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## Abstracts

- **NASA Specialized Center of Research and Training (NSCORT) in Gravitational Biology.** Brian S. Spooner and James A. Guikema. Division of Biology, Kansas State University, Manhattan, Kansas 66506-4901.

The Life Sciences Division of NASA has initiated a NASA Specialized Centers of Research and Training (NSCORT) program. Three Centers were designated in late 1990, as the culmination of an in-depth peer review analysis of proposals from universities across the nation and around the world. Kansas State University was selected as the NSCORT in Gravitational Biology. This Center is headquartered in the KSU Division of Biology and has a research, training, and outreach function that focuses on cellular and developmental biology.

- **Gravitational Studies in Cellular and Developmental Biology.** Brian S. Spooner. Division of Biology, Kansas State University, Manhattan, Kansas 66506-4901.

The paucity of data on the role of gravity in cellular and developmental biology has been examined, and a hypothesis has been generated that unifies potential gravity sensitivity in both plant and animal systems. This hypothesis considers the macromolecular order and functional importance of the extracellular matrix compartment, the intracellular cytoskeleton compartment, and the connecting plasma membrane-signal transduction compartment of plant and animal systems as potentially sensitive to alterations in the unit gravity environment in which they evolved.

- **The Role of a Cell Surface Inhibitor in Early Signal Transduction Associated with the Regulation of Cell Division and Differentiation.** Terry

C. Johnson, Daniel J. Enebo, Philip J. Moos, And Heideh K. Fattaey. Division of Biology, Kansas State University, Manhattan, Kansas 66506-4903.

Serum stimulation of quiescent human fibroblast cultures resulted in a hyperphosphorylation of the nuclear retinoblastoma gene susceptibility product (RB). However, serum stimulation in the presence of  $9 \times 10^{-8}$  M of a purified bovine sialoglycopeptide (SGP) cell surface inhibitor abrogated the hyperphosphorylation of the RB protein and the subsequent progression of cells through the mitotic cycle. The experimental results suggest that the SGP mediated its cell cycle arrest at a site in the cell cycle that was at the time of RB phosphorylation or somewhat upstream of the modification of this regulatory protein of cell division. Both cells serum-deprived and serum stimulated in the presence of the SGP displayed only a hypophosphorylated RB protein, consistent with the SGP-mediated cell cycle arrest point being near the G1/S interface.

- **Is Receptor Oligomerization Causally Linked to Activation of the EGF Receptor Kinase?** David A. Rintoul. Biology Division, Kansas State University, Manhattan, Kansas 66506-4901.

Transduction of a signal from an extracellular peptide hormone to produce an intracellular response is often mediated by a cell surface receptor, which is usually a glycoprotein. The secondary intracellular signal(s) generated after hormone binding to the receptor have been intensively studied. The nature of the primary signal generated by ligand binding to the receptor is understood less well in most cases. The particular case of the epidermal growth factor (EGF) receptor is analyzed, and evidence for or against two dissimilar models of primary signal transduction is reviewed. Evidence for the most widely accepted current model is found to be unconvincing. Evidence for the most widely accepted current model is found to be unconvincing. Evidence for the other model is substantial but indirect; a direct test of this model remains to be done.

- **Glucocorticoid Effects on Immune Cell Activation by Staphylococcal Exotoxins and Lipopolysaccharide.** Stephen K. Chapes, Karen m. Kopydlowski, Sherry D. Fleming and John J. Iandolo. Division of Biology and Department of Pathology, Kansas State University, Manhattan, Kansas.

Experiments were conducted to determine the effects of physiologically elevated corticosterone on the activation of macrophages and T cells. These studies find that the elevation of corticosterone does not affect the expression of membrane receptors on macrophages and does not affect the activation of

macrophages to produce cytokines. In contrast, elevated corticosterone levels correlate with enhanced T cell proliferation to both mitogens and superantigens.

- **Collagen in Organ Development.** Patricia Hardman and Brian S. Spooner. Division of Biology, Kansas State University, Manhattan, Kansas 66506-4901.

It is important to know whether microgravity will adversely affect developmental processes. Collagens are macromolecular structural components of the extracellular matrix (ECM) which may be altered by perturbations in gravity. Interstitial collagens have been shown to be necessary for normal growth and morphogenesis in some embryonic organs, and in the mouse salivary gland, the biosynthetic pattern of these molecules changes during development. Determination of the effects of microgravity on epithelial organ development must be preceded by crucial ground-based studies. These will define control of normal synthesis, secretion, and deposition of ECM macromolecules and the relationship of these processes to morphogenesis.

- **Eye Development and the Appearance and Maintenance of Corneal Transparency.** Gary W. Conrad. Division of Biology, Ackert Hall, Kansas State University, Manhattan, Kansas 66506; and James L. Funderburgh. Mount Desert Island Biological Laboratory, Salsbury Cove, Maine 04672.

Embryonic development of the eye, including the cornea, depends on the appearance and steady maintenance of intraocular pressure. The eye is a gravity-sensitive organ, as evidenced by changes in pupil diameter during parabolic flight. The cornea is largely a paracrystal of extracellular matrix. The extent to which it will polymerize normally in microgravity has yet to be determined.

- **Endochondral Bone Formation in Embryonic Mouse Pre-metatarsals.** Brenda J. Klement and Brian S. Spooner. Division of Biology, Kansas State University, Manhattan, Kansas 66506-4901.

Long term exposure to a reduced gravitational environment has a deleterious effect on bone. The developmental events which occur prior to initial bone deposition will provide insight into the regulation of mature bone physiology. We have characterized a system in which the events preceding bone formation take place in an isolated *in vitro* organ culture environment. We show that cultured pre-metatarsal tissue parallels development of pre-metatarsal tissue in the embryo. Both undergo mesenchyme differentiation and morphogenesis to form a cartilage rod, which resembles the future bone, followed by terminal

chondrocyte differentiation in a definite morphogenetic pattern. These sequential steps occur prior to osteoblast maturation and bone matrix deposition in the developing organism. Alkaline phosphatase (ALP) activity is a distinctive enzymatic marker for mineralizing tissues. We have measured this activity throughout pre-metatarsal development and show (a) where in the tissue it is predominantly found, and (b) that this is indeed the mineralizing isoform of the enzyme.

- **Microtubules as Key Cytoskeletal Elements in Cellular Transport and Shape Changes: Their Expected Responses to Space Environments.** Gary W. Conrad and Abigail H. Conrad. Division of Biology, Kansas State University, Manhattan, Kansas 66506 and Mount Desert Island Biological Laboratory, Salsbury Cove, Maine 04672.

Application of reference standard reagents to alternatively depolymerize or stabilize microtubules in a cell that undergoes very regular cytoskeleton-dependent shape changes provides a model system in which some expected components of the environments of spacecraft and space can be tested on Earth for their effects on the cytoskeleton. The fertilized eggs of *Ilyanassa obsoleta* undergo polar lobe formation by repeated, dramatic, constriction and relaxation of microfilamentous band localized in the cortical cytoplasm and activated by microtubules.

- **Plastids: Dynamic Components of Plant Cell Development.** James A. Guikema and Greg L. Gallegos. Division of Biology, Kansas State University, Manhattan, Kansas 66502.

The gravitropic bending of maize roots, as a response to reorientation of the root within a gravitational field, was examined for sensitivity to exogenous applications of the cytoskeletal inhibitor, cytochalasin D. Agar blocks were impregnated with this inhibitor, and were applied either to the root cap or to the zone of root cell elongation. Root growth was normal with either treatment, if the roots were not repositioned with respect to the gravitational vector. When untreated roots were placed in a horizontal position with respect to gravity, a 40 degree bending response was observed within one hour. This bending also occurred when cytochalasin D was applied at high concentrations to the zone of root cell elongation. However, when cytochalasin D above 40 µg/ml was applied to the root cap, roots lost the ability of directional reorientation within the gravitational field, causing a random bending.

- **Interaction of Membrane-Bound Lens Protein with the Lipid Bilayer.** L. Takemoto and F. Ifeanyi. Division of Biology, Kansas State University, Manhattan, Kansas 66506-4901.

Water soluble, cytoplasmic proteins may interact directly with the lipid bilayer of the cell membrane, but there is little known concerning the exact molecular mechanisms of the process. As a model system to study this interaction, we have characterized the interaction of the water soluble and cytoplasmic protein alpha crystallin with the lens membrane. The specificity of interaction and a possible molecular mechanism of the recognition process are discussed in regards to the possible functional importance of this phenomenon.

- **Early Events of Polyoma Infection: Absorption, Penetration and Nuclear Transport.** Richard A. Consigli, John I. Haynes, Jr., Deching Chang, LaDonna Grenz, and Donald Richter. Division of Biology, Section of Virology and Oncology, Kansas State University, Manhattan, Kansas 66506.

Polyoma virions have different attachment proteins which are responsible for hemagglutination of erythrocytes and attachment to cultured mouse kidney cells (MKC). Virion binding studies demonstrated that MKC possess specific (productive infection) and nonspecific (nonproductive) receptors. Empty polyoma capsids have hemagglutination activity and bind to nonspecific MKC receptors, but they are not capable of competing for specific virion cell receptors or preventing productive infection. Isoelectric focusing of the virion major capsid protein, VP1 separated this protein into six species (A through F). These species had identical amino acid sequences, but different in degree of modification (phosphorylation, acetylation, sulfation and hydroxylation). Evidence based upon precipitation with specific antisera supports the view that VP1 species E is required for specific absorption and that D and F are required for hemagglutination. The virion attachment domain has been localized to an 18 kilodalton fragment of the C-terminal region of VP1. Monopinoscytotic vesicles containing <sup>125</sup>I-labeled polyoma virions were isolated from infected MKC. A crosslinker was used to bind the MKC cell receptor(s) covalently to VP1 attachment protein, and a new 120 kilodalton band was identified by SDS-PAGE. An anti-idiotypic anti-body prepared against a neutralizing polyoma monoclonal antibody was used to identify a putative 50 kilodalton receptor protein from a detergent extract of MKC, as well as from an MKC membrane preparation.

- ***Drosophila melanogaster* as a Model System for Assessing Development under Conditions of Microgravity.** Michael K. Abbott, Richard B. Hilgenfeld, and Robin E. Denell. Center for Gravitational Studies in Cellular

and Developmental Biology, Division of Biology, Kansas State University, Ackert Hall Manhattan, Kansas 66506-4901.

More is known about the regulation of early developmental events in *Drosophila* than any other animal. In addition, its size and short life cycle make it a facile experiment system. Since developmental perturbation have been demonstrated when both oogenesis and embryogenesis occur in the space environment, there is a strong rationale for using this organism for the elucidation of specific gravity-sensitive developmental events.

- **Recognizing and Optimizing Flight Opportunities with Hardware and Life Sciences Limitation.** Marvin W. Luttges. Department of Aerospace Engineering Sciences, University of Colorado, Campus Box 429, Boulder, Colorado 80309-0429.

The availability of orbital space flight opportunities to conduct life sciences research has been limited. It is possible to use parabolic flight and sounding rocket programs to conduct some kinds of experiments during short episodes (seconds to minutes) of reduced gravity, but there are constraints and limitations to these programs. Orbital flight opportunities are major undertakings, and the potential science achievable is often a function of the flight hardware available. A variety of generic types of flight hardware have been developed and tested, and show great promise for use during NSTS flights. One such payload configuration is described which has already flown.

- **Brine Shrimp Development in Space: Ground-Based Data to Shuttle Flight Results.** Brian S. Spooner, Lynnette DeBell, Laura Hawkins, Janet Metcalf, and James A. Guikema. Division of Biology, Kansas State University, Manhattan, Kansas 66506-4901. James Rosowski. Division of Biological Sciences, University of Nebraska, Lincoln, Nebraska 68132.

The brine shrimp, *Artemia salina*, has been used as a model system to assess microgravity effects on developing organisms. Following fertilization and early development, the egg can arrest in early gastrula as a dehydrated cyst stage that is stable to harsh environments over long time periods. When salt water is added, the cysts can reactivate, with embryonic development and egg hatching occurring in about 24 h. A series of larval molts or instars, over about a 2 week period, results in the adult crustacean. We have assessed these developmental events in a closed syringe system, a bioprocessing module, in ground-based studies, and have conducted preliminary in-orbit experiments aboard the Space Shuttle Atlantis during the flights of STS-37 and STS-43. Although the in-flight data are limited, spectacular degrees of development have been achieved.



- **Transformed Vegetation Index for Measuring Spatial Variation in Drought Impacted Biomass on Konza Prairie, Kansas.** M. Duane Nellis. Department of Geography, Kansas State University, Manhattan, Kansas 66506. John M. Briggs. Division of Biology, Kansas State University, Manhattan, Kansas 66506.

Landsat thematic mapper satellite data were found to offer potential for regular monitoring of the Konza Prairie tallgrass prairie ecosystem. Data from two Landsat thematic mapper channels derived from an August 1989 scene were analyzed using a transformed vegetation index relative to above ground biomass samples on burned and unburned watersheds for Florence and Clime soils. In addition transformed vegetation index (TVI) values were analyzed relative to watersheds experiencing different burning frequency. Despite drought conditions during 1989, the combination of using Landsat thematic mapper in a transformed vegetation index provided a suitable measure of spatial variation in above ground biomass for diverse burning strategies and soil conditions.

- **Tebuthiuron Application for Brush Control in the Northern Flint Hills, Kansas.** Dale L. Nolte and Walter H. Fick. Department of Agronomy, Kansas State University, Manhattan, Kansas 66506-5501.

Brush invasion is a problem on some grazing land in Kansas. A study was initiated on two sites in the northern Flint Hills to determine the effectiveness of tebuthiuron for controlling selected woody species and the associated effect on botanical composition and basal cover. Tebuthiuron pellets (20% a.i.) were aerially applied to 4 ha plots at each site at 2 kg/ha in December, 1979. Tebuthiuron reduced the canopy covers at Siberian elm (46%) and Osage orange (44%) 46 months after treatment at the Geary County site. Canopy covers of Siberian elm, smooth sumac, and eastern cottonwood were reduced >50% 45 months after treatment at the Pottawatomie County site. A decrease in basal cover on the treated sites was not significantly different from a corresponding change on adjacent untreated sites. *Setaria* spp. increased on the tebuthiuron-treated site in Geary County, whereas sedge, *Scribner panicum*, and Japanese brome decreased between the first and second growing seasons after application. The 2 kg/ha rate used in this study, in conjunction with low rainfall and high organic matter and clay content of soils, was not adequate for complete control of the target species.

- **Chert Gravel, Drainage Development, and Sinkholes in the Walnut Basin, South-Central Kansas.** James S. Aber. Earth Science Department, Box 30, Emporia State University, Emporia, Kansas 66801.

High-terrace and hill-top chert gravel deposits are abundant in the Walnut drainage basin. These gravel deposits are designated here as the Leon Gravel, a formation that is equivalent to the Olpe-Norge soil. The Leon Gravel can be separated in some places into upper (hill-top) and lower (high-terrace) members on the basis of topographic position and soil development. Age of the Leon Gravel is not known with certainty; hill-top gravels are likely late Miocene or Pliocene; whereas, the high-terrace gravels are probably Pliocene or early Pleistocene. The Leon Gravel contains quartzite pebbles that presumably were reworked from Ogallala-type deposits. The quartzite pebbles were likely carried eastward by the ancestral Arkansas River, which may have flowed across the Flint Hills into southeastern Kansas. Bedrock features of the region have exerted a strong influence on the modern drainage pattern and sinkhole development; long-term southward crustal tilting has caused streams to shift to the south during valley entrenchment.

- **Plasma Confinement with Electrical and Magnetic Fields.** R. Jones. Physics Department, Emporia State University, Emporia, Kansas 66801.

Electric fields may represent a more effective way of confining a magnetoplasma.

- **Vertebrate Fossils from the Lawrence Formation (Douglas Group, Virgilian, Upper Pennsylvanian) in Northeastern Kansas.** Albert J. Robb, III. Mobil Exploration and Producing, U.S., Inc., 2319 N. Kansas Ave., Liberal, Kansas 67901.

The Lawrence Formation is a typical thick shale sequence of the midcontinent Upper Pennsylvanian cyclic depositional models, and contains a low diversity vertebrate assemblage composed exclusively of fish. This fauna, recognized from mostly fragmentary microscopic elements, includes both sharks (*Cladodus* and *Orthacanthus*) and bony fish (*Palaeoniscoidea* indet., cf. *Rhabdoderma*, and *Sagenodus*). These taxa do not occur within the same stratigraphic intervals, and suggest varied fresh water to nearshore marine environments of deposition. Although the small sample size, low diversity, and varied interpretations of environmental preferences for the vertebrate fauna limits its usefulness as an environmental indicator, the implications are consistent with other paleontologic and sedimentologic data.

- **Photosynthesis and Water Relations of Big Bluestem ( $C_4$ ) and Kentucky Bluegrass ( $C_3$ ) under High Concentration Carbon Dioxide.** H. He, M.B. Kirkham, D.J. Lawlor, and E.T. Kanemasu. Evapotranspiration Laboratory,

Department of Agronomy, Kansas State University, Manhattan, Kansas 66506-3801.

As the carbon dioxide (CO<sub>2</sub>) concentration in the atmosphere increase, comparing how C<sub>3</sub> and C<sub>4</sub> plants will respond is important. The objective of this study was to determine the photosynthetic rate, intercellular CO<sub>2</sub> concentration, transpiration rate, stomatal resistance, leaf temperature, water potential, and water requirement of a C<sub>3</sub> grass (Kentucky bluegrass, *Poa pratensis* L.) and a C<sub>4</sub> grass (big bluestem, *Andropogon gerardii* Vitman) growing in the fall in a tallgrass prairie in Kansas under two levels of CO<sub>2</sub> (ambient and two-time ambient). Elevated CO<sub>2</sub> increased the photosynthetic rate of Kentucky bluegrass by 141% but did not affect the photosynthetic rate of big bluestem. Intercellular CO<sub>2</sub> concentrations of both grasses were increased by about the same amount, which was about half the increase in the atmospheric CO<sub>2</sub> concentration. Doubled CO<sub>2</sub> reduced the transpiration rates and increased stomatal resistances of both grasses, but big bluestem was affected more than Kentucky bluegrass. The twice-ambient level of CO<sub>2</sub> increased (between 0.2 and 0.3 MPa) the water potential of both grasses. Doubled CO<sub>2</sub> decreased the water requirements of big bluestem and Kentucky bluegrass by 41.6% and 158% respectively.

- **Results of a Magnetometer Geophysical Survey for Buried DDT 55-Gallon Steel Drums, Riley County, Kansas.** Kenneth R. Neuhauser. Department of Earth Sciences, Fort Hays State University, Hays, Kansas 67601-4099.

Interpretation of a magnetometer survey along the Kansas River floodplain in Riley County, Kansas indicates two major isogam anomalies. The easternmost anomaly is tabular to subcircular, nearly east-west horizontally aligned, and caused by eleven 55-gallon steel drums buried 4 to 6 feet beneath the surface. The drums apparently were buried 20 to 40 years ago. On excavation it was determined that the drums were filled with the liquid-hydrocarbon insecticide dichloro-diphenyl-trichloroethane (DDT) and that none of the DDT had leaked from them. The westernmost, smaller, and more circular anomaly is caused by a small drainage culvert buried 3 to 5 feet down.

- **Recognition of Three Pioneer Scientists of Swedish Descent.** Leon Lungstrom. Bethany College, Lindsborg, Kansas 67456.

This study was carried out to investigate and record information on the life history and contributions of Johan August Udden, John Eric Welin, and Emil Olaf Deere. Udden and Welin were born in Sweden, whereas Deere was born in Illinois shortly after his parents arrived in this country from Sweden.

The information for this study was obtained by checking hundreds of references, files, letters, and other material which probably would have been lost if not retrieved at this time. Interviews were conducted with relatives of these men and others for information.

Each of these men began teaching when he was required to teach a large variety of subjects with a heavy teaching load. They were highly dedicated with keen intellectual curiosity and deep compassion for their students. Professor Udden was the first teacher in Bethany College. During his lifetime he became highly recognized for his research in geology. Four honorary doctorates were bestowed upon him. Professor Welin was a successful teacher for 45 years. Many of his students continued on into graduate work and became highly successful in the field of chemistry. Professor Deere, a teacher for 51 years, also was responsible for a fair number of students going into graduate school and the field of medicine. He contributed much through his many diverse activities to his community, state and nation.

- **The Life of Johan August Udden, Geologist, Teacher, Inventor: Through the Kansas Years.** James R. Underwood, Jr. Department of Geology, Kansas State University, Manhattan, Kansas 66706.

Johan August Udden, born in the village of Udd, Sweden in 1859, immigrated with his family to the United States in 1861; they settled in a farming community in Carver County, Minnesota. J.A. Udden attended Augustana College and graduated in 1881, having completed a classical program with emphasis in the natural sciences; he did not, however, have a formal course in geology. He accepted a post in Lindsborg, Kansas, in the fall of 1881 at Bethany Academy, later Bethany College, and remained there until 1888, when he was invited to return to Augustana as the first occupant of the Oscar II Chair of Natural History. He made the decision during his stay at Bethany to make geology his career, and although he did not publish his first scientific paper until he returned to Augustana, his early papers were based on observations made and materials collected during his years in Kansas.

- **Fritiof M. Fryxell--In His Footsteps.** J. Robert Berg. Department of Geology, Wichita State University, Wichita, Kansas 67208.

Born of immigrant Swedish parents in Moline, Illinois, on 27 April 1900, Fritiof M. Fryxell went on to become a legend with an extraordinary career in many fields and endeavors. He received the baccalaureate degree in English in 1922 from Augustana College, the Master of Arts degree from the University

of Illinois in 1923, and the Doctorate of Philosophy (in Geology) in 1929 from the University of Chicago.

I first encountered Dr. Fryxell as I entered Augustana College as a freshman in the fall of 1934. Although I had planned to pursue a degree leading to preparation for medical college, I soon was introduced to the legend of Fryxell by my fellow students who insisted that I absolutely had to have the opportunity of enrolling in a course with Professor Fryxell which I never regretted, following in his footsteps to obtain the bachelor, master, and doctorate degrees in Geology.

Numerous stories, biographies, and other accounts of his mountain climbing prowess, the establishment of Grand Teton National Park, compliments to him by Generals Eisenhower and MacArthur for his work with the military geology unit in WWII and work in the Philippines, all attest to the stellar performances of this legend.

Research and publications of Fryxell include glaciers of the Tetons, geomorphology and glacial geology of the San Joaquin basin, Sierra Nevadas, completion of Francois Matthes' work on Sequoia National Park and Yosemite, Tertiary structure, and volcanics in the Tetons, and Philippine oil possibilities.

- **Hollis Hedberg--Kansas, Geology and His Swedish Heritage, 29 May 1903-14 August 1988.** Georges Pardo and Frances Hedberg. 906 Amberson Avenue, Pittsburgh, Pennsylvania 15232 and 118 Library Place, Princeton, New Jersey 08540.

In 1926, when Hollis Hedberg went to Venezuela at the age of 23, he took with him the tools upon which he would build his life. They were all compactly resting in his head. His family life on the farm, the spirit of the Swedish community where cleanliness and friendly cordiality went together with sturdy hard work and integrity of character, his formal education, and an exploratory mind. In Venezuela he rushed into a study of the country. His 22 papers together with the company reports he wrote, are today recognized as classic and basic to the geology of Venezuela. He proposed the use of determining the refractive index of oil to simplify determining its weight. He faced the question of the origin of oil and the migration of oil. In the 60's he became convinced of the importance of offshore resources and masterminded a multisensor ship, the *Gulfrex*, to survey sedimentary basins worldwide. He tackled the scientific and political questions of the Law of the Sea. But his greatest contribution to science was his long and arduous struggle to establish guidelines and language for stratigraphic nomenclature published in the *International Stratigraphic*

*Guide* in 1976. He served on countless committees, advisory boards, and he befriended and was an inspiration to his colleagues, associates, students, and employees. He studied and translated the works of Swedish geologists. He received many awards in recognition of his use of the tools with which he launched his career.

- **Linnaeus' 1734 Dalaresa and His Geological Observations.** Daniel F. Merriam. Kansas Geological Survey, The University of Kansas, Lawrence, Kansas 66047.

In 1734, just 2 years after his famous Lapland journey, Carl Linnaeus took a 6-week, 520-mile trip through Dalacarla. Seven students accompanied him describing the topography, botany, geology, and economic conditions of the region. The trip started in Falun and proceeded northwest to Rättvik, Boda, Orsa, Mora, Älvdalen, Särna and Grövelsjön to Röros (in Norway) and back through Särna, Lima, Malung, Nås, and Borlänge to Falun. Linnaeus was only 27 years old at the time and had not yet completed his education. Each student was assigned tasks to perform along the way by the Societas Itineraria Reuterholmiana Club's president Linnaeus. It fell to Claes Sohlberg among other things to record information on the soil and mineral springs, and to Ingel Fahlstedt to describe the mineralogy (and groom the horses). The copper mine at Falun and the limestone quarries in the vicinity of Boda were described. Oil seeps and tar deposits were noted in the Boda quarries. Near Orsa they visited the sandstone quarries where grindstones were made and he commented on the lung disease of the quarrymen. They stayed in Röros and visited the copper mines. On the way back part of the trip was by boat on the Västerdalälvaen. Linnaeus displayed his acuteness of observation of geological features along the way and was particularly aware of the economic possibilities especially for mining. He recognized the difference in topography between the glacial material and the underlying bedrock (pre-Cambrian). Several of his ideas on geological processes were formulated while on this journey.

- **The Northeast Kansas History of Science Library Network.** Alexandra Mason. Kenneth Spencer Research Library, University of Kansas, Lawrence, Kansas 66045.

Four libraries in northeast Kansas collect actively in the history of science, informally dividing responsibility for the various fields among them. This distribution makes it possible in its collecting areas, and avoid competition in the rare book and manuscript market. Researchers have access within a 200-mile area to libraries with internationally recognized resources in the history of

science. This paper describes the specialties of each library in the area of rare books and manuscripts, including comments on holdings in Swedish science.

The libraries to be discussed are the Kenneth Spencer Research Library at the University of Kansas, Lawrence, Kansas, with specialties in natural history and economic history; the Clendening History of Medicine Library at the University of Kansas Medical Center in Kansas City; the Linda Hall Library in Kansas City, with great strengths in mathematics, physics, engineering, geology; and Kansas State University in Manhattan, with specialties in American agriculture and domestic economy. Of particular interest in Swedish science are the Linnaeus collections at the Spencer Library (over 2000 volumes) and at Kansas State University (about 1300 volumes) as well as the notable Swedish Scientific Journal holdings at the Linda Hall Library.