractable carbohydrates from the time of seed germination through seedling dormancy during one growing season. After germination in a greenhouse, four week old seedlings were transferred to a growth chamber where day-night temperatures were from 83 to 71 F respectively and the day length was kept at 14 hours until dormancy when day-night temperatures were reduced gradually to 40 and 36 F respectively and day length reduced to eight hours. Seedlings were fertilized alternately with Hoaglands #2 and micronutrient solution at seven day intervals. Ten seedlings were harvested every two weeks during the 16 week growing period for a total of eight harvests plus an additional harvest after dormancy. Parameters determined include dry weight by component and of cotyledons, seedling height and diameter and methanol extractable carbohydrate by component as well as cotyledons. Percent carbohydrate in foliage exceeded that in either stem, or foliage for every harvest period. Stem carbohydrates decreased steadily until the last two harvests, after which percent carbohydrates increased. Root carbohydrates remained in the same range as stem carbohydrates, but varied more, decreasing possibly as a result of growth flushes. Beginning with the induction of dormancy, root carbohydrates increased and percent carbohydrates in the cotyledons decreased steadily over the growing period. Based on mean values obtained from each harvest period, stem height was inversely correlated with percent carbohydrates in the stem ($r = -0.81$).

Preliminary Light and Electron Microscope Studies of Laticifers in *Stapelia bella* (Asclepiadaceae). BERNICE B. ELLIS and KATHRYN J. WILSON, Department of Biology, Indiana University-Purdue University at Indianapolis, Indianapolis, Indiana 46223.—Both nonarticulated branched and articulated nonanastomosing laticifers have been reported by Shaffstein (1932) present side by side in stem tissues of *Stapelia bella*. However, at both the light and ultrastructural levels, only nonarticulated branched laticifers have been identified in shoots of this plant. The origin of the nonarticulated branched laticifer system has not been determined. The growing cell tips penetrate all parts of the mature plant and are highly branched and coenocytic. The ultrastructure of developing and mature nonarticulated laticifers was studied in nonsucculent floral meristems. The most conspicuous ultrastructural feature of developing cells is the numerous small vacuoles some of which appear to originate from dilating endoplasmic reticulum. No plasmodesmata are apparent in walls. Golgi bodies are numerous in both developing and mature cells and Golgi vesicles probably make a significant contribution to the vacuolar system. Plastids are agranal leucoplasts with some internal lamellae and plastoglobuli. Numerous mitochondria appear functional even in mature cells. The mature proplast is osmotically sensitive and possesses a large central vacuole with peripheral cytoplasm. Electron dense latex particles appear first in small vacuoles in the peripheral cytoplasm of relatively immature laticifers and then the central vacuole of mature cells.

Structure and Development of the Glandular Secretory System in Staminate Inflorescences of *Cannabis sativa* (Cannabaceae). CHARLES T. HAMMOND, Saint

Meinrad College, and PAUL G. MAHLBERG, Indiana University, Bloomington, Indiana 47405.—The glandular secretory system of staminate plants of marihuana, like that of pistillate plants, consists of a variety of glandular hair types distributed over most of the plant surface with greatest abundance localized in flowering regions. The staminate glandular system differs from that of the pistillate system mainly in a reduced gland abundance and in a notable presence or absence of specific gland types. Two common types of glandular hairs found on staminate plants are bulbous and capitate-sessile types. These glands closely resemble their gland counterparts on pistillate plants, the former being small with a circular 20 um diam head on a few-celled axis and the latter with a large globose 40-50 um diam head also supported on a few-celled axis. Notably absent from staminate plants is the tall capitate-stalked gland type which characterizes the glandular complement of the pistillate inflorescence. A unique gland type found on staminate plants and lacking on pistillate plants is the antherial-sessile gland. As this name suggests, this gland type is found only on anthers of the staminate plant. These glands develop synchronously on very young anthers attaining a full sized 100-120 um diam head just prior to anthesis. Frequently gland heads become oblong in shape accenting their large size in comparison with capitate-sessile glands on the surrounding sepals. Occasionally atypical forms of the antherial-sessile gland are found in which cells of the few-celled axis supporting the gland head elongate to produce a short stalk. This stalk, however, is not homologous to the stalk of the capitate-stalked gland type as the latter arises from proliferation of surrounding epidermal and hypodermal cells.

A Phytogeographic Analysis of Leaf Architectural Features of the Fagaceae. JAY H. JONES and BETH L. FRIEDBERG, Department of Biology, Indiana University, Bloomington, Indiana 47405.—The Fagaceae has been investigated frequently by phytogeographers. Yet, no one has explored the extent and nature of phytogeographic variation in leaf architecture within the family as a whole. In fact, a scan of the literature reveals few comprehensive studies of this type on any plant family. A wide range of leaf material was examined in several major herbaria. Over three hundred leaves were collected for further analysis. These represented all geographical regions in which members of this family are found. Leaf architecture was examined using methods described by Dilcher, Hickey and Wolfe. Major phytogeographic variation was found to be correlated with differences in the taxonomic composition of various areas. For example, species of the strictly northern hemispheric genus *Fagus* consistently possess regularly spaced simple teeth and secondary veins which are straight distally and outwardly bowed near the petiole. Species of the exclusively southern hemispheric genus *Nothofagus* on the other hand frequently possess doubly serrate margins with irregularly spaced teeth or have entire margins. It appears that different genera have reacted differently to similar environments. For example, north temperate members of the genus *Quercus* have developed a lobed margin whereas conspecific members of the genus *Fagus* possess only dentate margins. Intrageneric phytogeographic variation within this family also appears to be significant. Tropical species of *Quercus* are entire margined whereas the temperate *Quercus* species tend to have lobed margins. A similar trend is also found in *Nothofagus*. Here the temperate forms are usually toothed and the tropical forms are entire. There also is a relationship between leaf apex angle and geographical latitude. Tropical forms usually possess more strongly tapered leaf apices than do the temperate forms. Several even possess drip tips. These observations conform well to those obtained in the foliar analysis of entire floras with respect to latitude.

Variation of Foliar Features in the Rhamnaceae: Tribes Rhamneae and Zizyphaeae.

JAY H. JONES, Department of Biology, Indiana University, Bloomington, Indiana 47405.—A survey of the Rhamnaceae has been undertaken in order to provide a basis for the analysis of fossil rhamnaceous leaf material and to explore the intra-familial evolution of leaf forms. The leaf structure of the tribes Rhamneae and Zizyphaeae has been determined and is the subject of this report. Collectively, species of these tribes exhibit considerable ecological latitude. The leaves are correspondingly modified from needle-like leaves of some xerophytic species to typical lanceolate mesophytic forms. Like other Rhamnaceae, leaves of all plants in these tribes are simple and most have percurrent tertiary veins which are perpendicular to the primary veins. A few possess reticulate tertiary venation. Entire margins are common and teeth when present are asymmetrical, small and irregularly spaced. Simple pinnate and acrodromous forms are found in both tribes. Among the simple pinnate forms eucamptodromous leaves predominate. A few brochidodromous forms exist however, again in both tribes. The presence of these and other characteristics in both tribes makes classifying leaves at the tribal level difficult. Variation in leaf form does not rigidly conform to accepted classification schemes based on reproductive material even though leaf form is species constant and useful in the identification of species or groups of species. Leaf form at the generic level is fairly consistent, however, and it is possible to assign isolated fossil leaves to specific genera or complexes of similar genera. The presence of strikingly similar leaf forms in both subfamilies suggests environmental selection from a common gene pool or, in some cases, flaws in current classification schemes.

The Gasteromycetes of Indiana. PHILIP A. ORPURT, Department of Biology, Manchester College, North Manchester, Indiana 46962.—The group of fungi known as the Gasteromycetes is considered to be among the most advanced forms. Their basidiospores are produced within a closed basidiocarp which may in some remain closed or in others does not open until the spores have matured and thus expose the fertile, spore-producing tissue known as the gleba. The Gasteromycetes are terrestrial occurring for the most part above the soil. Some may be subterranean and some occur on logs or on dung. The puffballs, the earthstars, the sclerodermas, the stinkhorns, and the bird's nest fungi are included within the group.

Relatively little effort has been made to collect and to catalogue species of Gasteromycetes for the state of Indiana since the early reports of L.M. Underwood in the 1890s. Underwood, who was the first Director for the Botanical Division of the Indiana State Biological Survey, reported the occurrence of 23 species of "puffballs" for the state in 1893. Additional species were subsequently added to the list by Underwood as well as by J.M. Van Hook for the Bloomington area (1911), by F.D. Kern for the Lafayette area (1912), by A.R. Bechtel for the Crawfordsville area (1939), and by J.O. Cottingham for Marion Co. (1948).

The writer has undertaken a compilation of the records of Gasteromycetes for the state of Indiana which will culminate in the development of an annotated list. An effort is underway to examine specimens of as many of the reported species as possible. Also, collections of fresh specimens of Gasteromycetes are being made.

Platanoid Fossils from the Dakota Formation: A Paleosystematic Problem.

ROBERT N. SCHWARZWALDER, JR., and DAVID DILCHER, Department of Biology, Indiana University, Bloomington, Indiana 47405.—The flora of the mid-Cretaceous is of special interest to the angiosperm paleobotanist because it was at that time that many of the evolutionary lines ancestral to modern flowering plants arose. The Dakota formation of mid-Cretaceous age contains a number of fossil leaves

with a structural similarity to extant *Platanus* species. These leaf-forms have been termed "platanoid" by E. W. Berry in reference to their *Platanus*-like appearance, but they have been placed in several diverse modern genera as well as a few solely extinct ones. Our research on a population of platanoid fossil leaves representing one species from a mid-Cretaceous clay deposit has allowed us to determine that the Platanaceae had evolved by that time. An analysis of tooth anatomy and fine venation patterns along with a morphological investigation of leaves and associated infructescences were instrumental in our assessment of the species. Platanoid leaves from sandstone deposits of the same age are systematically problematic as they possess several of the same morphological features but, due to their tremendous variation in form, poor preservation and the rare occurrence of associated reproductive material, have proven difficult to ally with modern angiosperm taxa. These sandstone impressions, although preserving fewer anatomical details than similar compression fossils, are amenable to similar types of analysis. There are clear relationships of certain members of this platanoid complex to the extant Platanaceae. Other platanoid species appear to have been arbitrarily placed in the group based upon features of gross morphology and lack sufficient structural detail for taxonomic placement.

An Ultrastructural Study of Soybean Cultivars Differing in Response to Salt Stress.

CAROL A. SINGLETON and ROBERT W. KECK, Department of Biology, Indiana University-Purdue University at Indianapolis, Indianapolis, IN 46223.—Two cultivars of soybean (*Glycine max* (L.) Merr.), "Lee" and "Jackson" were grown hydroponically under controlled conditions of temperature and light. After two weeks plants were treated either by adding 40 mM calcium chloride to the solution or kept as control plants without salt. Treatment caused severe chlorosis and death in the salt sensitive "Jackson" and little change in the salt tolerant "Lee". In both salt treated cultivars, apical root growth ceased and roots darkened in color. Roots were fixed for electron microscopy, and cortical cells examined for ultrastructural variation. The most notable difference between treated and control roots is the abundance of dilated endoplasmic reticulum in treated cells. Treated cells also possess a greater proliferation of small vacuoles and small vesicles of unknown origin than control cells. The mitochondria and other cell components appear normal in both treatments.

A Comprehensive Study of Select Stomatal Complex Features in the Fagaceae.

STEVEN L. STIER and JAY H. JONES, Department of Biology, Indiana University, Bloomington, Indiana 47405.—Stomatal length, width, guard cell width, stomatal complex type and the number of accessory cells were examined in leaves of the Fagaceae. Approximately 348 specimens representing 275 species, all 8 genera and all 3 subfamilies were collected from major herbaria. Isolated cuticles were prepared and examined with the light microscope. All specimens examined possessed anomocytic stomatal complexes. This feature is consistent within the Fagaceae and should be useful in the determination of fossil materials. The number of adjacent epidermal cells varied from 4 to 12 with familial, subfamilial and generic averages of 7. The generic and subfamilial ranges in stomatal length, stomatal width, and guard cell width overlapped considerably. Thus, the use of these features in the intrafamilial classification of fossil fagaceous leaves is not recommended. Significant differences were found in some cases, however, when generic means were compared. For example, *Fagus* species collectively have smaller stomata than those of *Nothofagus*, *Lithocarpus* and other genera. Although these and other statistically significant differences are of interest, they are not very useful for the classification of specific fossil leaf types.

A Critical Analysis of the Nature and Taxonomic Distribution of Foliar Trichomes in the Fagaceae. MARK WASSERMAN and JAY H. JONES, Department of Biology, Indiana University, Bloomington, Indiana 47405.—Taxonomic classification of fossil leaf remains has posed serious problems in the past due to a lack of information about the foliar characteristics of the Fagaceae. It is hoped that data gained in this study will provide a basis for the analysis of fossil material with probable fagaceous affinities. Trichome morphology and distribution has been surveyed in all 8 extant genera of this family. Over 300 specimens were collected from several major herbaria and systematically examined, using transmission light microscopy of cuticle preparations, epiillumination light microscopy of whole leaves and scanning electron microscopy. A wide range of trichome types was found to occur within this family. Identification of the leaves at the generic level appears to be possible. Laterally fused tufts can even be used to distinguish *Lithocarpus* species from the nearly identical *Castanopsis* species. The genus *Nothofagus* can be determined by the presence of large glandular trichomes. *Fagus* is characterized by the uniform presence of uniseriate multicellular trichomes and unicellular simple hairs. Of particular interest is the presence of a unique trichome complement in *Castanopsis chrysophylla* and *Castanopsis sempervirens* which set these species apart from other members of this genus. This seems to support the segregation of these species into the genus *Chrysolepis* as suggested by Hjelmquist. Work is continuing on the Quercoideae in order to elucidate phylogeographic and infrageneric differences in trichome complements.

Accumulation and Distribution of a Single Dose of ^{59}Fe in Wheat and Soybeans. CONNIE M. WEAVER, Purdue University, West Lafayette, Indiana 47907.—Accumulation of iron by edible parts of staple crops such as wheat and soybeans influences the dietary contribution of these foods. However, much of the total iron content of plant foods may not be available for human nutrition because plant seeds contain relatively high concentrations of phytate and fiber which have been associated with the binding of micronutrients. In order to accurately reflect the bioavailability of trace elements from specific foods, the approach of intrinsically labeling foods with the element of interest is used. This study investigated the efficiency of incorporating a single dose of ^{59}Fe into the edible portions of hydroponically-grown wheat and soybeans when added as a sequestered or unsequestered iron source and when added during the vegetative or reproductive phase of the plant growth cycle. For both plant species, more ^{59}Fe was accumulated by the edible plant parts when added in an unsequestered form during the vegetative period of the plant growth cycle. For wheat, 9.2% of the ^{59}Fe dose was accumulated in the mature grain and 27.4% of the dose was accumulated by soybean cotyledons. This information can be used to determine optimal conditions for efficiently labeling plants for further bioavailability studies.

Method and Duration of Weed Control Affect Survival, Height and Diameter of Planted Black Walnut. ROBERT D. WILLIAMS, North Central Forest Experiment Station, Forest Service, USDA, Bedford, Indiana 47421.—Fourteen year results from a weed control study established in 1967 on Pierson-Hollowell property near Martinsville, Indiana, show that differences in height and diameter are attributable to both method of weed control and number of years weeds were controlled after planting. Trees treated with simazine were taller and larger in diameter than trees treated with atrazine which were larger than those in cultivated plots. Trees in plots treated 3 years were taller and larger in diameter than trees treated 2 years which were larger than those treated only 1 year. Weed control method

resulted in differences in survival. Survival was lowest in the cultivated plots and best in the plots treated with simazine.