

BOTANY

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ABSTRACTS

A Proposed Third Function for Root Caps. WILLIAM W. BLOOM, Department of Biology, Valparaiso University, Valparaiso, Indiana 46383.—Root caps are believed to protect the delicate meristematic region of the root tip as it is pushed through the soil. Evidence suggests that root caps also control positive geotropism. No satisfactory explanation exists for the delay in the production of root hairs until after the primary root tissues have elongated. Root hairs, like rhizoids of ferns, only form on the exposed surfaces of cells. An examination of a number of longitudinal sections of root tips indicates that most root caps extend well into the region of elongation and closely adhere to the root in this region. The outer surface of the epidermal cells are not freed of the root cap until cell elongation has pushed them free of the enclosing cap, thus permitting root hair formation. This hypothesis is being tested experimentally.

Utilization of an Artificial Beach in Investigation of Phytopsammon Communities. WILLIAM DAVIES, Department of Biology, Indiana University-Purdue University at Fort Wayne, Fort Wayne, Indiana 46805.—Interstitial voids in freshwater sandy beaches harbor well-defined algal communities (phytopsammon). Coefficient of community and index of affinity data indicate the phytopsammon communities differ in composition from phytoplankton communities of adjacent lakes. Indices of diversity for phytopsammon communities along beach transects indicate significant relationships between phytopsammon community structure and substrate water content, substrate grain size, and grain size uniformity coefficients. Chlorophyll extraction and ^{14}C incubation techniques are being utilized in current studies of an artificial beach constructed at the Indiana University-Purdue University at Fort Wayne biological station at Crooked Lake. The artificial beach has been constructed to reduce variables in substrate grain size, grain size uniformity coefficients, detritus content and beach substructure.

A Developmental Study of Foliar Epidermal Features in *Castanea mollissima* Blume (Fagaceae). GINA FERNANDEZ, Department of Biology, Ripon College, Ripon, Wisconsin 54971, and Jay H. Jones and David L. Dilcher, Department of Biology, Indiana University, Bloomington, Indiana 47405.—Leaves of various ages were collected from chinese chestnut trees (*C. mollissima*) in order to assess changes in epidermal features that occur during development. Macerated cuticles were prepared for examination with the light microscope by standard methods. Leaves or leaf sections were critical point dried and prepared for examination with the scanning electron microscope. Isolated cuticles were extremely difficult to prepare from very young leaves and cleared leaves were used to assess epidermal features in early stages of development. Trichome initiation occurs very early in development. The highest trichome densities were found in very young (<2 cm) leaves. Trichome

density declined with leaf expansion on both adaxial and abaxial surfaces. The lowest densities occurred in old fully expanded leaves in which many trichomes had been lost. The relative proportions of the five trichome types found on these leaves varied with age. In addition the distribution of trichomes was also found to be type specific. Nonvenous areas tend to lose their pubescence sooner than venous areas. The stomatal complex is anomocytic and the development appears to be aperigenous. The epidermal development of *C. mollissima* appears to be representative of other Fagaceae. The results of this study provide some basis for determining the maturity of fossil Fagaceous leaves.

Effects of Irradiance on the Morphological Characteristics of Two Plant Species of the Maritime Strand. STEPHEN W. FLETCHER, Environmental Science and Engineering, Inc., Gainesville, Florida 32604.—Previous authors have described three types of shade response in plants, including shade tolerance by metabolic and morphological adaptation, shade avoidance through stem elongation, and intolerance with no ability to elongate. In order to examine the ecological implications of such responses, the morphological adaptation patterns as a function of growth irradiance were studied in *Cakile harperi* (sea rocket) and *Euphorbia polygonifolia* (seaside spurge), two annual plant species restricted to coastal beaches and sand dunes.

Both species were grown under controlled environments at a common 12-14 h photoperiod and three growth temperatures (32/29, 26/23, and 17/11 °C). Morphological aspects of shade adaptation at irradiance levels from 30-120 W m⁻² were described by measurements of leaf weight and area per plant, leaf area-weight relation, shoot/root ratio, stomatal density, and chlorophyll content. Stem length, internode length, and number of internodes were treated separately as measures of shade avoidance potential.

On the basis of field and laboratory survival patterns, chlorophyll levels and chlorophyll a/b ratios, both species were determined to be of the shade-intolerant type. However, both were found to be capable of some degree of morphological acclimation in response to shading. Relative leaf area was higher and stomatal density was lower in shade-grown plants. In *Cakile harperi* the increased relative leaf area was due to a decrease in leaf thickness; in *Euphorbia polygonifolia* this was effected by a shift in photosynthate distribution from root to shoot. Both species showed the minimum amount of stem elongation necessary to overtop the canopy level of dominant dune grass. This avoidance response was dependent upon internodal elongation rather than on an increase in the number of elongation sites, and upon the resultant stability of the stems. Since the response patterns of these species were found to be substantially affected by growth temperature, it is recommended that light acclimation studies be conducted as closely as possible to the optimal growth temperature or the known growing conditions for each species.

The Ultrastructure of Nonarticulated Branched Laticifers in *Asclepias tuberosa* L. (Butterfly Weed). VONDA FRANTZ and KATHRYN WILSON. Department of Biology, Indiana University-Purdue University at Indianapolis, Indianapolis, Indiana 46205.—Meristem, leaf, and stem tissues from *Asclepias tuberosa* seedlings and one year old plants were prepared for electron microscopy. Material was fixed in Karnovsky fixative (pH 7.0), post-fixed in 1.0 percent osmium tetroxide, dehydrated to acetone, and embedded in Spurr low-viscosity resin. Embedded material was sectioned, mounted on uncoated 300 mesh copper grids, stained in lead citrate and uranylacetate, and examined on an RCA EMU-3G electron

microscope at 50 KV. The ultrastructure of laticifers in *Asclepias tuberosa* was found to be comparable to nonarticulated branched laticifers in other *Asclepias* species. Maturing laticifers of *A. tuberosa* are characterized by an extensive vacuolar system, apparently degenerating plastids, an absence of plasmodesmata in the cell walls, and by their long branching morphology. A large central vacuole appears to develop by dilation of endoplasmic reticulum and by coalescence of small vacuoles in the maturing cytoplasm. Mature laticifers differ markedly for those of *A. syriaca* and *A. curassavica* because the large central vacuole does not contain rubber particles or other electron dense secretory products.

Paleobotanical Nomenclature: Principles, Problems, and Proposals. JAY H. JONES and DAVID L. DILCHER, Department of Biology, Indiana University, Bloomington, Indiana 47405.—The naming of fossil plants has posed problems since the inception of "modern" binomial nomenclature. The fragmentary nature of fossil remains and the fact that they cannot be interbred to test the validity of biological species prevent easy application of all rules in the International Code of Botanical Nomenclature. Attempts to modify the Code to accommodate fossil and other exceptional forms have historically led to the formation of special taxa, i.e. organ genera and form genera. Under the current code, fossil genera are functionally equivalent to extant genera; and the former taxa have been eliminated. There is still considerable disagreement as to whether or not these special taxa should be used. In addition to these disputes paleobotanists also concern themselves with the validity of applying modern generic or specific names to fossil materials. A somewhat related philosophical problem is whether or not to indicate the suspected taxonomic affinities of a fossil in its name. Such names can be quite misleading when the originally suspected affinities are proven incorrect and the original name must be conserved. The above problems are substantially a function of one's personal philosophy of how to deal with problems unique to fossils. A scan of the paleobotanical literature, however, quickly reveals frequent and flagrant disregard of parts of the ICBN for which fossils pose no particular problem. The localized trouble spots in the Code seem to lead some paleobotanists to loosely interpret the whole Code. A thorough reexamination of the purpose and practice of naming fossils seems to be in order, so that a precise and functional system can be established.

Fruits of the *Pterocarya* alliance (Juglandaceae) from the Paleogene of the Rocky Mountain Region. STEVEN R. MANCHESTER and DAVID L. DILCHER, Department of Biology, Indiana University, Bloomington, Indiana 47405.—Paleocene and Eocene deposits of the Rocky Mountain region have yielded three genera of winged fruits belonging to the *Pterocarya* alliance of the walnut family. Two of the genera are present in the modern flora of Asia, while the third represents an extinct form. Two fossil species from the Rocky Mountain region belong to the extant genus *Pterocarya*. Both are bi-winged, as are modern species of the genus. One of the species, *P. roanensis* Mac Ginitie, occurs in the Eocene Green River flora of Utah. Another species, with narrower wings, occurs in the as yet undescribed Eocene Wind River flora of Wyoming. The extant pterocaryoid genus *Cyclocarya* is represented by the species which Brown formerly called *Pterocarya hispida*, from the Paleocene Fort Union Formation. New collections of this species from North Dakota indicate that, like the living species *Cyclocarya paliurus*, the fossil had a seed which was 4-lobed at the base, surrounded equatorially by a single, large flange-like wing. A new extinct genus from the Paleocene Fort Union flora was previously described by Brown (1962) as *Pterocarya glabra*. This genus

differs from modern *Pterocarya* and *Cyclocarya* in having numerous (8 to 10) wings. The wings are arranged equatorially about a 4-lobed seed. Although it is pterocaryoid in its affinities, it can not be retained in the extant genus *Pterocarya*. In the present day flora there are only two genera in the *Pterocarya* alliance: *Pterocarya* and *Cyclocarya*. However, as indicated above, there were at least three genera in the Paleogene. This illustrates a pattern of decreasing generic diversity similar to that observed in the *Engelhardia* alliance of the same family. Some of the genera present in the early Tertiary, such as *Pterocarya* and *Cyclocarya*, have persisted to the present day while others, such as the multi-winged form from the Fort Union Formation, have since become extinct.

Stomatal Development in *Asimina triloba* (L.) Dunal. JOHN L. ROTH, JR. and DAVID L. DILCHER, Department of Biology, Indiana University, Bloomington, Indiana 47405, and BRENT A. MCKIM, North Harrison High School, Ramsey, Indiana 47166.

—*Asimina triloba* (L.) Dunal, commonly known as the Pawpaw, grows in temperate forests of eastern North America from southern Canada to the Gulf Coast. As such it is unique among the more than 2000 species of the tropical family Annonaceae. This provides an opportunity to assess the effects of environment on stomatal ontogeny by comparing stomatal development of the temperate and tropical species. The stomatal complex of *Asimina triloba* is generally brachyparacytic, but paracytic, hemiamphibrachyparacytic and amphibrachyparacytic variations are common. Its stomatal development is syndetocheilic. A rectangular meristemoid divides to form two cells of unequal size. The smaller of the two divides into two narrow cells forming a complex of three cells. The center cell divides to form the guard cells which develop an intervening pore. The two cells bordering the guard cells are the subsidiary cells and may be non-contiguous around the ends of the guard cells or contiguous at one or both poles. They enlarge and may undergo an additional division to form three or four subsidiary cells. Although *Asimina triloba* has been subjected to the rigors of a temperate environment since at least the Pleistocene, its stomatal development has remained essentially unchanged from that reported for its tropical relatives. This suggests that stomatal development is under rather strict genetic control and is not easily modified by environmental stress.

Bisexuality in the Pistilate Inflorescence of *Platanus occidentalis*. L. ROBERT SCHWARZWALDER, JR. and DAVID L. DILCHER, Department of Biology, Indiana University, Bloomington, Indiana 47405.—*Platanus occidentalis* L., the plane tree or sycamore, is a common plant along streams and rivers over much of Eastern North America. Consisting of seven to eleven species, the monotypic family Platanaceae is generally considered to have monoecious trees with unisexual inflorescences. Dissections of pistilate inflorescences of *Platanus occidentalis* reveal tight clusters of floral units each of which typically has nine carpels, three or four staminodia and an encircling membranous sheath. The staminodia commonly are assumed to be phylogenetically reduced stamens and the membranous sheath is hypothesized by some to represent a vestigial perianth. In examining numerous pistilate inflorescences we found varying degrees of bisexual development ranging from, rarely, fully functional stamens and carpels to the more common condition of sterile staminodia surrounding functional carpels. Pollen from stamens obtained from pistilate inflorescences was tested and found to be viable. While infrequent in *Platanus occidentalis*, bisexuality raises several phylogenetic questions. Whether this condition is an expression of the potential for bisexual development in *Platanus* or represents a reduction from a previously bisexual flower is difficult to ascertain.

without paleobotanical evidence. Our observations also raise questions concerning the sexual plasticity that may be expressed in flowering plants. While often assumed to be a static morphological feature, the formation of unisexual inflorescences in a monoecious species could be interpreted as one of a range of responses to a myriad of environmental pressures.

Endomycorrhizae Increases Growth of Sycamore Seedlings. JAMES P. SHEPARD and WILLIAM R. CHANEY, Department of Forestry and Natural Resources, Purdue University, West Lafayette, Indiana 47907.—Sycamore (*Platanus occidentalis* L.) germinants were transplanted into 45 six-inch-pots containing low phosphorus (1 ppm), sandy loam soil mix. Spores of the endomycorrhizal fungus *Glomus fasciculatus* (menge isolate) were incorporated as pot culture inoculum into soil of one-third of the pots at a rate equivalent to 2000 spores per ft² surface area. An equal amount of inoculum was filtered through a 44 μ m sieve to remove fungal spores and the filtrate added to another one-third of the pots to equilibrate other organisms and compounds present in the inoculum. One-third of the pots were untreated. Seedlings were grown in a greenhouse for 20 weeks. Growth was quantified at four-day intervals using the plastochron index, an estimate of morphological rather than chronological age. Inoculated seedlings had a greater ($p < .01$) plastochron age than filtrate treated and control seedlings. Regressions of plastochron index with time revealed a higher rate of leaf initiation by inoculated than non-inoculated seedlings. Endomycorrhizae inoculated seedlings also had a greater ($p < .01$) height and stem diameter and leaf and stem dry weight than untreated seedlings after 20 weeks of growth. The inoculum filtrate did not significantly influence seedling growth.

The Distribution and Uses of *Arundo donax*. MARILYN SUE VESELACK and JERRY J. NISBET, Ball State University, Muncie, Indiana 47306.—*Arundo donax* is widely distributed in warm sunny climates and is currently found growing in India, Burma, China, Southern Africa, Australia, in the Americas, in regions adjoining the Nile River and in the Mediterrean area. Historically, *Arundo donax* has been used by man for a variety of purposes. Starting as early as 5,000 B.C. Egyptians used *Arundo* to line underground pits used for grain storage. Mummies of the fourth century A.D. were wrapped with *Arundo*, and the plant has been adapted to a variety of fabrication uses including the making of fences, awnings, baskets, fishing nets, writing pens, and fishing poles. Pulp from *Arundo* has been used in making paper and rayon. A number of extracts with medicinal properties have been derived from the plant including donaxine, bufotenidine and dehydrobufotenine. *Arundo donax* has been significant to many civilizations for its use in the construction of musical instruments and in the manufacture of reeds for musical instruments. No synthetic reed material has as yet been manufactured which can match the tone quality contributed to woodwind instruments by high quality *Arundo* reeds.

Squirrel Resistant Black Walnuts for Direct Seeding? Not Yet. ROBERT D. WILLIAMS, U. S. Forest Service, Bedford, Indiana 47421.—We have observed in some of our nursery studies and direct seeding studies, where seed source was a variable, that squirrels seem to prefer the nuts from some trees over those of others. In a period from 1975 to 1979, in an effort to find a tree bearing squirrel resistant nuts, seeds from 55 trees have been offered to squirrels at 4 locations, in fall and spring sown direct seeding trials. We didn't find a mother tree that bears squirrel resistant nuts. We did confirm that squirrels prefer the nuts from certain

trees; but after the preferred nuts are consumed, they take the less preferred nuts.

Air Toxicity to Eastern White Pines in Indiana. WAYNE T. WILLIAMS and ROLAND W. USHER, The Institute of Ecology, 4600 Sunset Avenue, Indianapolis, Indiana 46208.—Air pollution disease is widespread on eastern white pine (*Pinus strobus* L.) in Indiana. Ozone concentrations sufficient to elicit phytotoxicity occur regionally numerous times each growing season, and sulfur dioxide concentrations considered to be phytotoxic are common at urban sites and rural areas downwind from coal-fired power plants. Severity of disease on the second needle complement differed in 1979 and 1980 in response to the regional air pollution load in 1978 and 1979. Tip necrosis of needles was more prevalent than needle flecking and chlorotic mottling, but both symptom types are considered primary manifestations of air pollution disease. Premature needle abscission was found to be widespread and more common in areas with more air pollution. But abscission was not as closely associated with disease severity as other symptoms including chlorosis/flecking, percent of trees with tip necrosis on the majority of foliage, and length of necrosis, all of which correlate with disease severity according to linear regression analyses. A disease index composed of these four components reflected changes in disease severity from year to year, and within and among study sites. Changes in frequency distribution of the principal index components are discussed in relation to changes in disease severity along a gradient of differing pollution concentrations and durations.