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The PROCEEDINGS contains communications (from symposia, from professional contributed paper sessions, and from collegiate competition sessions) representing papers submitted and accepted for oral presentation at the April annual meeting of the ACADEMY. The PROCEEDINGS appears in April of each year.

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NORTH DAKOTA ACADEMY of SCIENCE
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1990-91

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83rd ANNUAL MEETING

25 - 26 April, 1991

Minot, North Dakota

E D I T O R ' S N O T E S

The PROCEEDINGS of the NORTH DAKOTA ACADEMY of SCIENCE was first published in 1948, with Volume I reporting the business and scientific presented to the fortieth annual meeting, 2 and 3 May, 1947. Through XXI the single yearly issue of the PROCEEDINGS included both Abstract Full Papers. Commencing with Volume XXII the PROCEEDINGS was publis parts. Part I, published before the meeting, contained an Abstract paper to be presented at the meeting. Part II, published later, cc full papers by some of the presenters.

Commencing in 1979 with Volume XXXIII, the PROCEEDINGS chan 5 x 11" format, is produced from camera-ready copy submitted by auth issued in a single part prior to the annual meeting to be distr initially at the meeting in late April. Each presentation at the annu meeting is represented by a full page "Communication", which is more than an abstract, but less than a full paper. The communications contain actual results and conclusions, and permit data presentation. The communication conveys much more to the reader than did an abstract, but still provides the advantage of timeliness and ease of production.

The first section of this Volume 45 of the PROCEEDINGS contains 16 presentations in the three symposia offered at the 83rd annual meeting of the Academy, 25-26 April, 1991. These papers are organized by Symposia and are presented in the same sequence as presented at the meeting.

The second section of this volume contains the 20 communications presented in the professional sections of the meeting. All professional communications were reviewed for conformity with the instructions by the Editorial Committee prior to their acceptance for presentation and publication herein. The professional communications have been grouped together in this volume and are arranged alphabetically by the last name of the author presenting the paper.

The third section of this volume contains 13 collegiate communications, representing all those papers presented in the A **Roger Denison Student Research Paper Competition.** Undergraduate and graduate students reported on the results of their own research activities, usually carried on under the guidance of a faculty advisor. While student competitors were required to prepare a communication similar to those prepared by their professional counterparts, these communications were not reviewed prior to publication herein. The Denison Awards Committee judges the oral presentation and the written communication in arriving at their decision for first place and runner-up awards in both the graduate and undergraduate student competitions. In this section the first 4 papers are from the graduate competition (placed in alphabetical order by the last name of the author presenting the paper) and the second group of 9 papers are from the undergraduate competition (arranged in similar alphabetical order).

Readers may locate communications by looking within the major sections of these PROCEEDINGS (see the table of contents), or by referring to the author index for a page number reference to this volume.

This issue of the PROCEEDINGS also includes the Constitution and Bylaws of the ACADEMY, a list of officers, 1990-1 committee membership, a list of all Academy members as of 1 March, 1991, and a copy of the most recent (1990) financial statement of the Academy.

Roy Garvey
Editor

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RULES for PREPARATION of PROCEEDINGS COMMUNICATIONS

Submission.

1. Each paper presented at the annual meeting of the ACADEMY must be represented ' single page communications in the Proceedings. This includes A Roger Denison student resea tion papers.

2. Only communications intended for presentation at the annual meeting will be for publication. They must present original research in a concise form. Quantit should be presented with statistical analysis (means with standard errors). Papers y summarize conclusions or ideas without supporting data are discouraged and mally be accepted. The communication should include the purpose of the research, t gy, results, and conclusions.

3. Communications must be submitted on the special "blue-line" form and s aree legible photo copies to the Secretary, North Dakota Academy of Science. The for be folded; a cardboard backing should be used to avoid damage.

4. The authors' permission for the North Dakota Academy of Science to publish is implied by a submission. The ACADEMY does not restrict the right of authors to include data presented in a communication in full papers submitted at a later date to other publishers.

Manuscript.

5. **Authors are encouraged to utilize the full space available on an 8.5 by 11" page in order to provide sufficient information to fully describe the research reported.** Communications must be prepared to fit within the bounds of the "special blue-line form". Text should be presented using "elite" (12 character per inch) fonts and single line spacing (6 lines per inch). This should allow for approximately 62 lines of 100 characters each. Unless your printer/word processor uses "micro justification", DO NOT right justify your text. Begin paragraphs with a 3 character space indentation. Use a typewriter with carbon or good quality black silk ribbon, or a "laser printer" set for the narrowest margins which will retain the printed characters on the face of an 8.5 by 11.0 inch page. Special symbols not available on the fixed character printer must be hand lettered in black ink. Dot matrix print of less than "letter quality" is not acceptable.

6. Text, tables and diagrams reproduced on white bond paper, and high contrast photographs may be secured to the "blue line form" using "Tack Note" by Dennison or two sided mounting tape. Tape should not show on the top side of the bond paper or photograph being mounted. All typing, drawing and secured art or photographic materials must be within the boundaries of the blue-line form. The Proceedings will be published by direct photo-offset of the submitted communication (with a reduction to 80% of the original size to accommodate margins). No proofs will be prepared.

7. **Heading:** The title of the Communication, typed in capitalized characters, should be centered as the first line(s). It is suggested that authors select a sufficient number of keywords to describe the full content of their paper, and then construct a title using as many of these as practicable. Titles normally should not exceed 140 characters in length. In particular they should be free from unnecessary phrases such as "a preliminary investigation of" or "some notes on" which add little or nothing to their meaning. A blank line should follow immediately after the title.

   The names of the authors should be centered on the line immediately following the blank line after the title of the communication. Full first names are encouraged; however, the author should use initials if he/she normally uses that form in other publications. **Indicate the author to present the communication by an asterisk * after that person's name.**

   The business or institutional address of the author(s) should be centered on the line immediately following the line listing the name of the author. Typical entries might be:

Department of Chemistry, North Dakota State University, Fargo, ND 58105
Energy and Environmental Research Center, University of North Dakota, Grand Forks, ND 58282
USDA/ARS, Human Nutrition Research Center, Grand Forks, ND 58202

USDA/ARS, Biosciences Research Laboratory, Fargo, ND 58105
North Dakota Geological Survey, 600 East Boulevard, Bismark, ND 58505

8. **References:** Only essential references should be cited, and each should be indicated in the text by a number enclosed in parentheses; this number should be on the same line as the rest of the text, (e.g., "This topic has been discussed by Smith (5, 6)"). Note that a space is left between words and the parenthetical citation and that there is a space between numbers in multiple citations. References are to be assembled, arranged numerically in order of first appearance in the text, and placed at the end of the communication under a two inch line of ---------. In the Literature Cited the numbers are followed by a period and are placed flush with the left margin; if the reference exceeds one line, the succeeding line or lines should be indented 5 spaces. The following form of citation should be used:

1. Neary, D., Thurston, H. and Pohl, J.E.F. (1973) Proc ND Acad Sci 40, 83.
2. Batsone, G.F., Blair, A.W. and Slater, J.M. (1971) A Handbook of Pre-natal Pediatrics, pp 83-90. Medical and Technical Publishing, Lancaster.
3. Farah, A.E. and Moe, G.K. (1970) in Pharmacological Basis of Therapeutics, 4th edition (Goodman, L.S. and Gilman, A., eds), pp 677-709. Macmillan, New York.
4. Rajewsky, M.F. (1973) Abstr. 2nd Meeting European Association for Cancer Research, Heidelberg, Oct 2-5, pp 164-5.

9. **Abbreviations:** Only standard abbreviations should be used, and should be written out the first time used with the abbreviation following in parentheses. The North Dakota Academy of Science (NDAS) for example.

10. **Session Assignment:** To assist the Program Committee in organizing the presentations, please indicate on the reverse side of the blue-line form your 1st, 2nd, and 3rd preferences for the topical classification of your paper.

RULES for ORAL PRESENTATION of PAPER

1. All papers are limited to 15 minutes total time for presentation and discussion. It is suggested that the presentation be limited to 10 minutes with an allowance of 5 minutes for discussion. It is also suggested that major emphasis be placed on the significance of the results and the general principles involved rather than of the details of methods and procedures.

2. ACADEMY members represent a a variety of scientific disciplines; therefore, speakers should avoid "jargon" and briefly explain or define much specialized terminology as may be judged to be indispensable to the presentation.

3. Projectors for 2" x 2" slides and "overhead-transparencies" will be available in all session rooms. Opaque projectors and video playback equipment will be made available as required if advanced notice of need is given. Only visuals which can be read easily on projection should be used. Authors who desire suggestions for preparation of slides are referred to Smith, H W (1957). "Presenting Information with 2 x 2 Slides", Agron J 49, 109-13.

4. Timed rehearsals with slides are highly recommended. There is usually time for a maximum of 6 or 7 slides for a presentation of this kind.

S Y M P O S I U M

o n

GEO - DATA PROCESSING

Presiding: Jack Hammen
Department of Geography
University of North Dakota
Grand Forks, ND

Analytical Capabilities of a Geographic Information System
Jack Hammen*, Department of Geography, UND, Grand Forks

Optimization Classing: A Method of Mitigating Inacuracy in Computer Mapping and Geographic Information Systems
Mohammad Hemmasi*, Department of Geography, UND, Grand Forks

Oil and Gas Field Matting in North Dakota
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Paul E Nyren* and Bob D Patton
Central Grasslands Research Center, Streeter, ND

Geo-Processing for Geophysical Research
Will Gosnold*, Department of Geology, UND, Grand Forks

ANALYTICAL CAPABILITIES OF A GEOGRAPHIC INFORMATION SYSTEM

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Department of Geography
University of North Dakota, Grand Forks, ND 58202

Perhaps because of the rapid pace of technological developments, there exists considerable confusion concerning the functionality of such techniques/disciplines as automated cartography, database management systems (DBMS), computer-aided design (CAD), remote sensing, and geographic information systems (GIS). Geographic informations systems, in particular, are poorly understood. Cowen (1988) noted that the label GIS has been routinely applied to "...almost any software system that can display a map or map-like image on a computer output device" (p. 1551). A plethora of definitions abound some of which espouse GIS technology as a state-of-the-art achievement in information processing while others suggest that geographic information systems are not even necessarily computer-based. Obviously, there is a need for a universally-accepted criteria for defining (and communicating about) a GIS.

There are baseline analysis functions which are "sine qua non" regarding a GIS and which may thus be used to define the technology. They are encapsulated in a definition which states that a GIS: 1) creates new information through the synthesis of existing data; and 2) automatically updates spatial and textual databases with the new information created. Synthesis is accomplished primarily through the overlay of computer maps; the new map is automatically established in the appropriate databases and is itself available for further analyses with other maps. This characteristic - the automatic assimilation into the computer of newly-created information - alone is sufficient to differentiate a GIS from other computer mapping systems. While the map is still the basis unit for analylsis, a GIS does more than simply incorporate data into a map-like presentation. The existence of databases, both graphical and textual, in a GIS, provide further argument for the dichotomy between GIS and other systems.

The specific analytical functions of a GIS can be classified as primitive and derivative. Particular derivative functions depend on the internal data structure of a GIS and may be considered as ancillary functions facilitated by the GIS database and the processing power of the computer. They are not found in all geographic information systems but are such prevalent applications as to be inextricably associated with GIS technology. Image analysis, network tracing, coordinate geometry (COGO) computations, and terrain analysis are examples. Primitive functions are those found in all geographic information systems, regardless of the data structure. Piwowar and LeDrew (1990) list these functions and their associated definitions: 1) location - given an attribute and a region file, find all of the regions containing that attribute; 2) inclusion - given a point and a region, does the point lie within the region; 3) containment - given a point and a region file, which region contains the point; 4) proximity- given a particular region in a region file, what are its neighbors; 5) dimension - what are the areal coverages for each region in a region file; 6) intersection - given two overlapping region files, what are the proportions of each region from the first in each region in the second; 7) distance - given a point, p, and a point file, what is the point in the point file nearest to p; what is the distance from that point to p; and 8) interior - given a region, what is the centermost point (i.e., an inside point which is farthest from the boundary.

With a geographic information system, you can ask (and answer) such questions as: "What are all possible transmission line corridors between Grand Forks and Williston that do not rise above 700 feet in elevation; are at least 50 percent on public land; do not pass within 1 kilometer of known endangered wildlife populations; cross no streams at angles less than 80 degrees; and include no grades over 7 percent. Such a query demonstates the power of a GIS and highlights its primary differences from closely associated technologies.

Cowen, David J., 1988. GIS Versus CAD Versus DBMS: What Are the Differences? Photogrammetric Engineering and Remote Sensing 54(11):1551-1555.

Parker, H. Dennison, 1989. GIS Software 1989: A Survey and Commentary. Photogrammetric Engineering and Remote Sensing 55(11):1589-1591.

Piwowar, Joseph M.; and Ellsworth F. LeDrew, 1990. Integrating Spatial Data: A User's Perspective. Photogrammetric Engineering and Remote Sensins 56(11):1497-1502.

OPTIMIZATION CLASSING: A METHOD OF MITIGATING INACCURACY IN COMPUTER MAPPING AND GIS

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Cartography is defined as the art, science, and technology of making maps. The last several decades have seen greater improvements in the technology of mapmaking than previous centuries. With the advent of computers in cartography since the 1960s, changes in software and hardware have been fast and substantial. Cartography as the science of communicating information between individuals by the use of maps is also committed to scientific accuracy and precision. One of the disadvantages of computers for cartography, as a discipline, is that anybody who has access to a turnkey cartographic system, but no training in cartographic theory, can now easily produce maps. This study demonstrates inaccuracies and misinformation problems which may arise by using conventional class interval calculations in producing shaded choropleth maps. Popular computer mapping programs such as SYMAP, CALFORM, SAS/GRAPH, and ATLAS/GRAPHICS produce, by "default", a five category map using class interval computation methods of equal steps, quantiles, and ranks. They also allow for user defined class interval limits. Yet, most geographic data sets used in choroplethic mapping are rarely suited for classification with such simplistic methods (1).

An alternative solution is offered by Jenks' "optimization" method, a computer program written for the mainframe in 1980 and recently revised to run on PC. The latest version is available from the Department of Geography, Michigan State University. The program searches for solutions which maximize both within class homogeneity and between class heterogeneity. The process involves hundreds of computations while going through several iterations to achieve a solution which maximizes the value of Goodness of Variance Fit (GVF). The program produces optimal class limits, but not the GVF index, which must separately be calculated using the GVF formula.

Sum of Squares Total (SST) is the sum of squared deviations of individual data values from the overall mean of the data set. To calculate total Sum of Squares Within (SSW), first sum the squared deviations of class data values from the mean of each class and then sum these values for all classes (1). The GVF ranges from 0 to 100, with the higher the index number, the greater the classing accuracy. As an experiment, population density for 53 North Dakota counties is analyzed to calculate class intervals for a five category choropleth map. The data's structural characteristics are summarized by coefficients of skewness (2.9), kurtosis (9.0), standard deviation (9.9), and the mean (8.95). In the following table, the number of counties allocated to each class, values of GVF, and results of a one-way analysis of variance (F-Ratio) for seven different methods are presented.

Method	COUNTIES IN EACH CLASS I	II	III	IV	V	GVF Index	F-Ratio
Quantiles	11	10	11	10	11	58	1
Standard deviation	--	15	33	1	4	88	12*
Geometric series	2	20	18	9	4	92	12*
Arithmetic series	19	24	6	1	3	94	8*
Equal steps	43	6	1	1	2	94	97*
Natural breaks	35	13	1	2	2	97	15*
Optimal	22	15	12	2	2	98	81*

GVF = 100 - ((SSW / SST) x 100)

Source: Computed by author based on 1980 Census. * Significant at 0.05 level.

For this data set, the quantile method is the least desirable (GVF = 58), and natural breaks the most desirable one (GVF = 97). The four remaining traditional classing methods fall somewhere in between. However, the optimization method is superior to all of them as indicated by the highest value of GVF = 98. Using these class limits, seven choropleth maps of population density for North Dakota are produced. The traditional classing methods portray very different spatial patterns, and often convey inaccurate impressions of the mapped variable. The equal steps method puts 43 counties in Class I and the standard deviation method none. The optimization method assigned 22 counties to it. To detect these inaccuracies the mapmaker and map user must be acquainted with the area and the nature of map's theme. To avoid these pitfalls the cartographer needs to perform a careful preprocessing analysis of the data at the design stage. Currently the best available solution is offered by optimization methods including the one used here. Yet most thematic choropleth maps published in professional journals use traditional classing methods. Since maps are integral parts of a GIS, accurate classing enhances its analytical power. Of course, an alternative to a classed map is a classless map, a technique yet to be fully appreciated.

1. Smith, R. M. (1988) Professional Geographer, 38-1, 62-7.

OIL AND GAS FIELD MAPPING IN NORTH DAKOTA

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The Oil and Gas Field Map project entails the digitization, storage and display of basic oil and gas data through the use of the GIS. THe project's objective is to replace manually maintained oil and gas field maps with an automated system capable of plotting draftsman-quality maps at user-defined scales. At a minimum, oil and gas field maps contain the following digitized themes: landlines, lots, leases, communitization agreements (CAs), units, participating areas (PAs), compensatory royalty agreements (CRAs), field boundaries, gas storage agreements (GSA), and wells. Oil and gas wells are displayed as symbols with descriptive information depicted alongside. Related themes are added at the user's discretion,a nd frequently include: transportation, spacing units, lakes, streams, and rights-of-way (ROW).

The field map information can be displayed interactively, i.e., on screen, or as hard-copy output. Oil and gas field maps are used to support all facets of fluid mineral activities including operations, inspection and enforcement, planning, and reservoir management.

Multiple themes overlying 969 townships in Montana, North Dakota and South Dakota will need to be digitized to provide coverage for existing oil and gas fields. A total of 3,743 individual themes will have to be digitized to provide minimum oil and gas field map coverage. As of January, 1991, a total of 440 individual themes have been digitized, verified and converted to MOSS.

All base data is digitized from the USGS 7 1/2 minute mylar quads.

Data may be obtained by several methods. Digitizing is done through a public domain software called Automated Digitizing System (ADS). Data can be scanned, purchase as Digital Elevation Models (DEMs), or purchased from other agencies or private companies. Data type can be vector or cell data.

All software used in the GIS is of the MOSS family of public domain software. Analysis is performed through software called Map Overlay Statistical System (MOSS), for vector data, or Map Analysis and Processing System (MAPS) for cell data. Analysis such as buffer, distance (path/airline), query, area, or windows can be performed on data.

Output can be printed to the screen, a printer or to a plotter. A CalComp 1042 GT plotter is located in all district offices. A Kongsberg flatbed plotter is available at the Denver Federal Center for large maps.

The Geographic Information System runs on a Prime computer, using the Primos operating system. The Prime 6350 is a 32 bit, mini-computer, located in Billings, MT. It contains 13 disks, each holding from 496 to 817 megabytes of information. Each district office has a Prime 2450 system, with a 258 megabyte hard drive.

Planned enhancements include a variable offset-line program, which would allow the user to choose the theme and amount of line offset, help screens, a user friendly menu system, and multiple attribute files for will information.

ON THE ISSUE OF INTERAGENCY STANDARDS IN GIS

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The USDA Soil Conservation Service (SCS) is a federal agency primarily responsible for the wise use and management of privately owned land. To achieve this, SCS has invested heavily in Geographic Information Systems (GIS). For efficiency it has established, maintained, and utilized accuracy levels and data input and output standards.

The SCS has responsibility for the national coordination of digital soils data. It has established three soil geographic databases representing different intensities of soil mapping (county, state, and national). These databases are compatible with USGS-DLG, Census Bureau-TIGER, and Fish and Wildlife-NWI digital files.

With users having diverse operating environments and computer systems, the need for compatibility in data formats is obvious. The USGS has taken leadership in developing, defining, and maintaining federal standards. Working through the Federal Interagency Coordinating Committee on Digital Cartography, a Spatial Data Transfer Standards (SDTS) has been tested, and in July 1990, submitted to the National Institute of Standards and Technology. This standard, when accepted, will offer specifications to the GIS community and it will permit the efficient exchange of information between systems. Advantages go beyond simple system compatibility. THe standard will make data more available, reduce redundant data collection and make maintenance easier.

North Dakota has been slower than some states to fully utilize GIS technology. Instead of a hindrance, this may give the state an unique opportunity to establish and use digital standards to assure interagency compatibility. To date, most data acquisition has been on the project level of by counties seeking a computerized system for tax equalization.

As the demand for digital data increases the need for standards will become increasingly important. The cost of developing data will demand compatibility. Although a single GIS for the entire state is probably unobtainable, given the diversity of state and federal agencies,t he use of the SDTS will greatly assist in assuring a high level of compatibility.

The key to interagency standards, in lieu of a State GIS, is communication and cooperation. INterested state and federal agencies have loosely organized themselves hierarchically. At the lowest level is the GIS Users Group comprised of anyone interested in GIS technology. The second level is the GIS Technical Advisory Group who recommend data and accuracy standards, base maps, and inventory available digital data. The highest level is the GIS Administrators Group, comprised of agency heads. They review recommendations made by the Advisory Group and make policy to efficiently incorporate GIS technology. All levels are tied together through a GIS newsletter which promotes contacts and communication.

SPECTRAL MIXING MODELS FOR QUANTITATIVE SURFACE MAPPING

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Satellite remote sensing has long been viewed as an efficient method of mapping regional distributions of large-scale surface features. The extent of vigor of agricultural crops throughout the growing season are the most cogent example of using satellite data to create statewide maps with immediate economic potential. Remote sensing techniques have not, however, replaced low-level aerial photography when the need for pinpoint quantitative data arises. In general, the problem centers on the relatively low spatial resolution of most satellite imaging systems. The typical limit for most civilian imaging systems is on the order of 30 to 79 meters, considerable inferior to the 1-5 meter resolution of typical airborne surveys.

Multispectral image scanners, both aircraft and spacecraft-mounted, have the ability to generate a visual/near-infrared spectrum of an individual target pixel on the ground. This spectrum represents a unique "signature" for a given surface composition, either soil or vegetation. Unfortunately, when a satellite imaging system obtains a spectrum from a ground target, the recorded reflectance has been integrated over all but the largest and most homogeneous ground targets. Pixels which record the spectral signatures of several diverse ground cover mixed together. When the satellite data fails, it has been necessary to call in aircraft to perform high-resolution multispectral mapping.

The advent and wide-distribution of computer and imaging technology now make the formerly intractable task of analyzing mixed pixels feasible. since a ground pixel represents reflectance values from a finite spatial area and each component within that are reflects incoming solar radiation in a characteristic fashion, the concept of spectral mixing comes into play. In it's simplest linear form, the assumption is that all ground components within a pixel. If the reflectance characteristics of each individual component (known as end-members) are known, it is relatively straight-forward to deconvolve to measured multispectral reflectance into it's constituent parts. In particular, by using the linear mixing model proposed by Adams, et al. [1986] and implemented and tested by Blount et al[1990], a researcher can generate synthetic images in which the concentration of each ground component is rapidly and quantitatively mapped over large spatial areas.

This approach requires a foreknowledge of the spectral characteristics of all possible targets and mixtures of targets. The required spectral libraries are currently being built by researchers worldwide. Applications of this technique are widespread, particularly in areas where conventional aircraft multispectral scanner surveys are either too expensive or logistically impossible. A pilot project has already been completed near Jamestown for mapping the multitemporal variations in wetland acreage during dry and wet years. The routine quantitative mapping of crop vigor and canopy cover are one prime example for the Northern Great Plains. New multispectral scanners to be launched in the mid-1990's will further enhance both the accuracy and timeliness of such satellite derived concentration images.

Adams, J.B., Smith, M.O., and Johnson, P.E., (1986) J. Geophys. Res., 91,8098-8112.

Blount, G., Smith, M.O., Adams, J.B., Greeley, R., and Christensen, P.R., (1990) J. Geophys. Res., 95, 15463-15482.2

The Determination of Above-Ground Biomass Through the Use of Multispectral Analysis

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The science of range ecology includes the evaluation of the impact of various changes on the productive potential of the plant community. These evaluations rely heavily on the determination of above-ground biomass. Current evaluation methods require time-consuming techniques which, at best, sample only a small fraction of the total area.

Recent advances in computer technology have allowed the use of sophisticated geographic information systems (GIS). These programs, which only a few years ago required large main frame computers, can now be run on desktop personal computers or on more sophisticated laptop or portable machines.

The ability to assess green biomass has come about with the development of various vegetation indices. These ratio-based indices for vegetation assessment typically use the red and color infrared (CIR) bands. They contrast the chlorophyll absorption region in the red against the high reflectivity in the CIR (1). The ratio between the CIR and red radiations was found to be a sensitive indicator of green biomass (2).

At Central Grasslands Research CEnter, remote sensing is being used to evaluate changes in above-ground biomass on grazing intensity study. This study will evaluate four levels of stocking on native mixed grass prairie. The four levels of grazing are replicated three times providing 12 study pastures. Sample sites have been located on silty and overflow range sites within each of the study pastures. Above-ground biomass is determined on each site by clipping all green biomass with five 0.25 m^2 frames. These data are collected during peak production around late July. At the time the biomass samples are being collected, aerial photos are taking using a light aircraft and 35 mm infrared film. The 35 mm transparencies are then digitized and analyzed using the Map and Image Processing software developed by Micro-Images. A modification of the transverse vegetation index (TVI) described by Deering, et al. (3) is used to analyze the images to determine the green biomass values.

$$(CIR-RED / CIR+RED)^{1/2} \times 100$$

Sub-samples of the brightness values on the TVI raster are averaged and a regression analysis performed.

Due to the short time that the study has been underway, differences in forage production are due to the productive potential of the site rather than the result of grazing intensity. Therefore, no samples were collected from sites having less than 2,142 kg/ha total above-ground biomass. In future samplings, an attempt will be made to sample areas of low above-ground biomass to extend the sample range. The images collected in July 1990 did contain areas devoid of any green biomass and these areas had a TVI value of zero. When the regression equation was forced through the origin an r^2 of 0.97 was obtained.

1. Tueller, P.T. (1989) J. Range Manage. 42(6):442-553.
2. Tucker, C.J. (1979) Nasa Tech. Mem. 80293
3. Deering, et al. (1975) Proc. 10th International Symposium on Remote Sensing of Environment. Vol. 2, pp. 1169-1178.

GEO-PROCESSING FOR GEOPHYSICAL RESEARCH

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Computer-generated graphical display of geophysical data and processes that vary in time and space not only enhances presentation; it provides a new method for analysis. An excellent example of the method can be seen in simultaneous computation and graphical presentation of numerical solutions of the diffusion equation. The "real-time" graphical display reveals more about diffusion processes than does the conventional approach of generating computer printouts of starting and ending conditions. This type of analysis is a powerful aid in developing forward models of physical systems because of the visual feedback one receives while "watching" a process in action. Analysis of thermal fields around magma intrusions, subsurface temperature fields responding to climate change, and heat advection by flowing groundwater at an underground coal gasification site have been significantly aided by graphical displays of thermal diffusion using the finite-difference method for numerical modelling.

Another capability using computer-generated graphics lies in representing scalar and vector fields in three dimensions. Geophysical potential fields are three dimensional, but they normally are observed only in the two-dimensional plane of the Earth's surface.Historically, graphical representation of potential field data has been in the form of contour lines projected onto a two-dimensional plane such as a map or a cross-section. Reduction of a 3-D field to the 2-D plane on which it was observed has become ingrained not only because of sampling restrictions but also because of limitations to a 2-D format for presentations. Now, micro-computers provide the capability to operate on and display surface in an inherently superior fashion to 2-D displays. An example emphasized here is the application of directional derivatives to different surfaces representing respectively gravity, temperature, and elevation.

In summary, the use of graphical displays of computer models of geophysical processes may bring about intuitive leaps in understanding because the process permits us to see things that otherwise we could not visualize.

S Y M P O S I U M

o n

FROM the HUMAN GENOME to PROTEIN ENGINEERING

Presiding: Kevin D Young
University of North Dakota School of Medicine
Grand Forks, ND

Techniques and Applications of Human Genomic Mapping
Kevin D Young*, UND School of Medicine, Grand Forks, ND

Computer Aided Manipulation of Gene and Protein Sequence Data
Dianne Kube*, UND School of Medicine, Grand Forks, ND

Analysis of Two Major Applications in Protein Engineering
Charles S Craik*, University of California, San Francisco, CA
(Video tape presentation)

TECHNIQUES AND APPLICATIONS OF HUMAN GENOMIC MAPPING

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The Human Genome Project has as its goal the complete chemical description of the genetic component of the human cell. This requires the determination of the exact sequence and location of approximately three billion nucleotide base pairs in the human chromosomes. So far, less than 1% of the 100,000 human genes have been isolated, sequenced, and cloned (replicated) (1).

Such information promises to make important contributions in several different areas. For example, about 3,000 hereditary diseases are known (2). The identification of the genes responsible and characterization of the genetic defects which lead to the diseases would be useful in detection, prediction, and perhaps treatment. Several of these genes have already been mapped to specific chromosomes: for example, Huntington's disease has been located on chromosome 4 and the gene for Duchenne muscular dystrophy has been located on the X chromosome (2). The genetic defect which causes cystic fibrosis was mapped to chromosome 7 in 1985 and the responsible gene was located more precisely and was cloned four years later (3). Knowledge of extensive regions of genomic sequence also holds promise for the study of the evolutionary relatedness of humans and other animals, and for study of the comparative biology among all organisms.

At the current rate it will require several hundred years to sequence the entire human genome (1). New technology promises to decrease the time required so that the sequence may be in hand in 15 to 20 years. Nevertheless, the first useful information about the genome will come in the form of a rough "map" of the locations of interesting genes. To construct such a map, a series of "landmarks" located evenly around the chromosomes is required. The landmarks which are being developed are known as RFLPs (pronounced "Rif-lips", an abbreviation for: Restriction Fragment Length Polymorphisms). Genes can be located in relation to one of the RFLPs and this information can be used to more rapidly identify, clone, and sequence the gene of interest.

DNA can be cut into pieces by proteins called restriction enzymes, and the DNA pieces created are called "restriction fragments." There are over 200 different restriction enzymes which cut DNA at different places to produce different sized fragments. These fragments are useful for mapping because cutting a person's DNA with a restriction enzyme produces a unique set of restriction fragments. Each particular restriction fragment is inherited from one's parents, just like other physical characteristics. Therefore, these fragments can be followed in families (just like the inheritance of eye color) and can be used to "fingerprint" each person (with an accuracy much greater than any other physical characteristic) (2). The number of known RFLPs has increased from 4 in 1979 to 1193 as of 1987 (4). The seminar will explore how RFLPs are being used to help locate genes involved in hereditary diseases, and how they are being used as a legal aid in criminal and paternity cases.

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1. Silverman, P.H. (1990) The human genome project: prospects and politics. Amer. Biotechnol. Lab. 8, 4.

2. White, R. and Lalouel, J-M. (1988) Chromosome mapping with DNA markers. Sci. Amer. 258, 40.

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COMPUTER AIDED MANIPULATION OF GENE AND PROTEIN SEQUENCE DATA

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The amount of information generated in the biological sciences since the 1960s has grown at an exponential rate with the advent of molecular biology and recombinant DNA techniques. In the 1980s, personal computers emerged as indispensable tools for the collection, analysis and interpretation of the enormous volumes of data. Although DNA sequence information is accumulating rapidly, the determination of the three dimensional structure of proteins remains a comparatively more difficult and time consuming task. Currently there are over 30,000 DNA sequences in the EMBL data bank, more than 15,000 protein sequences in the Swiss-Protein Data Bank, and only around 400 protein structures in the Brookhaven Structural Data Base.[1] Thus, much of the data that scientists need to organize and manipulate is sequence information.

The ultimate goal in analyzing genetic sequence information is to improve our understanding of the relationship between primary amino acid or nucleotide sequences and the tertiary structure of the resulting molecules. It is hoped that this understanding will allow us to predict biologically important, functional properties of proteins or nucleic acids from a knowledge of sequence alone. As a first step toward this goal, the physical and chemical properties of nucleic acid (DNA, RNA) or amino acid (protein) sequences can be analyzed. Also, two or more sequences can be aligned and compared with one another to identify strongly conserved regions among the molecules, which may reveal clues about their functional and evolutionary relationships.

Computer software for sequence analysis has become increasingly more sophisticated, yet easier to use and more available to researchers. PC's are now commonplace in the laboratory, and a user-friendly sequence analysis software package may be readily installed on an available unit. The major DNA and protein sequence databases are included with the software packages. Management programs enable effective and efficient use of the large data bases as well as individual sequences or library files. With computational tools readily accessible, one has the power to manipulate and analyze enormous amounts of sequence information, and to ask questions that aid in its interpretation.

The types of protein sequence analysis available include proteolytic enzyme/chemical susceptibility analysis, subsequence analysis, calculation of pI, molecular weight, amino acid composition, hydrophobicity, chemical property plots, reverse translation, and construction of optimal gene probes. As the size of databases increases, so does the accuracy of predictive algorithms such as the detection of sites and signatures in proteins, and prediction of a protein's secondary structure from sequence. Protein sequences may be optimally aligned and compared. The types of nucleic acid sequence analysis may include searches for coding regions, restriction analysis, sequence comparison and homology (including alignment and similarity matrices), and secondary structure analysis (including hairpin loops, RNA secondary structure, and helix distortion).

This seminar will focus on a demonstration of a protein and nucleic acid analysis software package.

[1]Thorton, J.M and Gardner, S.P. (1989) Trends in Biol. Sci. 14:300-304.

ANALYSIS OF TWO MAJOR APPLICATIONS IN PROTEIN ENGINEERING

[Videotape presentation of a seminar presented to the American Chemical Society, November 16, 1990]

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[NOTE: Abstract prepared by K. Young]

One of the long term objectives of research in molecular biology is to understand how the structure of a protein determines and influences its function. The structure of a protein can be determined by X-ray crystallography and its function can be studied by various biochemical techniques. However, until recently, the connection between structure and function has been one of inference based on the relationship between the structure of the protein and the structure of its substrate. This has been very useful and has led to a greater appreciation of the "lock-and-key" concept of how enzymes function.

Researchers are now able to ask more detailed structure-function questions. The classical procedure, used to great effect for years, was to change one or more selected amino acids in the protein and see what effect this had on the function of that protein. In the past, this has involved guess-work as to which amino acids were important combined with a hit-and-miss search for appropriately mutated proteins. Two revolutionary technical advances have changed the way these problems can be approached. First, computer software and graphics have advanced so that molecules can be visualized and manipulated. This means that identification of important amino acids in proteins is easier: potential changes to the protein can be made "in computero" and their effects on structure can be visualized before the biological experiments are attempted. Although a measure of guess-work is still unavoidable, many more potential alterations can be contemplated in more detail. The second advance occurred on the biological side. The ability to clone genes and easily manipulate DNA now allows researchers to insert predetermined mutations at precise locations within proteins. Therefore, the current version of the classical approach to the study of structure and function combines computer-aided selection of important amino acids with the ability to create specific mutations in the cloned gene of the protein.

In this video seminar presentation, Dr. Craik reports how he and his co-workers have used these tools to create proteins with different enzymatic activities. His primary goal at this point is to demonstrate that such protein engineering is possible in principle. In the first example, the proteolytic enzyme, trypsin, was modified so that its activity was inhibited by addition of copper. Such an inhibition does not occur with the normal enzyme. Creation of this "metal switch" involved a knowledge of the chemistry of copper binding and the computer-aided ability to search through the three dimensional structure of trypsin for amino acids which could be altered to create potential sites for such binding.

In the second example, Dr Craik uses the computer-aided procedure to discover more effective inhibitors of a protease from the virus which causes AIDS (the HIV virus). The approach is to map the active site of the HIV protease and then screen compounds (in the computer) for their ability to bind to that site. This method is in current use to predict the structures of compounds most likely to have pharmacological effects toward a variety of proteins and compounds.

The conclusion from these types of studies is that intelligent engineering of proteins is possible. At this point, a major goal of this experimental work is to define in more detail the rules for such engineering.

S Y M P O S I U M

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SCIENCE TEACHING in the HIGHER EDUCATION ENVIRONMENT

Presiding: Clark Markell
Division of Science
Minot State University

Microscale Organic Experiments in the Undergraduate Curriculum
J M Knoblich*, Department of Chemistry, Jamestown College

Computer-Driven Laser-Videodisc Imagery in Planetary Geology
DeWayne Martin*, Division of Science, Minot State University

Biogeochemical Cycles: One Approach to Multidisciplinary Science
Clark Markell*, Division of Science, Minot State University

Biogeochemical Cycles: Representative Results from Science Teacher Research Projects
Robert Crackel*, Division of Science, Minot State University

Writing to Learn in General Education Geology Courses
Eric N Clausen*, Division of Science, Minot State University

Build a Better Mousetrap and . . . . .
Michael B Thompson*, Division of Science, Minot State University
Paul J DeWaal Malefyt, Surrey High School, Surrey, ND

MICROSCALE ORGANIC EXPERIMENTS IN THE UNDERGRADUATE CURRICULUM

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There has been a dramatic shift during the past five years from macroscale to microscale experiments in the undergraduate organic laboratory. The publication of three or more microscale organic laboratory manuals, the development of numerous microscale kits and NSF funded microscale workshops are all indicative of this new and fast growing trend.

The reasons for converting some or most of the experiments in an organic chemistry course to microscale are many:

1. reduction in costs for reagents and solvents,
2. greater safety,
3. less exposure to toxic and corrosive chemicals,
4. major savings in disposal of waste solvents and reagents,
5. less time required for experiment.

One author claims that students can do twice as many experiments when using the microscale versus the macroscale technique.

Microscale technique means students work typically on one-tenth to one-thousand the scale of the conventional organic laboratory. Thus, most microscale experiments will use 50 to 250 mg of reactants and typically 1 to 5 ml of solvent.

Total conversion to microscale experimentation is not recommended because the student would not be trained in certain techniques such as the use of the separatory funnel or vacuum distillation. It would also mean abandoning large amounts of macroscale equipment found in most laboratories which the student will most likely encounter in the real world.

The Williamson laboratory manual was chosen because it is presently the only manual which includes both the macroscale and microscale procedures for most experiments (1). Also, the microscale organic kit developed by Williamson is the least expensive kit available and is very versatile and easy to use.

The type of equipment needed to set up a microscale laboratory and the cost will be presented plus the successes and failures encountered during the first year of conducting microscale experiments will be discussed.

1. Williamson, K.L. (1989) Macroscale and Microscale Organic Experiments. D. C. Heath and Company, Massachusetts.

COMPUTER-DRIVEN LASER-VIDEODISC IMAGERY IN PLANETARY GEOLOGY

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Most science teachers utilize visual aids to illustrate physical characteristics of objects that cannot be viewed directly in the classroom. Color slides are often used to show spatial relationships, physical form, and surface appearance of landforms and rock types in geology. A course that emphasizes these types of characteristics might utilize several thousand color slides to show specific features. The logistics of storing, sorting, showing, and re-storing that many slides can become overwhelming.

Planetary geology includes studies of the surface features of the planets. During the past three decades NASA has obtained several hundred thousand photographs of the various planets in the solar system. A collection of color slides of these images would be extremely difficult to utilize. Fortunately many of these images are now available on videodiscs.

A videodisc can store 54,000 still frames on each side. Videodisc players use an eight digit call number to retrieve each image. In a sense videodisc players are much like manual slide projectors that are somewhat awkward to use and are very susceptible to errors in calling up frames. However, videodisc players can be interfaced with a computer. The computer can be programmed to call up a precise series of images and can direct the player to show these images on the monitor for varying periods of time. Videodiscs now available also contain film clips and computer graphics. These films can also be programmed into the sequence of images to form a coherent package.

Early computer to videodisc interfaces were designed for the Apple series of computers because of their use in education. Later interfaces and programs were designed for the IBM/compatibles. The current trend is for authoring software for the Macintosh utilizing HyperCard and scripting.

All types of computers allow for a variety of levels of use when interfaced to videodisc players. Basic programs include prepackaged units that the teacher can step through using an alphanumeric keypad. Slightly more advanced programs allow selection of materials and sequence by input from the keyboard or by using barcode with an optical wand. Still more complex programs are interactive and include complex branching patterns that are activated by student input. These can be used for either teaching or testing. The most complex programs for computers interfaced with videodisc players now in use utilize videodisc images and sounds that are integrated with computer generated print overlays, digitized images, digitized sound, and synthesized speech in an interactive mode. Prepackaged programs of this type are limited in material and level. None are now available in geology at the college or high school level. Programs of this type also require a minimum of 4 megabytes of working memory.

Programs can be written for all types of computers in Basic if you include a subroutine that generates the proper frequency and modulation from the computer that the videodisc player will recognize as a keystroke. Specific information for the pin-in and pin-out data of each computer and player can be obtained from the technical department of each company.

For the non-programmer, several companies now provide software that includes the video drivers and subroutines that allow you to have your computer talk to your player. Images and film clips are selected and given time of display designations by either keyboard, mouse, or keypad. Authoring programs with the new software is simple and almost foolproof.

Those interested in using videodiscs might begin with two sources: Optical Data Corporation and the Ztek Company. Much of the original software and many of the videodiscs on planetary geology were produced by Optical Data Corporation (formerly VideoVision). Ztek Company lists software, players, interfaces, and videodiscs in most science fields from a variety of manufacturers.

Optical Data Corporation
Box 97
Florham Park, NJ 07932

Ztek Company
P.O. Box 1055
Louisville, KY 40201-1055

BIOGEOCHEMICAL CYCLES: ONE APPROACH TO MULTIDISCIPLINARY SCIENCE

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A multidisciplinary course in global biogeochemical cycles was offered for North Dakota science teachers at Minot State University during the summer of 1990. This nine week graduate course is required in the M.A.T.: Science degree at Minot State. It was developed in response to a perceived national (1,p.21) and regional need to provide science teachers with greater exposure to ideas which transcend disciplinary boundaries and are essential to understanding relationships among all the science disciplines. It was assumed that most undergraduate teacher training programs provide preservice students with little opportunity to conduct field based research projects, and therefore teachers have had little experience with sampling,analytical techniques or presenting scientific findings in a written and oral format. A required multidisciplinary research project in this course was designed to address these weaknesses.

The course was team taught by a biologist, chemist, and geologist. Students held undergraduate majors in biology, medical technology, mathematics, earth science, and chemistry. This diversity led to lectures on key concepts and required laboratory work with instruments such as a computer interfaced diode array spectrophotometer and atomic absorption spectrophotometer. Each student was assigned appropriate laboratory space and was given access to a variety of field sampling equipment housed in the MSU Science Division.

The multidisciplinary objective of the course was also achieved through readings and lectures. Students, for example, were each given recent issues of the American Geophysical Union periodical entitled, "Global Biogeochemical Cycles" and asked to report on papers during Friday seminar sessions. The source, flux, sink taxonomy used by many authors publishing in this journal, quickly became part of the class "sociology". This was reinforced when students were encouraged to consider this taxonomy as they selected a chemical species and cycle to study.

Lectures and text assignments drew upon works by Rambler (2), K. Turekian (3), and the many papers written concerning the Hubbard Brook Experimental Forest.

Results:

1. Student research reports are summarized on the chart below. Several students worked with plant species known to be a bioaccumulator for the chemical species they selected to study.
2. The concepts in the course and their relationship to global warming, land fill sites in North Dakota, National curricular initiatives, and North Dakota State secondary science syllabi were frequently discussed in seminars.

PROJECT SUMMARY

STUDENT NAME	CHEMICAL SPECIES	FIELD AREA	MATERIAL COLLECTED	ANALYTICAL PROCEDURE USED	SOURCE/FLUX/SINK RELATIONSHIP
Aalund	2,4-D	J. Clark Salyer Refuge	Soil	Colormetric Comparator	Flux/Sink
Fogarty	Cyanide	Lead Deadwood, SD	Water samples - streams	Colormetric Comparator	Flux
Fruitger	Selenium	Rolla, ND	Plants	Diode Array Spectrophotomer	Flux/Sink
Hinsz	Potassium/Nickel	Fort Yates, ND	Well water samples near landfill	Absorption Spectrophotometer	Flux
Jacobs	Lead	Laboratory	Duckweed Lead Absorption	Absorption Spectrophotometer	Flux/Sink
Jaberi-Kathrein	Phosphate	Dickinson, Minot, ND Sewage Lagoon	River water	Diode Array Spectrophotomer	Flux
Lagasse	Selenium	Rolla, ND - Lignite Ash	Plants	Diode Array Spectrophotomer	Flux/Sink
Potts	Arsenic	Deadwood, SD	Water samples - streams	Diode Array Spectrophotomer	Flux
Stevens	Copper/Iron	Deadwood, SD	Water samples from streams	Colormetric Comparator	Flux

1. AAAS, (1990) The Liberal Art of Science: Agenda for Action, American Association for the Advancement of Science, Washington, D.C.
2. Rambler, M.B., Margulis, L., Fester, R., (1989) Global Ecology: Towards a Science of the Biosphere, Academic Press, Inc., Boston, P.204
3. Karl Turekian is editor of Global Biogeochemical Cycles, a journal published by the American Geophysical Union.

BioGeoChemical Cycles: Representative Results from Science Teacher Research Projects

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In education, the various scientific disciplines are presented as distinct entities. Each year throughout grades 7-12 a different science is presented (Biology, Chemistry, Physics, or Earth Science) and there is very little time in the curriculum to show how these subjects relate to each other. The trend continues in higher education where there is little explicit correlation of the different scientific areas except in such subjects as Biochemistry which by its very nature is concerned with the overlap of two different fields. A different approach would be to study, at some point, the interrelationships of these scientific disciplines. At Minot State University this type of approach is being investigated in our graduate program for science teachers. A course entitled BioGeoChemical Cycles was offered at MSU for the first time during the summer of 1990. Faculty members who serve instructors and lecturers for the course were: Dr. Dennis Disrud, Professor of Biology; Dr. Robert Crackel, Assistant Professor of Chemistry; and Dr. Clark Markell, Professor of Earth Science. Each faculty member discussed various topics from his own discipline with the emphasis being on the cyclic nature of processes.

In addition to the lecture and discussion portion of the course, the students were required to perform individual research projects in which they concentrated on one or more species and a cycle in which it was involved. The results of these projects were written up to be turned in to the instructors and presented orally to the entire class. To help the students prepare for the projects, time was taken during the first few weeks to show them how to use the scientific literature (including computerized literature searching) and how to operate several instruments which they could use in making measurements on their samples. Each student was also allocated a small research budget (approximately one hundred dollars) which could be used to purchase additional equipment and supplies or to defray other costs (e.g. literature searchs and travel expenses). The students had an eight week time-frame in which to work on their projects.

The student projects covered a number of different species (elements,compounds, and ions). Each project examined how human activity has changed the natural cycle of that species. To accomplish this the students needed to identify natural sources and the sources due to human activity. Ideally the samples collected would reflect cycles both with and without human influence. Some students chose to study different aspects of a cycle of the same species. Other students collected samples from the same locations but then analyzed these samples for different species. One student designed his experiments so that they could be carried out in the laboratory to mimic what was occurring in nature. The table below summarizes the types of projects which the students performed. It is organized according to the chemical species being studied.

CHEMICAL SPECIES	DESCRIPTION
Selenium	Concentrations in Yellow Sweet Clover near a source of coal ash
	Concentrations in surface and ground water near a source of coal ash
Arsenic	Presence in surface water near mining operations
Copper	Presence in surface water near mining operations
Cyanide	Presence in surface water near mining operations
2,4-D	Presence in soil samples
Phosphate	Presence in surface water near wastewater treatment facilities
Lead	Removal from water by organic and inorganic media
Zinc and Tin	Presence in surface water samples near homes

WRITING TO LEARN IN GENERAL EDUCATION GEOLOGY COURSES

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Writing emphasis sections of Introduction to Physical Geology for Minot State University general education students have been offered since March 1990. Students write in-depth essays to outline processes used in solving laboratory problems, to summarize key ideas presented in textbook readings and in videotapes, and to relate key ideas and concepts to diverse societal and philosophical problems. Writing is used to help students organize thoughts, explain concepts, personally interact with geology, and relate geological information and processes to everyday experiences.

Students individualize assignments by selecting from instructor-designed study units each week. A typical study unit includes textbook readings, watching one or more videotapes, and completing one or more laboratory exercises. All textbook readings and viewing of videotapes is done as homework. Laboratory work is done during regularly scheduled laboratory periods.

Essays are written both in class and as homework. In-class essays respond to questions related to each study unit. Individualized questions for each student are selected by the instructor. Out-of-class essays are developed by students to explain key ideas and concepts in each study unit. Most essays are graded on a satisfactory/unsatisfactory basis. Students must adequately explain key concepts and processes using their own words to obtain a satisfactory grade. Subject to some limits, students are permitted to rewrite unsatisfactory papers.

Selected papers are submitted for formal grading. These papers are assigned grades based on the student's level of thinking with respect to the geological concepts discussed. Levels of thinking described in Women's Ways of Knowing (1) are used to assign grades. Highest grades are given to students who view concepts from multiple contexts. Above average grades are given to students who view concepts from a single context, but who can apply the ideas in independent ways. Average grades are given to students who satisfactorily explain concepts using their own words. Students who can not explain concepts and processes using their own words are given failing grades.

Class meetings are used for in-class writing and for large and small group discussions. There are no formal lectures. In place of lectures students have access to an extensive collection of videotapes covering physical geology topics. Videotapes include Open University films, Public Broadcasting Series, films developed by professional societies, and commercial films. The videotapes feature geologic settings throughout the world and Solar System. These videotapes are available in the main library and can be checked out overnight. Students like the freedom to watch the videotapes in their preferred learning environment. They can watch tapes more than once to increase understanding and/or share tapes with friends and family members.

Class meetings frequently begin with an assignment to write about the topic to be discussed. Discussions follow these writing assignments or are based on previously assigned in-class and out-of-class essays. Discussions consist of students sharing essays either orally, by reading papers aloud, or silently, by exchanging papers. Instructor involvement is usually limited to answering questions and/or developing strategies to get all students involved in the discussions.

Students write evaluation essays at the end of each quarter. Essays indicate students perceive workloads in these writing emphasis sections to be heavier than workloads in classes with typical lecture/test formats. Yet, general education students, completing these writing emphasis sections, report a strong preference for the writing emphasis approach. The consistent flow of writing assignments, as opposed to cramming for a few tests, is considered to be a major advantage of the writing emphasis approach. Students report they learn and retain more by being forced to explain concepts and processes on paper. Students claim the writing assignments and discussions make the course more interesting. Students also report going beyond required assignments --especially watching additional videotapes. Student reaction to the writing emphasis sections is good in spite of the perception of heavier workloads.

1. Belenky, M.F., Clinchy, B.M., Goldberger, N.R., and Tarule, J.M. (1986) Women's Ways of Knowing: The Development of Self, Voice, and Mind, Basic Books, New York.

BUILD A BETTER MOUSETRAP AND . . . . . .

Michael B. Thompson (1) and Paul J. DeWaal Malefyt (2)
(1) Division of Science, Minot State University, Minot, North Dakota
and
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In Fall, 1985, a small mammal sampling program was carried out in an area near the city of Minot using sixteen classic oil can live traps. Two criteria were used to select the trapping areas: (1) a reasonable expectation that mammals would be present, and (2) close proximity to Minot State University so the trapline could be checked for animals frequently. From the first day a series of problems developed that made the project an exercise in problem solving.

Initially a single trapline was set. When the trapline was checked the first time it was discovered that all traps had been destroyed by a motor-cyclist who had deliberately driven along the trapline, systematically crushing all traps and their contents. A subsequent trapline was stolen. These led the author to design a new trap. It was determined that these and several other potential problems could be solved with the new trap design. The problems addressed were: (1) prevention of vandalism; (2) the crushability of the can traps; (3) heat related deaths of small mammals in the can traps; and (4) the placement of bait, a method to ensure animal contact with the trigger and prevention of bait spoilage.

The vandalism problem was solved by locating private land with restricted access. Four inch (I.D.) PVC pipe was selected as a substitute for the classic oil can. The PVC pipe is the same diameter as the oil can, much sturdier and can be cut to the desired length. The white color reflects some noonday sun. The open, distal end of the trap is closed with hardware cloth to provide ventilation. The contact end of the trigger mechanism is shaped into a closed circle, resembling an automobile radiator hose clamp. This circle holds a sixteen ounce pop bottle cap filled with bait. The bait is held off the bottom of the trap and the animal is required to manipulate the trigger mechanism to feed.

The simplicity of the new trap design lends itself to use by elementary and secondary science classes. Almost any kind of container may be used. The dimensions of the components, such as trigger and door, can be altered to fit the materials at hand.

During the Summer of 1989, the senior author was a faculty member of a Title II grant supported class and introduced 18 North Dakota primary and secondary teachers to the new trap. The co-author was a member of that class and has used the trap design with his classes in Surrey during Fall semesters of 1989 through 1991. The co-author has had his classes build and set traplines to sample the small mammal population surrounding Surrey. The co-author encountered a different set of problems. The cost of PVC pipe has risen by 100% since 1985 so he and his students obtained large soup cans from the school food service. The original can lid is used as the door and a mechanism was designed to prevent the door from closing into the can-trap. The co-author and his students have continued the tradition of each generation overcoming new sets of problems.

The students at Surrey High School have trapped 265 small rodents in the three years of the project. The species caught are: Microtus pennsylvanicus 1; Blarina brevicauda 2; Microtus ochrogaster 17; Mus musculus 97; and Peromyscus maniculatus 148. Four additional species were trapped in random sampling: Eutamias minimus 1; Spermophilus richardsoni 5; Spermophilus tridecemlineatus 2; Clethrionomys gapperi 9. The author trapped and transported 7 Sciurus sp. from his garden to a city park.

All the components of the trap can be obtained in any locality. Most of the components can be constructed from common household items. At present the cost of a single live trap is approximately $1.00. The actual out-of-pocket cost are for the commercial mousetrap used to close the door of the trap and for the hardware cloth used to close the opposite end of the PVC pipe. If tin cans are used in place of PVC pipe, the cost per trap is about $.50.

The parts list for a single trap is simple:

Trap body. This can be PVC pipe or any size of can.
Door. Sheet tin can be cut to size. The lids and bottoms from coffee cans are the correct size.
Trigger/bait holder. Any source of wire strong enough to withstand the closing pressure. The thicker wire coat hangers work well.
Hardware cloth. Used to close the open end of the trap. If cans are being used they are closed.
Thin wire. To hold the pieces together. This can be bought commercially but the wire in twist ties works as well.
Mouse trap. This is used to provide the closing power for the trap. The cost is about $.50 per mouse trap.

Assembly time is approximately 15 minutes per trap if the materials are laid out ahead of time.

PERSONNEL SUPPLY AND DEMAND IN THE CLINICAL LABORATORY: A NORTH DAKOTA PERSPECTIVE

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Employment of clinical laboratory scientists is currently expanding faster than the average for all occupations. Staffing shortages are reported to be a current problem for many N.D. hospitals and clinics, as well as nationwide. As a result, many laboratory positions remain vacant, with no immediate signs of replacement. This has a serious impact on healthcare in North Dakota since the practice of modern medicine is impossible without tests performed by clinical scientists.

In February, 1990, a joint study was conducted by **Minot State University, Trinity Medical Center,** and **St. Joseph's Hospital** to assess current supply and demand of clinical laboratory scientists in North Dakota. Ninety-six (96) medical laboratory employers within a 180-mile radius of Minot were surveyed to determine employment conditions. Questions concerned perceptions on supply and demand of laboratory personnel , as well as factors contributing to turnover, a medical facility's ability to recruit or attract new laboratory scientists, and perceived values of North Dakota-trained clinical scientists.

Laboratory managers were asked to complete a 94-item multiple-choice questionnaire designed by the researchers. **Part A** contained questions on perceptions pertaining to supply and demand of clinical laboratory scientists, factors that contribute to turnover, and factors that affect the ability to recruit and attract new personnel. **Part B** examined recent and projected staffing patterns for clinical laboratory scientists. **Part C** examined current perceptions of laboratory managers to recent clinical scientist graduates and their schools.**Part D** was used to collect demographic information. Data were tabulated using a Chatsworth data card reader interfaced to an IBM-PC computer. A Gemstone software program was utilized. Data were statistically analyzed employing a one-way Analysis of Variance (ANOVA) and "t" test.

Thirty (30) N.D. laboratory managers responded to the survey. Of these, 63% indicated they are managers or supervisors of hospital laboratories, 30% clinic laboratories, and 7% other laboratories. Greater than two out of three managers (70%) described their community as "rural", 46% reported their laboratories serve a population less than 5,000; 17% , a population 5,000-10,000;17%, 10,000-25,000; 17%, 25,000-50,000; and, 3%, over 50,000. Two out of three managers (67%) have bachelor's degrees, 4% have master's degrees, and 3% have doctorates. Three out of five (60%) have both a college degree and a professional license to practice clinical science. Of those reponding, 77% are females and 97% are Caucasian, 14% are 21-30 years old, 63% are 31-45 years old, and 23% are over 45 years. With regard to years of professional experience, 3% have 1-5 years, 64% have 6-20 years, 20% have 20-30 years, and 13% have over 30 years experience. Of those responding, 3% have been in their current position less than one year; 23% less than 1-5 years; 43%,6-20 years; 23%, 20-30 years; and, 7%, over 30 years.

Ninety percent of managers believe clinical scientists trained in N.D. contribute to the improved quality of life in N.D. and the entire nation. Nearly all (97%) consider the quality of clinical scientists trained in N.D. to be "good" or "very good". A high percentage (90%) report clinical scientists easily find employment elsewhere in the U.S.A and 74% believe more clinical scientists will be needed in the 1990's than can be supplied. As a result, 87% see an inevitable decline in quality of staff and laboratory services as shortages become more severe. Seventy-seven percent of managers cite a need for counter-measures to combat staffing shortages.

More than half (52%) of North Dakota laboratory managers are coping with the clinical scientist shortage by increasing salaries, improving job satisfaction, and more intensive recruitment. Nearly half (47%) report their laboratories are competitive to the same degree as other laboratories, whereas 10% are more competititve.

Results of our study compare favorably with similar studies nationwide.1,2 For example, a survey of 367 midwestern laboratory managers indicates a personnel shortage in 63% of responding facilities, with 66% of all respondents projecting an even greater need for qualified professionals in the future 1.

There is no single solution to the clinical laboratory scientist shortage, just as there is no single cause. The solution will require good leadership from laboratory managers, directors, pathologists, and educators. Attitudes will have to change, particularly those individuals who come in contact with potential clinical scientists. Needed is a more intense recruitment effort, as well as improved public relations that involve a greater area and number of potential students. In addition, the public must be made more aware of the significance of clinical scientists, their qualifications and the nature of their work.

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IMPLEMENTATION OF NSF - INSTRUMENTATION AND LABORATORY IMPROVEMENT GRANT AT THE UNIVERSITY OF NORTH DAKOTA DEPARTMENT OF CHEMICAL ENGINEERING

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The Department of Chemical Engineering at the University of North Dakota received a National Science Foundation, Instrument and Laboratory Improvement grant (NSF-ILI) in November of 1988. The project was entitled "Fermentation, Centrifugation, Distillation and Control Experiments for a Chemical Engineering Laboratory." The NSF-ILI program is open to all U.S. Universities and can be used to purchase instrumentation and laboratory equipment to be used for undergraduate instruction. The program was formerly offered only to non-Ph.D. granting institutions, but is now available to all U.S. Universities and Colleges. The National Science Foundation requires that matching funds be used to acquire the instrumentation. However, they do not require that the matching funds be secured at the time of application. Three years are allowed to acquire the matching funds and to implement the new equipment.

The UND Department of Chemical Engineering acquired matching funds from industrial and alumni contributions. These matching funds were not solicited until after the notification of the award was made. The proposed equipment has been purchased and has been placed into operation in several undergraduate laboratories. The equipment and laboratories will be described.

The project implemented using NSF-ILI funds mimics the major unit operations in the regionally important industry of fermentation of agricultural products to produce ethanol as a gasoline additive. The cohesiveness and common theme of the proposed equipment was well received by the reviewers and received higher marks than a "grab bag" approach for unrelated instrumentation. Five major pieces of instrumentation, along with ancillary equipment were obtained: a bench scale stirred-tank bioreactor (fermenter), a bench scale continuous centrifuge, an UV-Visible spectrophotometer, an eight-tray bubble-cap distillation column, and the data acquisition instrumentation and microcomputers used to monitor and control the distillation column. The instrumentation mimics the major processing steps in the fermentation of agricultural products to form ethanol for a gasoline additive. At the Alchem processing facility located in Grafton, ND, corn or potatoes are fermented in beer wells. A spectrophotometer is used to monitor sugar and alcohol concentrations during fermentation. After fermentation, the solids are separated in a continuous centrifuge with the solid being dried for cattle feed. The liquor is then distilled. The distillation columns use microprocessor controls.

The five major pieces of equipment have been used to develop four separate experiments for the senior-level chemical engineering laboratory, two separate experiments for the junior-level chemical engineering laboratory and support experiments and demonstrations for three additional undergraduate courses. The laboratory experiments developed are listed below:

ChE 331 - Chemical Engineering Laboratory II (Junior level)
- Determination of Growth Kinetics of Yeast (fermenter).
- Particle-in-the-Box Model of Conjugated Dyes (UV/visible spectrophotometer).

ChE 431 - Chemical Engineering Laboratory IV (Senior level)
- Optimization of Alcohol Production from Yeast Fermentation (fermenter and UV/visible spectrophotometer).
- Optimization of Continuous Centrifuge (continuous centrifuge).
- Continuous Distillation of Ethanol/Water (distillation column).
- Control of a Feed Perturbation in a Distillation Column. (distillation column, and computer data acquisition).

ChE 405 - Mass Transfer Operations (Senior level)
- Continuous Distillation Demonstration (distillation column).

ChE 408 - Chemical Process Dynamics (Senior level)
- Computer Data Acquisition and Control Demonstrations (computer data Acquisition instrumentation).

ChE 421 - Chemical Reactor Design and Kinetics (Senior level)
- Kinetics of Methanolysis of Benzoyl Chloride in Methanol (UV/visible spectrophotometer).
- Residence Time Distribution of Continuous Stirred Tank Reactor (fermenter).

Currently, there is significant industrial interest in the application of chemical engineering principles to biotechnology processes. Also, with the advent of the microcomputer, new supervisory control algorithms and data acquisition systems are being developed and used by industry. Both of these important applications of chemical engineering are currently included in lecture courses at UND. The acquisition of the new laboratory instrumentation allows the students to gain important hands-on experience in both of these significant areas of chemical engineering.

AIDS AND DRUGS: A STUDY OF MINOT STATE UNIVERSITY FRESHMEN

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Introduction:

Whereas most university students have a fairly good base of information about drugs and AIDS, our study serves as an essential link between what Minot State University (MSU) students know and what they do with regard to drugs and AIDS. Using the study, we will continue to monitor freshmen students at MSU for five years and follow the classes, testing them each year for possible changes in attitudes towards drugs and AIDS. A Gallup Report(1) indicates one adult in four and one teen-ager in three view drug abuse as the most important problem facing the United States. Our study clearly indicates the need for programs that provide students with the necessary health education and enhance attitudes that reinforce preventative behaviors.

Experimental:

A total of 594 freshmen students, 221 males and 373 females who pre-enrolled as freshmen at Minot State University were surveyed in group settings in Hoffman auditorium in Moore Hall. All subjects had finished high school prior to data collection. Of those responding, 64 (11%) were younger than 18 years, 423 (72%) were 18-23 years, 75 (13%) were 22-35 years, and 18 (3%) were over 35 years. The remainder did not give ages. Freshmen were asked to complete a 50-item AIDS and Alcohol Questionnaire, designed by MSU research investigators. Multiple-choice survey questions were designed to elicit the greatest amount of information concerning attitudes toward drugs, alcohol, and AIDS. Students were informed in writing that all answers were confidential and they need not give their name(s). In addition, a "Statement of Use" on the first page of the questionnaire informed students as to the purpose of the study and assured students' confidentiality. Data were tabulated using a Chatsworth data card reader interfaced to an IBM-PC and a Gemstone software program was utilized. Data were statistically analyzed, using a one-way Analysis of Variance (ANOVA) and "t" test.

Results and Discussion:

A high percentage of respondents, 572 (96%) believe drug addiction and alcoholism are serious problems that may destroy an individual's life. Yet, many freshmen view drinking as an integral part of living, 503 (85%) say most of their friends drink alcoholic beverages, and 181 (31%) describe social activities that do not have alcoholic beverages as "boring". A similar study by Heck(2)at the University of Kansas revealed 10 % of students, aged 17-53, were light drinkers. Our study indicates that more than half , 307 (52%), believe most students are expected to drink at parties and on dates and that peer pressure makes it difficult to say "no". One half of the respondents, 299 (50%) consider it easy to purchase illicit drugs in their home communities. One out of four, 149 (25%) say some of their friends use drugs and slightly more than one of four, 157 (26%) admit some friends use marijuana, "crack", or LSD. Nearly half, 267 (45%) favor mandatory drug testing and approximately the same number, 266 (45%), think mandatory drug testing violates students' rights. With a majority of MSU students traditionally coming from northwestern North Dakota, the study indicates illicit drugs and alcohol are a problem-even in smalltown North Dakota.

On the AIDS issue, nearly two out of three, 380 (64%) practice a sexual lifestyle that avoids exposure to the AIDS virus. A high percentage 558 (94%) believe condoms should be used to prevent the spread of AIDS. Three out of five students, 354 (60%) view sexual abstinence an acceptable personal option to avoid AIDS and 392 (66%) believe "Just Say No" is an effective way to combat AIDS.

Although economic and medical consequences of alcohol and drug abuse have long been known, it is only recently that public concern has started to increase measurably. This is due to the recognition of AIDS, a disease that has affected the public more than any epidemic in the last several decades. Interactions between alcohol, drugs, and AIDS are becoming more clearly defined ,as well as the role that drugs may play in transmitting AIDS to the non-drug- using heterosexual community.

Colleges and universities have a definite role in battling ilicit drugs, alcohol, and AIDS and they have an obligation to help students protect themselves from these social health issues. Students should be given survival skills, enabling them to make the necessary responsible decisions about social health issues.The massive link between AIDS and drug use must be increasingly acknowledged and addressed in national campus strategies. As these societal issues intensify, colleges and universities will need to balance concerns of students who are affected. This will require an effective planning process that takes into account resources of a given institution and needs of the population it serves.

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AN ASSESSMENT OF UNDERGRADUATE PLACE NAME KNOWLEDGE CONCERNING THE MIDDLE EAST AND NORTH AFRICA

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Place name locations which are in the headlines because of a global crisis or American military intervention seldom appear to be well-known by undergraduates in the United States (1,2). Such a finding is the case for students at the University of North Dakota when results are analyzed for the International Geographical Union's World Basic Place Vocabulary Test (3). This diagnostic instrument for assessing place name knowledge was used in the fall semester of 1990 with undergraduates in GEOG 151 (Introduction to Cultural Geography) to determine composite student place name levels at the Grand Forks campus as part of ongoing research on trends in student place name mapping abilities since the 1986 benchmark results reported by Munski and Jensen (3). Because of the involvement by the United States armed forces in the Persian Gulf that began in August of 1990 just prior to the start of the fall semester and continued past the end of that academic term, it is important to determine what is the level of student knowledge of Middle Eastern and North African place name locations as a prelude for effective teaching about this part of the world.

The International Geographical Union's World Basic Place Vocabulary Test fifty test items include five Middle Eastern and North African nation-states (Algeria, Egypt, Iran, Saudi Arabia, and Turkey), the Mediterranean Sea, and Cairo. These seven place names are of critical importance in terms of orienting people to the locations of events which transpired in the Persian Gulf Crisis during the period of the fall semester of 1990. Consequently, student identification of these places was of special interest when the pre-test and post-test were administered.

Seventy-three undergraduates took the pre-test in the last week of August, 1990. The class average was 42.23 points out of 50.00 points, considerably higher than the norm of 38.50 points out of 50.00 points established in 1986. Yet, low scores for pre-test results on the Middle Eastern and North African nation-states were consistent with past student pre-testing (4). Using the standard of 80 percent correct, the students achieved below that level for Algeria (65.75% correct), Iran (68.49% correct), Saudi Arabia (76.71% correct), and Turkey (69.86% correct). Pre-test scores for Cairo (82.19% correct), Egypt (89.04% correct), and the Mediterranean Sea (93.27% correct) were above the cut-off mark.

Only sixty-one undergraduates took the post-test in the first week of December, 1990. The class average was 45.16 points out of 50.00 points, again considerably higher than the norm of 42.50 points out of 50.00 points established in 1986. While student place name knowledge improved significantly on the post-test for Algeria (80.32% correct), Iran (88.52% correct), Saudi Arabia (86.88% correct), and Turkey (80.32% correct), only slight improvement was seen for Cairo (85.24% correct), Egypt (90.16% correct), and the Mediterranean Sea (96.25% correct).

Why undergraduate place name knowledge of Middle Eastern and North African locations improved is open to speculation. Was it because of higher success in remembering locations for that part of the world from GEOG 151 map exercises or because of increased attention to maps in the news media about the Persian Gulf Crisis? It appears that both conditions must be taken into account for explaining the upward trend. As a result of this assessment, not only are students in GEOG 151 during the spring semester of 1991 being tested with the International Geographical Union's World Basic Place Vocabulary Test but they are having their map reading abilities pre-tested and post-tested using a place name exercise involving an outline map specifically of the Middle East and North Africa and questioned about how they are acquiring their place name knowledge. If North Dakotans are going to continue to be assigned to "Operation Desert Storm," then it is imperative that undergraduates be assisted in learning how to identify correctly places involved in the Persian Gulf Crisis.

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A Pilot Study of Undergraduate General Knowledge in Geography at the University of North Dakota

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Baseline testing of geography knowledge of undergraduates enrolled in introductory geography courses has been most vigorously pursued in Indiana (1, 2). The instrument used, The National Council for Geographic Education Competency-Based Geography Test, Secondary Level, Form II, is a means to measure student abilities in topics of map skills, place-name location, physical geography, and human geography. Form I of this test also is a diagnostic for determining student geography knowledge in those sub-fields of the discipline, and it was used in the fall semester of 1990 at the University of North Dakota in GEOG 151 (Introduction to Cultural Geography). Results of this pilot program in GEOG 151 indicate that undergraduates are entering college-level geography courses with barely minimal abilities in the discipline.

Sixty-seven undergraduates took the pre-test in the last week of August, 1990. Scores ranged from a maximum of 69 of 75 points to a minimum of 25 of 75 points. The class average was 54.34 points out of 75 points. Pre-test scores on map skills were lower for map questions dealing with interpreting physical geography phenomena than for identifying cultural geography activity. Basic place name vocabularies on the pre-test indicated a general weakness on Asian and African locations, a condition similar to what has been revealed using the International Geographical Union's World Basic Place Vocabulary Test at the University of North Dakota (3). Student pre-test scores on physical geography concept and content items generally were high except when the questions involved examples drawn from Africa or Asia. Human geography concept and content items were not known any better overall compared to physical geography topics. When test items were drawn from Third World examples for either human or physical geography concept or content items, undergraduates scored low.

The post-test was administered in the first week of December, 1990. Fifty-four students took the test and averaged 58.9 of 75 points. Post-test scores ranged from 70 points to 36 points. Substantial gains were made by students relative to the portions of the test dealing with map skills (gains on 7 out of 8 questions) and with place name locations (gains on 11 out of 12 questions). Major improvements were made on the post-test concerning physical geography concepts and content (gains on 15 out of 20 questions). Post-test scores on the human geography concepts and content were mixed (gains on 23 out of 35 questions), and test-item analysis revealed continued "blindspots" on the human geography portions of the test when examples came from the developing world.

Now that this pilot test has been conducted, plans are underway to have the National Council for Geographic Education Competency-Based Geography Test, Secondary Level, Form I instrument administered at other North Dakota University System institutions. A statewide data base is necessary to determine whether or not undergraduates at the different colleges and universities of North Dakota have major deficiencies of geographic knowledge and skill when they enter these institutions. Such information will enable the North Dakota Geographic Alliance to map out a strategy to deal more effectively with how best to help college and university faculty work with high school instructors in preparing secondary students to be ready to undertake post-secondary education in geography. Furthermore, student achievement on this test as a post-test can be used by the college and university faculty as a tool in the process to upgrade the teaching of geography at the post-secondary level. Because today's incoming undergraduates are not well-versed in geography nationally (4), the North Dakota students seem to be typical of their peers. However, this performance level is not acceptable anywhere. Consequently, now is the time to remedy such deficiencies in order to have a more geographically-literate citizenry in the future.

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THE EFFECTS OF DIETARY BORON, VITAMIN D_3, AND THEIR INTERACTION ON GLYCOLYTIC METABOLITES IN CHICKS

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Recent findings indicate that dietary boron affects energy metabolism. Previous research with chicks has shown that supplemental dietary boron (SDB) significantly decreases abnormally high concentrations of plasma glucose induced by vitamin D_3 deficiency (1). In general, the effects of SDB are more marked in the vitamin D_3-deficient chick than the vitamin D_3-adequate chick (2) and suggest that boron deficiency perturbs a vitamin D_3-dependent system. Because glycolysis is a fundamental energy metabolism pathway, and glyceraldehyde dehydrogenase in the glycolytic pathway is inhibited by boron in vitro (3), it seemed appropriate to investigate the overall effect of boron on glycolysis. Thus, a 2x2 factorially arranged experiment was designed to determine the effects of dietary boron on energy metabolism.

Day-old cockerel chicks (18 per group) were housed in two all-plastic chambers and were fed a diet based on ground corn-casein-corn oil and containing 0 or 2.25 mg boron (as orthoboric acid)/kg, and vitamin D_3 at 125 (marginal, MVD) or 625 (adequate, AVD) IU/kg. At 28 days of age, the chickens were killed. The liver from each chick was removed within 10 seconds after decapitation and then freeze-clamped and ground to a fine powder under liquid nitrogen. Two 1 g samples of powder were homogenized in 5 ml of cold acetone or 6 ml of 0.6 M perchloric acid and were then centrifuged at 10,000 g for 10 minutes. The hepatic concentrations of all glycolytic metabolites were calculated from spectrophotometric data according to previously described methods (4).

Table 1. Effects of dietary boron, vitamin D_3 deficiency and their interaction on the concentration of selected glycolytic metabolites in the liver (wet weight basis)

Treatment		Fructose-1,6-biphosphate	Glycerate-1,3-biphosphate	Glycerate-3-phosphate	Glycerate-2-phosphate	Dihydroxy-acetone phosphate
B mg/kg	Vit D_3 IU/kg	μmol/g	μmol/g	μmol/g	μmol/g	μmol/g
0	125	0.069	0.33	0.22	0.065	0.057
0	625	0.074	0.27	0.29	0.075	0.070
2.25	125	0.038	0.28	0.17	0.055	0.051
2.25	625	0.062	0.30	0.26	0.064	0.052
			Analysis of Variance			
Boron		0.001	NS	NS	0.0003	0.02
Vit D_3		0.02	NS	0.03	0.0009	NS
B x VD		NS	0.02	NS	NS	NS
VD, 125:B, 0 vs 2.25		0.002	0.057	NS	0.009	NS
VD, 625:B, 0 vs 2.25		NS	NS	NS	0.008	0.02
Mean square error		0.0005	0.005	0.02	0.0001	0.0003

SDB lowered hepatic concentrations of fructose-1,6-biphosphate (Fl-6P), glycerate-2-phosphate (G2P) and dihydroxyacetone phosphate (DiOHAcP). AVD, compared to MVD, significantly increased concentrations of Fl-6P, glycerate-3-phosphate, G2P (Table 1), phosphoenol pyruvate, pyruvate, and lactate (not shown). An interaction between SDB and vitamin D_3 affected concentrations of glycerate-1,3-biphosphate (Gl-3P) such that SDB lowered Gl-3P concentrations in only the MVD chicks. In the MVD chicks, SDB decreased concentrations of Fl-6P and G2P. In the AVD chicks, SDB also decreased the concentration of G2P. In the AVD groups, the boron-deprived chicks, compared to the SDB chicks, exhibited elevated concentrations of DiOHAcP. The findings suggest that dietary boron modulates hepatic glycolysis, particularly when dietary vitamin D_3 intake is inadequate. The findings suggest that physiological concentrations of boron affect glycolysis indirectly, perhaps by modifying glycogen utilization.

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MINIMIZATION OF TRIHALOMETHANE FORMATION IN DRINKING WATER

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Increased attention has been given to trace organic contaminants in drinking water in recent years. The growing concern over these contaminants is a result of evidence that some trace, dissolved organics have carcinogenic and mutagenic properties. Of the various organic contaminants that can be found in drinking water, major emphasis has been placed on trihalomethanes (THMs). It is well established that a major source of THMs in finished drinking water is the interaction of chlorine with natural organics. The question of how THMs levels in finished drinking water can be reduced without weakening the bacteriological protection afforded by chlorination is a prime concern of the water supply industry. The answer generally falls in one of the three categories: 1) Removal of THMs precursors prior to chlorination, 2) Modification of the chlorination process, or 3) Removal of THMs after formation. The purpose of this study falls into the first category which is to investigate the feasibility of using biological activated carbon (BAC) columns in the removal of trace, dissolved organics that cannot be removed by conventional water treatment processess (Coagulation, Flocculation and Filtration) before chlorine is added. Factors affecting the performance of BAC columns are investigated in this study. These include hydraulic detention time and hydraulic loading rate. The influent and effluent of BAC columns and Granular Activated Carbon (GAC) column used as a control column were monitored for Total Organic Carbon (TOC), Turbidity, pH, Alkalinity, UV-Vis, Dissolved oxygen (DO) and Bromoform formation potential (BFP).

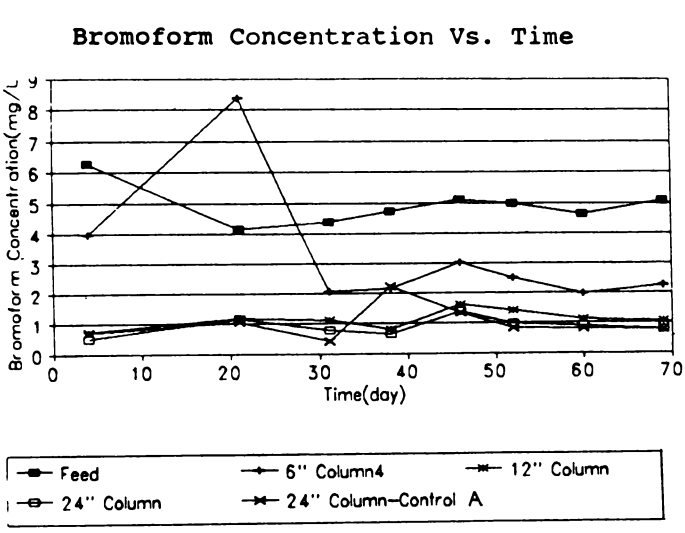
The surrogate parameter which was used to substitute for trihalomethane formation potential test (THMFP) was bromoform formation potential (BFP) test. This can be considered as forming a more general class of parameters called haloform formation potentials (HFP). In the HFP tests, chlorine (Cl_2) is replaced as an oxidant by bromine (Br_2). The primary trihalomethane that is produced by reaction with natural organic substances are bromoform ($CHBr_3$), rather than chloroform ($CHCl_3$).

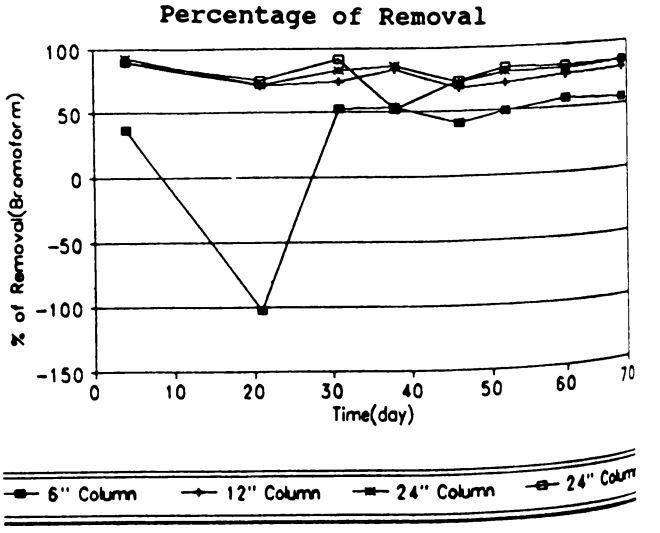
Natural organic substances + Cl_2 ----- CHl_3 + other products

Natural organic substances + Br_2 ----- $CHBr_3$ + other products

The major advantage of the BFP test over THMFP test is that bromoform can be measured with a spectrophotometer. Hence the cost and complexity of gas chromatographic analysis are avoided.

The average bromoform concentration in the feed water was 4.3 mg/L. The average effluent bromoform concentration for the 6-inch, 12-inc, 24-inch, and 24-inch (control) columns were 3.30 mg/L, 1.12 mg/L, 0.88 mg/L and 1.01 mg/L, respectively. In terms of the bromoform removal rate, the 6-inch, 12-inch, 24-inch, and the 24-inch (control) columns were able to remove 49%, 76.7%, 81.6%, and 79.4%, respectively. Therefore, the increase in the hydraulic detention time of the BAC columns had increased the bromoform removal rate.





THE MODIFICATION OF RAT BONE MINERAL COMPOSITION BY CHANGES IN DIETARY ARGININE, METHIONINE, BORON AND POTASSIUM

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Several studies have indicated that dietary boron can affect the composition and structure of bone (1). Moreover, the response of animals to low dietary boron varies markedly as the diet varies in its content of several other nutrients including potassium, arginine and methionine (1). Thus, we performed an experiment for which one objective was to ascertain whether bone mineral composition is influenced by dietary changes in these nutrients because a change in composition would suggest that they are important nutritional factors for normal bone formation or metabolism.

Male weanling Sprague-Dawley rats were assigned to groups of six in a fully crossed, three-way 2x4x2 experimental design. The basal diet, which contained a marginal amount of methionine, was the same as that described previously (2) except potassium chloride was omitted from the diet. Environmental conditions also have been described (2). The experimental variables were: per g fresh diet, boron supplements of 0 and 3 μg; potassium supplements of 1.0, 1.4, 1.8 and 3.6 mg; and either an arginine supplement of 10 mg or a methionine supplement of 2.5 mg. The rats were fed their respective diets for seven weeks, fasted overnight, weighed, then anesthetized with ether for cardiac exsanguination and decapitation. One femur was removed and frozen for later analysis. The femurs were prepared in our usual manner for mineral analysis by inductively coupled argon plasma atomic emission spectrometry (2,3).

Table 1. Effect of boron, potassium and amino acids on femur mineral composition

Dietary Treatment		Femur (dry)							
B, μg/g	K, mg/g	B, μg/g	Ca, mg/g	P, mg/g	Mg, mg/g	K, mg/g	Cu, μg/g	Fe, μg/g	Zn, μg/g
		Supplemental amino acid - 10 g arginine/kg diet							
0	1.0	1.61	213	100	2.99	3.29	2.49	68	131
0	1.4	1.59	212	99	2.73	3.19	1.99	56	138
0	1.8	1.70	197	92	2.56	3.17	1.89	55	129
0	3.6	1.49	207	98	2.31	3.14	1.92	53	105
3	1.0	1.92	222	105	3.21	3.24	2.40	58	144
3	1.4	1.85	202	94	2.75	3.22	1.98	55	123
3	1.8	2.26	206	101	2.36	3.12	1.96	58	121
3	3.6	1.73	210	99	2.49	3.11	2.03	48	96
		Supplemental amino acid - 2.5 g methionine/kg diet							
0	1.0	2.27	201	94	6.27	5.61	3.70	134	313
0	1.4	1.84	197	93	5.40	5.81	4.42	103	276
0	1.8	1.96	204	95	4.93	5.62	3.95	106	255
0	3.6	1.64	201	94	4.59	5.58	4.09	116	256
3	1.0	3.89	197	94	6.61	5.61	4.10	135	308
3	1.4	3.27	201	94	5.34	5.81	4.37	111	274
3	1.8	2.57	202	94	4.89	5.80	3.84	103	259
3	3.6	2.40	207	96	4.25	5.43	3.69	100	221
		Analysis of variance - p values							
Boron		0.0001	NS	0.02	NS	NS	NS	NS	0.01
Potassium		0.007	0.005	0.0004	0.0001	NS	0.0001	0.0001	0.0001
Amino acid		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
B x K		NS	NS	0.004	(0.07)	NS	NS	NS	0.008
B x AA		0.002	NS	NS	NS	NS	NS	NS	NS
K x AA		0.01	0.0001	0.003	0.0001	NS	0.0001	0.001	0.0001
B x K x AA		NS	0.001	0.0001	NS	NS	0.008	NS	0.03

Femur mineral composition was affected by the dietary variables, especially by the different amino acid supplements which were expected to either enhance (arginine supplementation) or alleviate (methionine supplementation) the effects of a marginal intake of methionine. The concentrations of boron, magnesium, potassium, copper, iron and zinc were higher, while the concentrations of calcium and phosphorus were lower, in femurs of the methionine-supplemented than in femurs of the arginine-supplemented rats. With all the elements except potassium, the changes were modified by dietary boron and/or potassium. The findings indicate that the calcification of the femur is influenced by boron, potassium and methionine status. Thus, these nutrients apparently are important for the normal development and maintenance of bones.

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THE FREQUENCY DISTRIBUTION OF SOMATOTYPE IN A SAMPLE

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Sheldon et al. (1) proposed a three component somatotype to describe human physique: 1) endomorphy (En) as an index of roundness, 2) mesomorphy (Me) as an index of angularity, and 3) ectomorphy (Ec) as an index of linearity. A person's somatotype is a combination of the three components, although one component (the dominant component) usually contributes more than the other two to the description of a person's physique. Bolonchuk et al. (2) described the relationship between body composition and the components of somatotype. The purpose of this study was to report the frequency of different somatotypes observed in a sample of adults and to compare the somatotype frequency distribution of the men with the frequencies previously reported for men by Sheldon (1,3).

Adult women (439) and men (563) volunteered to participate in this study. The subjects ranged in age from 18 to 83 years. Body weights ranged from 43 to 135 kg and body heights ranged from 142 to 213 cm. Somatotype was computed by using body measurements according to the method of Carter (4). Frequencies were computed for six different somatotype groups based on the three dominant somatotype components modified by one of the other two. For example, "Ec En" indicates dominant endomorphs modified by ectomorphy; mesomorphy contributed least to describing the physique.

Sheldon et al. (1) reported somatotypes of 46,000 American men between the ages of 18 and 65 years and the frequency distribution is shown in Table 1. About 30.3% were dominant mesomorphs, 13.0% were dominant ectomorphs, and 13.4% were dominant endomorphs. In 1954, Sheldon et al. (3) reported the somatotypes of 4,000 males (Table 1). Only 16.2% were dominant mesomorphs, 11.5% were dominant ectomorphs, and 9.3% were dominant endomorphs. The percentage of dominant mesomorphs was considerably less in the second sample. In the present study (Table 1), 24.2% of the males were dominant endomorphs, 54.5% were dominant mesomorphs, and 14.2% were dominant ectomorphs. Our finding that most males are dominant mesomorphs is consistent with Sheldon's reports. The observation of increased prevalence of mesomorphy in the present study exceeds the predictions of Sheldon (1,3).

The distribution of somatotypes in a large sample of women has not yet been published. Of the 439 women in our study, 50.4% were dominant endomorphs, 13.5% were dominant mesomorphs, and 12.5% were dominant ectomorphs.

When the frequency distribution of somatotype was examined over increasing age of the subjects, even greater polarization by dominant physique was found. In the subjects over 60 years of age, 64.5% of the males were dominant mesomorphs and 75.0% of the females were dominant endomorphs.

The general pattern of body structure in American men has been consistent during the past 40-50 years. The only change is an apparent increase in the proportion that can be described as muscular. Data on women are lacking. Women today demonstrate a general tendency toward roundness. These general tendencies reflect changes in nutrition and activity for the American public.

Table 1. Frequency Distribution of Somatotypes (Percentages)

	Sheldon (1)	Sheldon (4)	This Study	
	Male	Male	Female	Male
Ec En	5.7	3.3	9.8	2.3
Me En	7.7	6.0	40.6	11.9
En Me	14.3	8.6	12.1	36.4
Ec Me	16.0	7.6	1.4	18.1
Me Ec	9.4	7.0	2.0	9.8
En Ec	3.6	4.5	10.5	2.5

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POSSIBLE EVIDENCE OF SCURVY IN A PREHISTORIC SKELETON FROM THE NORTHEASTERN PLAINS

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Scurvy or Vitamin C (ascorbic acid) deficiency is a disease limited to a few mammals that lack the ability to manufacture this vitamin. Among those mammals that cannot produce ascorbic acid are humans and primates. Vitamin C is necessary for the proper production of intercellular components. The primary manifestation of Vitamin C deficiency is systemic hemorrhage (1, 2). Historic records indicate the European immigrants to the New World regularly suffered from scurvy. Those same records indicate that the disease was unknown among indigenous Native American populations (3).

The Red Lake River Mounds, site 21RL1, is a prehistoric cemetery located in northwestern Minnesota in Red Lake County west of the city of Red Lake Falls. This cemetery is attributed to the Arvilla culture, a Late Woodland (pre-horticultural) people of the Northeastern Plains (4). Although the precise age of this cemetery has not been established it is considered to date to ca A.D> 900. Seventeen individuals were identified from the recovered skeletal remains. Eight individuals were adult, four sales and four females. One adult female (age 30-35 years) display an unusual series of skeletal lesions. This individual is represented by an intact skull and the larger appendicular bones of the skeleton. Both tibiae, fibulae, ulnae, and the right radius exhibit periostitis (surface bone inflammation). This periostitis occurs as multiple foci lesions ranging in diameter from 1-3 cm. The appearance of these lesions indicates that the bone inflammation was active at the time of death.

While the most visible feature of scurvy is on the soft tissue it can also have a direct effect on the skeleton (1, 2). Skeletal involvement results from spontaneous and trauma induced subperiosteal hemorrhages. These localized foci of inflammation are seen as localized periostitis. These can occur on any skeletal element but are most often seen on the superior margins of the orbits and on the lower appendages. The tibia is the most frequent location due to the relative absence of muscle tissue surrounding the bone and the ease of traumatic injury.

A differential diagnosis includes systemic hematogenous infection and non-specific multiple traumas (4, 5). The individual recovered from the Red Lake River Mounds displays periosteal lesions supportive of a hemorrhagic origin. Indicators include multiple bone involvement and the localized nature of the periosteal foci of inflammation. If this series of lesions is scorbutic in nature it is the first documented case in this region of North America and provides further evidence that the Late Woodland of the Northeastern Plains was a time of nutritional instability (5).

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AGING BLACK-TAILED PRAIRIE DOGS FROM NORTH DAKOTA BY EYE LENS WEIGHT

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Relatively little is known about aging in black-tailed prairie dogs (Cynomys ludovicianus Ord). As part of a population study on this species (1), 469 specimens were collected from four dog towns in Billings County, North Dakota from 29 May to 26 July 1977 (Town 1 - T140N, R102W, S30 center; Town 2 - T140N, R102W, S29, 30, 31, 32 intersection; Town 3 - T140N, R100W, S5 NW 1/4 and 6 NE 1/4; Town 4 - T140N, R101W, S1 SE 1/4). This paper describes and evaluates the use of eye lens weight as an aging technique for black-tailed prairie dogs.

The left eyeball of each specimen was removed and preserved in 5% formalin. If the left eyeball was damaged, the right was preserved. Some lenses could not be used due to loss or damage. A modification of Lord's technique (2) was used to determine dry lens weight. The fixed lenses were later removed from the preserved eyeballs and dried at 95 C until they reached a constant weight, usually after about 96 h. Lenses were removed singly from the oven and weighed to the nearest 0.2mg on a precision balance.

Eye lens weight of pups rapidly increased from the time of first emergence from the natal burrow throughout the summer, ranging from 4.2 to 11.4 mg for females ($\bar{X}$ = 8.6, S.D. = 1.4, n = 97) and 5.4 to 11.0 mg for males ($\bar{X}$ = 9.0, S.D. = 1.4, n = 93). Eye lens weights of yearling females ranged between 10.2 and 17.0 mg ($\bar{X}$ = 13.9, S.D. = 1.3, n = 73), of yearling males between 10.8 and 16.6 mg ($\bar{X}$ = 14.3, S.D. = 1.3, n = 78), of adult females between 15.6 and 22.4 mg ($\bar{X}$ = 18.8, S.D. = 1.5, n = 64), and of adult males between 16.4 and 22.0 mg ($\bar{X}$ = 18.8, S.D. = 1.3, n = 26). Although some sexual dimorphism was evident in all age classes, mean eye lens weights differed significantly between the sexes only in the yearling group ($t = 2.04$, d.f. = 149, $P < 0.05$). However, longevity was greater in females than males causing adult mean lens weights to appear similar between the sexes when all adults were grouped together because more older females than older males were represented in the sample.

Eye lens weight was a fairly good technique for aging pups during their first summer of life. Mean lens weights differed significantly between pups and yearlings in both females ($t = 24.4$, d.f. = 168, $P < 0.001$) and males ($t = 25.8$, d.f. = 169, $P < 0.001$), but older groups were harder to distinguish. After animals reached two years of age, aging by eye lens weight alone had limited use.

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TITANOIDES PRIMAEVUS, THE FIRST DESCRIBED PALEOCENE MAMMAL FROM NORTH DAKOTA

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The first new Paleocene mammal from North Dakota was discovered by Vernon Bailey in 1913 and named by Gidley (1) in 1917 as the new genus and species *Titanoides primaevus*, based upon a partial lower jaw (USNM 7934). Since the initial recognition of *Titanoides*, five species have been assigned to the genus (2), with specimens from Texas, Colorado, Wyoming, Montana, and Alberta, together with additional material from North Dakota (3). The first appearance of the genus is Tiffanian (late Paleocene), with its last appearance in the Clarkforkian (latest Paleocene) (3). In spite of the wide geographic range and relatively common occurrence of *Titanoides* in late Paleocene faunas, there remained numerous uncertainties about the locality that produced the genoholotype. Up until the present study, the stratigraphic horizon, geographic location, and biochronologic assignment were only generally known.

Gidley (1) described the type locality as "3 miles northeast of Buford (Fort Union of early days), North Dakota," and reported the producing horizon as "Paleocene, Fort Union formation (type section)." The photo given by Gidley to show the geographic location of the locality is known to be incorrect (2). Simons (2) improved on the data somewhat by describing the locality as Tiffanian in the "Sentinel Butte shale member of the type section [type area] of the Fort Union formation." Note is made here that there is no published type section for the Fort Union Group (or formation of some authors). Although Bailey's field notes (Cox, 1990, written comm.) do not provide any information on his collection of the specimen, photographs documenting the site were taken. These photos were supplied to Glenn Jepsen (Princeton University), who in turn gave them to Robert Witter, who, together with Frank Goto, relocated the site. They recovered a complete upper dentition and pieces of the skull of *T. primaevus*, which, because of numerous similarities, convinced Simons (2) that the specimen (PU 16490) was from the same individual as USNM 7934. The precise location for the Witter quarry was never published or otherwise precisely recorded in the Princeton archives.

Using photographs kindly provided by Mr. Witter (1990, personal comm.), Witter's and presumably Bailey's original quarry of *T. primaevus* was relocated in 1990. The locality is in sec. 32, T.153N., R.103W., Williams Co., about 2.4 miles (3.8 km) northeast of Buford, North Dakota. The locality is approximately 45 m above the base of the Sentinel Butte Formation. During the process of documenting the type locality of *T. primaevus*, another mammal-producing horizon was discovered at about 23 m below the type locality. This new locality has so far produced multituberculate, marsupial and placental mammals, including specimens of the questionable primate *Plesiadapis*, which suggest a middle Tiffanian age (probably the mammalian biochron Ti3). This, in turn, suggests a middle Tiffanian (Ti3 or possibly Ti4) age for the genoholotype of *T. primaevus*. This age interpretation is consistent with the known occurrence of the species elsewhere. The oldest reported specimen, which is a single, partial tooth, is from the Judson locality (Ti3), approximately 24 m above the Cannonball Formation in the Tongue River Formation (4). *T. primaevus* has also been recorded from the Riverdale locality (Ti4?, 3, 4) in the Sentinel Butte Formation, McLean County (ND), the River Basin Survey locality no. 3 (Ti3-6, 5) in the Sentinel Butte Formation, McKenzie County (ND), Ti5 localities in Wyoming (6, 7), and Clarkforkian (Cf1?) localities in Colorado (3, 8).

The faunule of the Riverdale locality was described in detail by Holtzman (4) and included a well-preserved skull of *T. primaevus* (FMNH PM 8655). Holtzman interpreted the Riverdale locality to be in the upper portion of the Tongue River Formation, approximately 30 m below the top of the formation. The horizon of the locality has been reinterpreted as in the lower part of the Sentinel Butte Formation, about 25 m above its base (9).

The River Basin Survey locality no. 3 produced another skull of *T. primaevus* (USNM 20029). This locality was discovered by T.E. White as part of the Missouri Basin Project of the Smithsonian Institution. Although the quarry site has not been precisely relocated, the horizon and general location have been fixed within the lowermost portion of the Sentinel Butte Formation (lower 30 m). The locality is probably located in sec. 29, T.153N., R.101W., McKenzie County (ND). The precise biochron for this locality has not been determined, but the proximity and stratigraphic context of the locality, compared to the type locality of *Titanoides*, suggests a middle Tiffanian age (Ti3?).

One additional North Dakota locality has produced specimens of *Titanoides* (4). This locality was discovered by Messrs. Morris and Ralph Cross in 1961 and collected with M.C. McKenna from the American Museum of Natural History. The locality was relocated in 1990, and found to be in the lower portion of the Sentinel Butte Formation in sec. 19, T.148N., R.101W., McKenzie County (ND), not sec. 30 of this township as previously reported (4). Research continues on determining a more precise stratigraphic position of this locality, but its age is probably middle Tiffanian (Ti3 or Ti4).

In summary, *Titanoides* is known to occur at five localities in North Dakota, all of which are probably middle Tiffanian. The lowest possible occurrence is the Judson locality (Ti3) in the Tongue River Formation. The remaining localities represent a middle Tiffanian age (Ti3 or Ti4) and are all in the lower Sentinel Butte Formation.

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THE VASCULAR FLORA OF EDDY, FOSTER AND WELLS COUNTIES, NORTH DAKOTA

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The vascular flora of Eddy, Foster and Wells counties in central North Dakota was studied during the growing seasons of 1989 and 1990. The collection of over 2400 plants, along with 438 voucher specimens previously filed at the North Dakota State University Herbarium, resulted in a checklist of 576 plant species, plus 10 plant varieties. The checklist contains 86 families, of which the Asteraceae has the most species (Table 1). Although no new species were reported for the state, two North Dakota endangered plant species were found. Cypripedium candidum (little white lady's slipper) was last collected in the 1950's in Eddy County by O.A. Stevens, and was also found during this study. Utricularia intermedia (bladderwort) was collected for the first time in Eddy County. This species had previously only been found in McHenry and Pembina counties.

The geology of Eddy, Foster and Wells counties is unique. The retreat of the Wisconsinian glaciers left a number of end moraines in all three counties, as well as large meltwater trenches still inhabited by the Sheyenne and James Rivers (1). Drainage is poor in many areas, leading to the numerous wetlands present throughout the study area. The Missouri Coteau begins in the southwestern corner of Wells County, with many prairie potholes present in the depressions. The three counties comprise about 2600 square miles. About 70% of the area is cultivated, and approximately 27% of the remaining 30% is intensively grazed (3, 4). Table 2 summarizes the remaining native plant diversity.

Table 1
The ten largest vascular plant families in Eddy, Foster and Wells counties, ND flora (2)

Family	Genera	Species
Asteraceae	44	96
Poaceae	44	76
Cyperaceae	5	44
Fabaceae	14	31
Brassicaceae	16	27
Rosaceae	11	25
Lamiaceae	15	17
Ranunculaceae	5	17
Polygonaceae	3	15
Salicaceae	2	14

Table 2
Statistical summary of the vascular flora of Eddy, Foster and Wells counties, ND

Divisions of Tracheophyta	Families	Genera	Species & Varieties
Pteridophytes	4	4	6
Conifers	1	1	2
Monocots	16	72	162
Dicots	65	217	416
Total	86	294	586

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EVALUATION OF CHEMICAL AND CULTURAL PRACTICES FOR CONTROL OF FUSARIUM ROOT ROT IN SPRUCE

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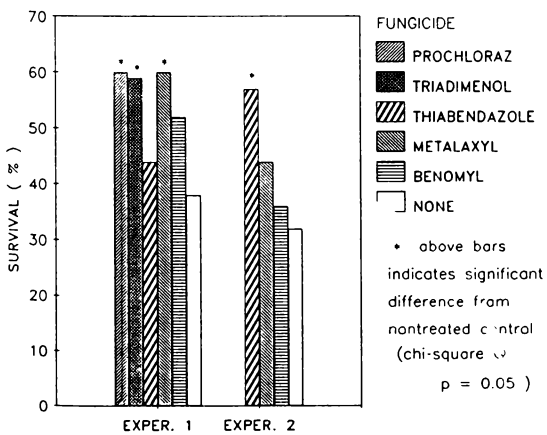
Spruce (Colorado, P. pungens Engelm., and Black Hills, P. glauca (Moench) Voss. var densata Bailey) are among the most important trees for windbreak planting on the northern Great Plains (1). In North Dakota nursery production, spruce are grown for two years in seedbeds (2-0), then lifted and transplanted to grow for an additional two years (2-2). Root rot and damping-off caused by Fusarium oxysporum Schlect. is one of the most common diseases of conifer seedlings, including spruce (2). This fungus survives in soil or debris from preceeding crops. Infection occurs within the first few weeks after seed is sown, although stunting and death may not be apparent until later (3).

In 1985, 1986 and 1987, nursery beds of spruce were examined for symptoms of root rot. Losses were determined by comparing number of merchantable seedlings harvested from beds showing various levels of symptomatic plants. Dying and dead spruce seedlings were collected for isolations from transplant beds, and from severely symptomatic patches and at random in 2-0 seedbeds. The plants were carefully lifted from the soil to extract as much of the root system as possible. Root systems were washed, cut into segments, surface disinfested with a 0.5% sodium hypochlorite solution, and rinsed with sterile water. Pieces 2 cm long were placed on a potato dextrose agar in petri dishes and incubated at room temperature (22-26 C) for 10-14 days. Fungal colonies were transferred individually and subsequently identified.

Cultural (grading) and chemical (fungicide dips or drenches) nursery procedures were tested to control root rot. An 8 cm minimum height and culling of symptomatic plants were used in grading of 2-0 spruce seedlings before transplanting. Several fungicides were tested to determine if they could reduce or prevent infection by soaking roots of seedlings before transplanting for 15 min ("root dip") or by drenching the soil in patches where symptoms occurred. Fungicides were mixed with water at these rates (g active ingredient per liter): prochloraz (0.32), triadimenol (0.32), thiabendazole (0.94), metalaxyl (0.11), and benomyl (0.59). Treatments applied in 1985 were evaluated in 1987.

In April, 1985 an examination of the transplant beds revealed losses of 67% in 2-1 growing stock and 76% in 2-0 growing stock. In each of the three years, symptoms observed in seedbeds included yellowing, stunting, and mortality, all typical of Fusarium root rot. Symptomatic plants were present throughout beds but tended to be in patches. On plants with top symptoms, roots were darkened and showed a dry cortical rot. Degree of top symptoms appeared to reflect extent of root damage. Fusarium oxysporum was the principal pathogen isolated from symptomatic seedlings but a Pythium sp. was also recovered.

FIGURE 1. EFFECT OF FUNGICIDE ROOT DIPS AT TRANSPLANTING ON SURVIVAL OF COLORADO SPRUCE AFTER TWO SEASONS.



A significant increase in survival in the transplant beds was obtained by grading 2-0 Colorado spruce seedlings before transplanting. When applied to graded 2-0 seedlings at transplanting, root dips of prochloraz, triadimenol and metalaxyl significantly increased survival of Colorado spruce transplants through their second year (Fig. 1). In a second similar experiment, only thiabendazole root dips significantly improved survival. Soil drenches of these same chemicals, applied to beds when symptoms appeared, were ineffective. Root dips or drenches had no significant effect on survival of Black Hills spruce.

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A PRESERVATIVE SOLUTION TO REPLACE FORMALDEHYDE IN BOTTLED SPECIMENS OF PLANTS AND FUNGI

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Fresh green plants and larger fungi such as mushrooms are mostly water and become distorted and shrunken when dried. To preserve overall shapes of structures or the symptoms of a disease, specimens are often fixed and stored in solution. Nearly every botany teaching collection contains plant specimens preserved in liquid-filled bottles. Many such liquids contain formaldehyde, either as the sole preservative or as part of a fixative-preservative mixture such as "formalin-acetic acid-alcohol" (FAA) (1). Since formaldehyde is volatile at room temperatures, vapor is released every time such bottled specimens are opened. In addition, specimen bottles are seldom fully air-tight, so that rooms where collections are stored may have formaldehyde fumes present even when no bottles have been opened. Limits on formaldehyde vapor in the workplace have been established to protect workers. At present, OSHA sets a 1 ppm exposure limit on a time-weighted average for an 8 hr day (2).

The Plant Pathology Department at NDSU had about 300 bottled specimens of fungi and diseased plants stored in FAA in glass jars. The total volume of FAA was about 50 liters containing 2% formaldehyde. In 1987, a search for a suitable solution to replace FAA was begun. Since the specimens were already fixed the main objective was a solution to preserve them, not necessarily one to act as a fixative as well.

Proprietary preservative solutions are sold for this purpose but many have two drawbacks for use in botanical teaching collections. One disadvantage of commercial materials is high cost. Since botanical teaching is chronically underfunded at nearly every school and college, the cost of a large amount of storage liquid might well be considered of low priority. A second disadvantage of many commercial products is their use of glutaraldehyde as an active ingredient. Glutaraldehyde has very low volatility and thus solves the fume problem of formaldehyde solutions. Glutaraldehyde is a rapid and highly effective fixative and preservative. It is commonly used in specimen preparation for electron microscopy where a high degree of fine structure needs to be preserved. Glutaraldehyde's rapid fixation extends to the eyes of the user as well and even a tiny droplet can cause serious eye damage. One may well ask if this is material for high school or undergraduate students to be handling routinely.

Since formaldehyde solutions needed to be eliminated and the risk associated with glutaraldehyde was judged unacceptable in our situation, a home-made preservative solution suitable for indefinite storage of already fixed botanical specimens was devised. Our criteria were relative safety, effective preservation and low cost using readily available materials.

TABLE 1 Botanical Preservative Solution.

Ethanol 95%	420 ml
Lactic Acid 85% USP	60 ml
Benzoic Acid crystals	5 g
Distilled water to	1 liter

A 40% ethanol solution was selected as the basic preserving liquid, acidified by adding 5% lactic acid to resist bacterial growth. To reduce mold growth, 0.5% benzoic acid was incorporated (Table 1). Both these chemicals are cheap, readily available and relatively safe, since they are present in foods at levels similar to those used here.

The entire Plant Pathology teaching collection of preserved fungi and diseased plants was transferred to this solution in 1988. Plant parts included inflorescences, fruits, leaves, bulbs, tubers and roots. Fungi included Ascomycetes, Basidiomycetes and Myxomycetes. After two years no evidence of deterioration or microbial attack has appeared on any of the specimens and they have retained the color they had at time of transfer.

Transfer of specimens from formaldehyde should be done in a fume hood using proper safety precautions including wearing splash goggles and rubber gloves. The waste formaldehyde solution is a hazardous waste and should be properly disposed of under the supervision of the school's safety officer.

ACKNOWLEDGEMENT: The author thanks S. P. Charlton, NDSU Safety Officer, for critical review of this report.

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FREQUENCY DEPENDENT CHARACTERISTICS OF FATTY ACID FILMS ON SILICON

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The capacitance-voltage (C-V) characteristics of metal-insulator-semiconductor (MIS) structures containing thin native oxides and thermally evaporated stearic acid films are very different from the properties of MIS structures with only thermally grown Silicon Dioxide (SiO_2) insulators. The former structures show frequency dispersion at high frequencies with negative bias voltage(accumulation region) but reduction in dispersion with positive bias voltage(inversion region) whereas the latter structures did not show such dispersion.

MIS structures are formed on p-type Silicon wafers as follows. First wafers with native oxide are cleaned in ethanol, rinsed in deionized water and blow dried. Subsequently, stearic acid insulator films (1200Å thick) are deposited by thermal evaporation in vacuum (~ 10^{-6} Torr) followed by aluminum contacts. Film thickness is recorded by digital thickness monitor and plots are made using C-V plotter with current sensitive pre-amp and lock-in amplifier.

The change of capacitance for MIS structures of SiO_2 /stearic acid over the frequency range of 10 to 40KHZ is shown in Fig.-1. Obviously, as the frequency increases the capacitance decreases more in the accumulation region than in the inversion region. Similar capacitance decrease with the frequency has been previously reported for GaAs substrate with different insulators (1,2 and 3) and ascribed to the creation of higher density of surface states at the interface. In Fig-2 C-V plots for several MIS structures with only SiO_2 insulators, produced by the Texas Instruments in a clean room environment, have been studied but no frequency dispersion is observed. We presume that the observed frequency dispersion in MIS with SiO_2/ stearic acid is due to the creation of electron like surface states at the interface.
These interfacial states may limit the utility of thermally evaporated stearic acid in MIS applications.

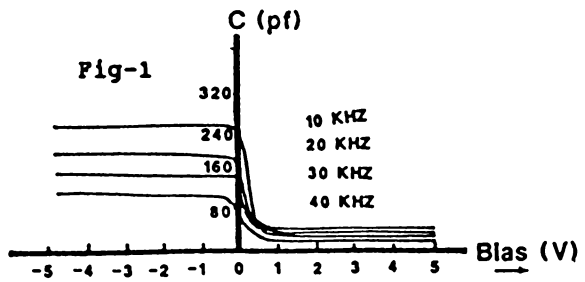

Fig-1

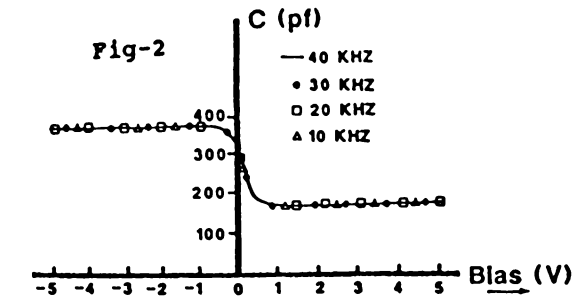

Fig-2

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METABOLISM OF METRIBUZIN IN SOMACLONAL VARIANTS OF TOMATO

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Tomato (*Lycopersicon esculentum* Mill.) cultivars vary widely in their response to the triazinone herbicide metribuzin (4-amino-6-tert-butyl-3(methylthio)-1,2,4,triazin-5(4H)-one) that inhibits photosystem II. One mechanism proposed for herbicide tolerance is formation of a water-soluble glucose conjugate, catalyzed by UDP-glucose:metribuzin N-glucosyltransferase (MGT) (1). MGT activity in leaves rises to a maximum within a few hours, and declines in the light. An active MGT with different properties is produced in tomato callus and cell suspension cultures: MGT activity is similar in the light or darkness (2). The reason for the differences between the two systems remains unclear.

Because it is produced in small quantities (1), MGT is difficult to isolate and utilize in biotechnological programs that incorporate the gene for enzyme synthesis into metribuzin-sensitive crop plants. The objective of this research was to produce somaclonal variants with a high MGT titer, by using tissue culture techniques. 'Sheyenne', 'Fireball', 'Betterboy', 'Vision', 'Floradade', 'Spring Giant' and 'Heinz 1706' tomato cultivars were placed into culture. Leaf disks, hypocotyls and cotyledons formed calli on MS medium (3) and B5 medium (4) containing various combinations of growth regulators. Calli were transferred to shoot-inducing media (MS + 4 mg/l zeatin) and then to root-inducing media (MS + no growth regulators or + 0.1 mg/l NAA). Regenerated plants were transferred to the greenhouse and assayed for MGT activity. 'Sheyenne', 'Fireball', 'Betterboy' and 'Spring Giant' and 'Vision' cultivars were regenerated successfully. The tissue and media for callus initiation varied with the cultivar.

Regenerated plants varied in their responses to topical sprays of metribuzin (1.5 kg ai/ha) from highly sensitive to highly tolerant. The MGT specific activities (nanomoles of metribuzin N-glucoside formed/mg protein/h) of selected survivors were: 'Vision' 9.25 ± 0.47, 'Fireball' 8.50 ± 0.05 and 'Sheyenne' 6.0 ± 0.0. This compares to commonly obtained values of MGT activities ranging from 8.4 to 11.5 for seed-germinated 'Sheyenne' plants. The response to light of MGT from somaclonal variants of 'Sheyenne' was similar to that of seed-germinated plants, varying from 1.1 to 8.4 to 0.1 at 0, 5.5 and 11.5 hours after the beginning of the 14-hour photoperiod.

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ISOLATION AND CHARACTERIZATION OF *AGROBACTERIUM TUMEFACIENS* FROM *BETA VULGARIS* FOR ENHANCED TRANSFORMATION OF SUGARBEET

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The use of *Agrobacterium tumefaciens* for transformation of plant genomes has been used with great success. In sugarbeets, *Agrobacterium* mediated transformation is limited due to the recalcitrant nature of sugarbeet (*Beta vulgaris*) cultures to regenerate following transformation (1, 2). The number of virulent strains of *Agrobacterium* for use on sugarbeet is limited.

We have isolated strains of *Agrobacterium* from sugarbeet root galls. Twelve galls from field grown sugarbeets were ground in 150 ml of 0.5 M KPO_4 buffer (pH 7.5) using a Waring blender. A 1 ml aliquot was plated onto selectable media D1 (3) or New and Kerr (4) containing 65 units ml^{-1} bacitracin and 30 μg ml^{-1} streptomycin. All *Agrobacterium* strains isolated from D1 plates were olive colored. The *Agrobacterium* isolates were separated into biovar I or biovar II by testing for utilization of lactose (3-ketoglucoside production), erythritol, and melezitose.

Agrobacterium strains were tested for antibiotic susceptibility using Difco Dispens-O-Disc™. The following antibiotics were examined: erythromycin 15mcg, chloramphenicol 30 mcg, norfloxacin 10 mcg, rifampin 5 mcg, tetracycline 30 mcg, vancomycin 30 mcg, carbenicillin 100 mcg, gentamicin 10 mcg, cefotaxime 30 mcg, nalidixic acid 30 mcg, colistin 10 mcg, polymyxin B 300 units. *Agrobacterium* isolates from separate galls showed little variation in susceptibility to the antibiotics except chloramphenicol. Two wild strains showed susceptibility to chloramphenicol.

Plasmid mini-preparations were done to look for a plasmid profile. Of the twelve strains tested, none had plasmids less than 20 kilo-base pairs.

We are presently checking the wild *Agrobacterium* strains for virulence on sugarbeet petiole sections *in vitro*. In addition, virulence will be determined on sunflower, tobacco and sugarbeet plant stems *in planta*. Those showing high virulence will be incorporated into our sugarbeet transformation program.

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CHARACTERIZATION AND PATHOGENICITY OF RHIZOCTONIA FROM SOYBEAN

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Root rot is becoming an important soybean disease in the Red River Valley. Root rot pathogens have not been intensively studied, but preliminary research indicated that Rhizoctonia solani is one of the fungi involved. The objectives of this research were to identify the anastomosis groups (AG) (1) of R. solani on soybean and determine their pathogenicity.

In August and September of 1989, soybean plants showing symptoms of root rot were collected from 100 fields in the central and southern Red River Valley of North Dakota. Isolations of Rhizoctonia on water agar were made from stems and roots of 650 plants. Multinucleate isolates (2) were identified to anastomosis groups by pairing with known testers.

All Rhizoctonia isolates were tested for pathogenicity on Ozzie soybeans in the greenhouse by placing 7 day old cultures on water agar in soil and planting 1 cm above the inoculum. Emergence and disease severity based on lesion size were evaluated within three weeks. The experimental design was a randomized complete block. The experiment was repeated and data were pooled following testing for homogeneity of variance.

Forty one isolates of R. solani and two binucleate Rhizoctonia-like fungi were obtained. Within R. solani, there were 28 AG 4, 10 AG 5, 2 AG 2-2, and 1 AG 3. Isolates had no significant effects on emergence, but there were significant effects on disease severity (Table 1). All AG 4 and AG 2-2 isolates were pathogenic, but there were significant differences among the AG 4 isolates. AG 5 was generally less pathogenic than AG 4. AG 3 and the two binucleates were not pathogenic on hypocotyls, however, the binucleates caused minute lesions on roots. This report indicates that AG 4 and AG 2-2 are important soil borne pathogens of soybean in the Red River Valley.

Table 1. Pathogenicity of Rhizoctonia on Ozzie soybean

Anastomosis Group	Disease* Severity	Anastomosis Group	Disease Severity
AG4	3.19	AG5	2.38
AG2-2	3.02	AG5	2.38
AG4	3.01	AG4	2.36
AG4	2.97	AG4	2.32
AG4	2.97	AG4	2.30
AG2-2	2.94	AG4	2.27
AG4	2.86	AG4	2.24
AG4	2.82	AG4	2.19
AG4	2.77	AG5	2.13
AG4	2.75	AG4	2.13
AG4	2.74	AG4	2.12
AG4	2.73	AG5	2.07
AG4	2.72	AG4	2.06
AG4	2.66	AG5	2.06
AG4	2.63	AG5	1.99
AG4	2.62	AG5	1.97
AG4	2.60	AG5	1.93
AG4	2.56	AG3	1.44
AG4	2.52	Binucleate	1.19
AG4	2.50	Binucleate	1.14
AG5	2.46	Control	1.10
AG4	2.45	LSD=0.66**	

*Disease severity based on a 1-5 scale where 1=no lesions on hypocotyl, 2=lesions < 3mm, 3=lesions 3-6 mm, 4=lesions >6 mm and 5=plants 75% wilted or dead.

**Fishers protected least significant difference, P=0.05

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DETECTION OF AN IMMUNORELATED PEPTIDE IN CULTURED TISSUES OF HIGHER PLANT SPECIES

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Examination of protein synthetic patterns in developing plant tissue cultures revealed the presence of an abundant 27kD peptide which was not detected in seedling explants. Appearance of this peptide was concomitant with callus formation induced by the presence of natural or synthetic auxin in *Sorghum bicolor* (L.) Moench tissue cultures and has been termed callus-associated peptide one (CAP1) (1). A screen of whole plant organs using two-dimensional polyacrylamide gel electrophoresis (2-D PAGE) with a silver amine stain indicated the presence of CAP1 only in crown tissues and then in amounts greatly reduced relative to *in vitro* cultures. Challenging plants with any of five auxins, however, greatly stimulated CAP1 accumulation in crown tissues. A second callus-associated peptide (CAP2) was found in *in vitro* callus sectors which had lost the ability to differentiate into organ primordia. Analysis of immunoblots from 2-D PAGE indicated an immunorelatedness of this 44kD peptide to CAP1. Both peptides are capable of binding Con A and are considered to be glycoproteins; therefore, molecular mass estimates from comparison to marker proteins on gels should be considered as approximations and are likely overestimates.

Upon examination of protein extracts of *in vitro* cultured tissues from higher plant species, it was observed that peptides immunorelated to CAP1 exist in taxonomically related tribes (Festuceae, Aveneae, Triticeae, Eragrosteae, Chlorideae, Paniceae, Andropogoneae) of the grass family (2), but were not detected in other monocots or any of the dicots sampled. Immunoblots of single dimension SDS-PAGE which were probed with a polyclonal antiserum raised against CAP1 and visualized with a secondary anti-IgG/enzyme conjugate indicated the presence of a peptide of similar relative molecular mass (i.e. 26 - 27kD) in 12 of 13 members of the Poaceae tested. Two genotypes of 'indica' rice (tribe - Oryzeae) failed to show any detectable immunoreactive peptide when probed with this antiserum. Representative species of three other monocot families (Iridaceae, Liliaceae, Lemnaceae) and 17 species representing 12 dicot families (Fabaceae, Rosaceae, Malvaceae, Cucurbitaceae, Brassicaceae, Euphorbiaceae, Rutaceae, Linaceae, Apiaceae, Solanaceae, Asteraceae) were all negative with respect to the presence of "CAP1."

The role that this peptide or its immunorelated counterparts play in cultured and whole plant tissues is not currently known. The induction of this peptide in the presence of auxins to accumulate in abundant amounts suggests a possible role in auxin metabolism. As more species are examined it is becoming apparent that CAP1 is highly conserved amongst many members of the grass family, but any analagous peptide in other families must be sufficiently divergent to have epitopes unrecognizable by this polyclonal antiserum. Current efforts focus on the production of a cDNA and its sequencing as a means of comparison to known sequences and to more precisely explore the auxin inducibility of CAP1.

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HOST SPECIALIZATION IN COCHLIOBOLUS SATIVUS, A FUNGUS CAUSING ROOT ROT OF WHEAT AND BARLEY

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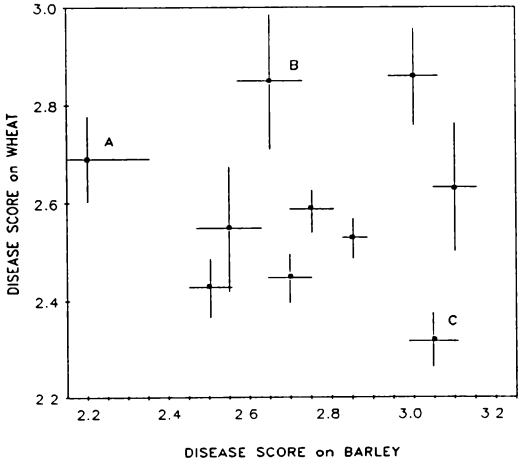
Root rot of spring wheat and barley caused by Cochliobolus sativus (Ito and Kurib.) Drechsl. ex Dastur is widespread in North America. Symptoms include dark brown lesions on all below ground plant parts. Severity of the disease increases with continuous cropping to barley or wheat either because the soil population of the causal fungus increases (1) or because the population of C. sativus shifts to more aggressive types (2). Rotation with non-cereal crops lowers the soil population below the threshold where significant loss occurs. Specificity of C. sativus to either barley or wheat has been suggested (3), but not confirmed. If specificity were a major selection factor, it might be expected that cultures adapted to the host cropped continuously would be favored. One difficulty with attempting such studies under field conditions (3), is the likelihood of confounding factors. This paper reports a study of pathogenicity of a limited number of C. sativus pure cultures under controlled conditions.

Cultures of C. sativus from barley and spring wheat were collected during the summer of 1989. Plant parts (leaves, roots) were washed in running water for 5 min, surface-disinfested in 0.5% NaOCl for 3 min, rinsed and air dried. Plant tissue was cut into 5 mm pieces, placed on agar medium in petri dishes and incubated at 21 C for 8 days (4). Individual colonies were transferred to potato dextrose agar in tubes. Monoconidial sub-cultures were derived and used for all further work.

For this study, ten cultures of C. sativus were used, four isolated from barley and six from wheat. Inoculum of each culture was grown on wheat leaf agar in culture bottles incubated at 21 C for 8-10 days. Conidia were harvested by agitating the culture with sterile distilled water. The conidial suspension was mixed with sterile sand and air dried for 12 hr. Inoculum density was 400 conidia per gram. Individual plastic growing tubes (3 cm diam X 15 cm deep) were filled with sterile sand to 5 cm from the top. Four seeds of wheat or barley were planted in each tube and a 3 cm layer of sand-conidia inoculum was added. Each tube received inoculum of one culture. Each of three experiments used a randomized complete block design with three replications. Each tube was an experimental unit. Plants in six non-inoculated tubes served as controls in each replication. At five weeks after planting, plants were removed and scored for disease. Severity of infection was scored as 1 = clean, 2 = slight, 3 = moderate or 4 = severe, based on number and size of C. sativus lesions on the subcrown internode. All comparisons were based on Analysis of Variance of disease scores as indicated by disease scores.

Figure 1. Relative pathogenicity of ten *C. sativus* cultures to barley and wheat. Horizontal and vertical bars indicate standard errors of means of three experiments. Dotted diagonal line indicates equal pathogenic potential based on means of wheat/barley test plants.



All cultures tested were at least somewhat pathogenic to both wheat and barley as indicated by disease scores significantly higher than the non-inoculated controls. The average disease score caused by cultures isolated from barley (2.74) was not significantly different from that caused by cultures from wheat (2.60). Seven of the ten cultures ranked similarly for wheat and barley in disease-causing ability (Fig. 1). Two cultures, both derived from wheat, showed pathogenicities less than average to barley but greater than average to wheat (A,B,Fig. 1). One culture, derived from barley, showed high pathogenicity to barley but was least so to wheat (C,Fig 1).

While more tests with a much larger number of cultures are needed, it does appear that some C. sativus cultures exhibit preferential pathogenicity to wheat or barley, although most do not. The importance of host-specialized versus non-specialized cultures in the etiology of common root rot remains to be determined.

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RESPONSE OF CHRONICALLY AND ACUTELY OVARIECTOMIZED GILTS TO GONADOTROPIN RELEASING HORMONE (GnRH)

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Reproductive performance of the female pig is dependent upon secretions of gonadotropins from the anterior pituitary. Previous studies involving gonadotropin releasing hormone (GnRH) manipulation have shown that luteinizing hormone (LH) pulse frequency and pulse amplitude are directly related to corresponding changes in GnRH pulse frequency and pulse amplitude (1). By an alternative method of endocrine manipulation, intact and ovariectomized gilts actively immunized against GnRH were used to demonstrate the influence of a hypophysiotropic substance on gonadotropin secretion (2). Although the effects of administering GnRH and GnRH antagonists have been experimentally demonstrated on intact and acutely ovariectomized gilts, very little research has been performed on chronically ovariectomized gilts. The objective of this study was to demonstrate that luteinizing hormone secretions are not only influenced by releasing factors but also by the physiological state of the animal at the time of treatment.

Twenty prepubertal gilts were bilaterally ovariectomized and cannulated via the jugular vein and assigned to one of four groups; acute treatment (n = 5), acute control (n = 5), chronic treatment (n = 5), and chronic control (n = 5). Forty-eight hours following ovariectomy, blood samples (3.0 ml) were taken every 10 minutes for two hours from the acute control and acute treatment animals. After two hours of pretreatment sampling, each gilt in the acute treatment group received a 100 I.U. GnRH injection, whereas, the acute control gilts received a sterile saline injection (5.0 ml). Procedures involving the chronic treatment and chronic control gilts were identical to that of the respective acute groups, except treatment began 14 days following ovariectomy. All blood samples were immediately centrifuged at 3000 rpm, 4° C for 10 minutes and the plasma was removed and frozen (-20° C).

Analysis of plasma LH concentrations using a double antibody radioimmunoassay were performed on each sample with mean LH concentrations for each group plotted as a function of time (Fig. 1). Group means within time were tested using pairwise comparison for differences by Student's t-test.

The mean LH concentrations of samples taken during the 70 minutes post-injection were significantly different ($P < .025$) between treatment groups and their respective control groups. These data demonstrate that LH secretion in ovariectomized gilts, regardless of time post-ovariectomy, are responsive to GnRH administration. When mean LH concentrations of the acute treatment and chronic treatment groups were compared during the 70 minutes post-injection, there were no differences except for the samples taken at 20 minutes post-injection ($P < .05$). These results indicate that LH secretion patterns are influenced by the physiological state of the animal at the time of treatment and may depend on the length of the chronic state.

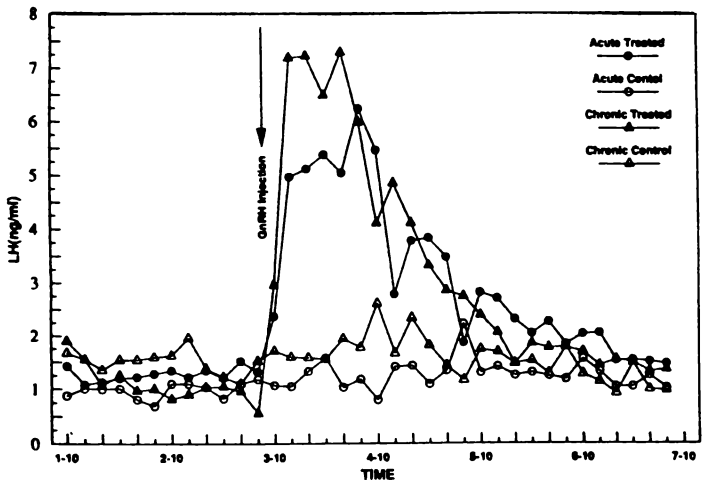

Figure 1. Mean LH Concentration in Chronically or Acutely Ovariectomized Gilts.

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SPECTROSCOPY AND PHOTOCHEMICAL STUDIES OF CITRATE COMPLEXES OF IRON(III)

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In a previous study (1) we reported that under similar reaction conditions, the photoreduction rate of iron(III) to iron(II) in presence of the biologically and nutritionally important tricarboxylic and dicarboxylic acids depends on the nature of the carboxylate ligand. In this report additional work on the photochemistry and spectroscopy of citrate complexes of iron(III) as a function of pH is discussed.

Photochemical Reactions in solution: The experimental procedures were followed as reported earlier (1). Irradiation was carried out using a 450 W Hanovia Hg lamp equipped with a filter transmitting 366 nm light. *o*-Phenanthroline was added immediately after irradiation to quantitatively trap the photo-reduced iron(II) and allow the spectrophotometric determination of the ferrous ion formed in the solution. The quantum yields for reduction of iron(III) to iron(II) by citric acid were found to depend on pH and the carboxylate ligand concentration. No photoreduction of the iron(III)-citrate occurred below pH 1.5. This observation could either imply a lack of formation of a complex ion, or a lack of photoactivity in any complexes present. At pH 2.9 photoreduction of iron(III) to iron(II) was observed ($\Phi = 0.18$) but the quantum yield decreased rapidly with increasing pH. Although hydrolysis of iron(III) at pHs greater than 2.9 might not completely be ruled out, the increased "ferroxidase" (2) activity of citrate with increasing pH could account for the lower quantum yield. Nevertheless, the data suggest the formation of a photoreducible iron(III) citrate complex in the pH range 1.5-5. Timberlake (3) has suggested that above pH 1.5 a dimeric complex ion, $Fe_2(H_{-1}Cit)_2^{2-}$ is the principal species in solution. Our work suggests that it is this dimeric complex ion which is the photochemically reducible species.

Photochemical Reaction in the Solid: Iron(III)-citrate was prepared by suspending an equimolar ratio of iron(III) and citric acid (0.5 M) in water. H_2SO_4 or $NaHCO_3$ was added to this solution to adjust the pH to that of interest. The resulting suspension was stirred and allowed to equilibrate for about 2 hours. 95% EtOH was added to the reaction mixture to form a precipitate. After the reaction mixture had formed a gel, it was vacuum-freezed-dried. The KBr pellet of the iron(III)-citrate was prepared (1 mg of sample, pH 3.8 in 50 mg of KBr) for the photochemical study. The iron(III)-citrate is photoactive. Upon irradiating the sample directly in the pellet holder with 366nm light, changes were observed in the IR spectra that are consistent with disappearance of the dinuclear iron complex and appearance of $CO_2(g)$.

Magnetic Data: Magnetic behavior of iron(III)-citrate was measured by an nmr method (4) that uses the difference in chemical shift of a reporting compound (t-BuOH) in the presence and absence of a paramagnetic compound in solution..

Our measurements of the magnetic susceptibility of iron(III)-citrate solutions indicates that the magnetic moment decreases with increasing pH. This suggests the formation of one or more complexes exhibiting antiferromagnetic behavior due to super-exchange coupling of the iron(III) centers in the complexes. This exchange is believed to occur via overlap of the metal d orbitals with the bridging oxygen orbitals in either π super-exchange (antiparallel or parallel) or σ super-exchange (antiparallel) pathway (5 and references therein).

Electronic spectra: Electronic spectra of iron(III) (3.3E-4 M, pH 1.5) have a broad absorption band in the near UV region that tails into the visible and obscures the weak spin-forbidden d–d band. Upon addition of citric acid (0.055 M, pH 1.5) to the iron(III) solution, the electronic spectrum resolves into an absorption band with maximum at 300 nm. This band was assigned to an iron(III)-sulfate-citrate complex in view of the fact that the analogous iron(III)-nitrate-citrate, or iron(III)-chloride-citrate have absorbance maxima at 330 nm and 350 nm respectively. Aqueous solutions of iron(III)-citrate exihibiting such a characteristic band are photo-inactive. Increasing the pH of the iron(III)-citrate solution obscures the band and increases the absorbances in 200-300 nm region. Conversely, by decreasing the pH of the solution the characteristic band could be reproduced. In other words, the electronic absorption features of iron(III)-citrate solution could reversibly be reproduced within experimental errors by addition of $H_2SO_4/NaHCO_3$ (pH range 1.2-4.0).

On the other hand, electronic spectra of solution containing an equimolar ratio of iron(III) to citric acid ligand (0.5 M) are also a function of pH. In highly acidic solution, the iron(III)-citrate complex shows no electronic absorption band in the visible. However, upon increasing the pH, a new band forms (645 nm). The mechanism by which such electronic transition gains intensity with increasing pH (via $NaHCO_3$ addition) could be related to the observed antiferromagnetic behavior.

Thus the IR, NMR, and Uv-vis spectra features of iron(III)-citrate provide the information that enable us to anticipate the potential photoactivity of the complex ion at a given pH.

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THE USE OF MAGNETITE AS A CATALYST FOR THE CHEMICAL VAPOR DEPOSITION OF CARBON ON CARBON FIBERS

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Composite materials have received attention in recent years because of the increased need for light-weight, high-strength materials. A composite consists of a high-strength fiber, such as carbon fiber, surrounded by a matrix material. Carbon-carbon composites are structures made from a woven preform of carbon fiber surrounded by a matrix of carbon. Current methods for the fabrication of carbon-carbon composites are very slow. They may be made by either pitch resin impregnation and pyrolysis or by the decomposition of a hydrocarbon gas (i.e., methane) in a chemical vapor deposition process. The use of a catalyst for the chemical vapor deposition of carbon from methane gas would speed the process considerably. This work investigates the use of magnetite (Fe_3O_4) particles as a catalyst for the deposition process.

A 2^{5-1} half-fraction factorial with a defining relation of I=12345 was employed with the variables and run descriptions as shown in the design matrix below. Two replications plus four center points were run, for a total of 36 runs.

	Variable	+	0	-
1	magnetite concentration	1/100	1/1,000	1/10,000
2	ferrofluid type	EMG-805	1:1 mix	EMG-905
3	methane flowrate (cm^3/min)	200	150	100
4	methane:nitrogen ratio	1:2	1:3.7	1:10
5	deposition time (hours)	8	6	4

Two sources of magnetite particles, Ferrofluidics Corporation's EMG-805 (water-based) and EMG-905 (mineral oil-based), were used. The magnetite particles had an average diameter of 100 Å (1). The carbon fibers (T-500 6K) were produced from a polyacrylonitrile (PAN) precursor and were purchased from Union carbide (now Amoco). Approximately 0.1 g samples of carbon fibers (with sizing removed) were used for the experiments. Glazed porcelain boats were used as sample containers. The boat with the fibers was filled to the rim with ferrofluid solution of appropriate dilution. The water was evaporated from the water-based samples in an oven at 350 K for 20-24 hours. The heptane and mineral oil were evaporated from the mineral oil-based samples on a hot plate for 30 minutes followed by 18-20 hours in an oven at 350 K. The prepared samples were placed inside a tube furnace and heated to approximately 1250 K under a nitrogen flow. When this temperature was reached, the methane was turned on and the N_2 and CH_4 flowrates were adjusted to the desired settings. The percent mass gain from the initial fiber sample was calculated. The mass gains obtained ranged from -0.87% to 24.79%.

A factorial analysis of the experimental results showed that the magnetite concentration (X_1), methane to nitrogen flowrate ratio (methane concentration, X_4), and the deposition time (X_5) have a significant effect on the carbon deposition rate (percent mass gain of the sample). A check for curvature indicated that the following linear model for the process based on these experiments could be proposed: $Y = 10.299 + 2.534\ X_1 + 4.234\ X_4 + 2.998\ X_5$, where the X values are -1, 0, or +1, as indicated in the design matrix given above.

Since the type of ferrofluid is unimportant, this factor may be ignored when determining the rate expression. The ratios of the rates at the two methane compositions indicate a first order rate expression of the form $\rho = k\ P$, where P is the partial pressure of methane. The values of the rate were computed by using the average of the two experiments. The values of the rate constant can now be grouped by dilution and ferrofluid type. The average rate constant at a dilution of 10,000 for the EMG-805 was 0.0606 g/g atm hr. The average rate constant at a dilution of 10,000 for the EMG-905 was 0.0723 g/g atm hr. The average rate constants for a dilution of 100 were 0.1024 g/g atm hr and 0.1325 g/g atm hr for the EMG-805 and EMG-905 fluids repsectively. Therefore, for the 10,000 dilution of the ferrofluids, the average rate constant is 0.0665 g/g atm hr, while for the 100 dilution the average rate constant is 0.117 g/g atm hr. For no ferrofluid, the rate constant is 0.0565 g/g atm hr (2). The effect of the ferrofluids is to increase the rate constant by more than a factor of two.

Magnetite particles have been shown to promote the deposition and decomposition of methane on the surface of PAN-based carbon fibers. The rate of deposition is largely independent of the type of ferrofluid used and the gas flow rate. The rate was a strong function of the dilution of the ferrofluids, which indicates that the number of active sites is important. The overall rate is first order in methane composition. Ferrofluids may be used as a catalyst to increase the rate of deposition of methane on carbon fibers and potentially could be utilized to fabricate carbon-carbon composite structures.

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WIND ENERGY CONVERGENT SYSTEM

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Wind energy convergent systems are recently becoming more and more popular as an alternative energy source due to the increased cost of fossil fuels as well as their limited supply and negative impact on the environment. The present goal of designers is to develop a wind machine that is inexpensive to produce, not overly sophisticated, and performs well in its given location. If these objectives are met, the price per kilowatt of electricity produced by these machines will be low enough to make this a feasible alternative to fossil fuels.

One design being investigated by this group consists of a four foot diameter, stall control blade which will provide power through a transmission to a 3/4 HP induction generator. In order for this system to produce electricity it must be interfaced with the utility grid. This connection allows the electricity produced by the wind machine to be sold back to the utility and to provide a source of power for the field windings of the induction generator that is in phase with the utility grid. All the components of this system, with the exception of the generator, will be designed and built by this team.

The blade will be of the constant chord length, constant twist angle type and will use the Seri Thin-Air Foil profile. The final dimensions of the blade will be determined using the PROP software program to give the optimum blade geometry. The inherent features of this blade will cause it to stall out when the wind speed reaches 40 mph. This stall control feature eliminates the need for a mechanical speed limiting device and simplifies the system. The blade will be constructed by developing a 3-dimensional computer model of the blade, using the CAD system. This information will then be fed to a 3-axis, computer numeric controlled milling machine which will precisely carve out the blade from a piece of hard wood stock.

The transmission will consist of a cog belt and pulley system having a gear ratio of 2:1. This is needed to bring the speed of the generator up to approximately 1800 rpm where it will begin to produce electrical power. Once the transmission and generator set up have been constructed, a bench test can be conducted using a bexometer(used to measure rotational torque) to determine the efficiency of the transmission and generator and to give an indication of the amount of power the blade will need to provide at the rated condition. This data will then be entered back into the PROP program and the necessary refinements will be made to the blade geometry before construction begins.

Once the complete system has been assembled, it will be mounted on a trailer and pulled at different wind speeds, over its range of operation, to simulate the actual conditions. The data collected from these tests will indicated how much power the system will produce at various wind speeds. When this data is combined with the statistical wind data of a certain area, the total annual energy production of the system can then be calculated.

DEPROTONIZATION OF ACETIC ACID

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In the gas phase reaction between the acetic acid molecule and fluoride or hydroxide anions the expected result is the abstraction of the more acidic proton. According to research done by Joseph Grabowski and Xucheng Cheng (1) of Harvard University the anion-induced deprotonization of acetic acid tended to show less selectivity between the protons of differing acidity than was expected. This resulted in a 50/50 split with the hydroxide addition and a 75/25 carboxylate enolate split with the flouride addition. The intent of my research is, through application of quantum mechanical methods, to help explain these results.

Reactions taking place in the gas phase at low to moderate pressures can be approximated reasonably well by looking at the individual reactions. This approximation, along with the advent of more sophisticated and powerful computational devices and programs such as GAUSSIAN86 (2), allows the application of quantum mechanical theory to study and characterize the reactions by looking at the reaction path as well as molecular and transitional energies.

When a reasonable transition state is able to be found we then have a good appoximation of the energy barrier that has to be overcome for the reaction to take place. Comparison of two suspected transition states allows us to make a guess as to which reaction would be the most likely to occur. When a transition state is not readily found or possibly doesn't exist another procedure can be applied to the same end.

This method uses what we call an energy map. This process requires looking at several points along a suspected reaction path. At each point an energy is calculated and then plotted against the distance between the incoming group and the intended point of attack. In the case of the reaction I am looking at, the distance would be between an incoming hydroxide or fluoride ion and the proton intended to be abstracted.

If the graph we have constructed shows a steady increase in energy and the points along the path seem to have a reasonable structure, the data points to a possible path with a small or no energy barrier. As all reactions wish to travel a path of least resistance this is a likely guess for the actual path.

If there is a point where there is an increase in energy followed by a decrease in energy, a possible point for a transition state exists and further study of that path is warranted.

The following data are for the hydroxide addition to the carbon end proton resulting in enolate ion formation. These data (energy in hartrees and lengths in angstroms) indicates no barrier energy to this reaction.

Similar results have been observed for the hydroxide addition to the oxygen end proton supporting the 50/50 split. The flouride calculations are yielding less sympathy to my search at the moment.

Bond length

OH- to H	Energies	OH- to H	Energies	OH- to H	Energies
1.2	-304.10244491	1.8	-304.09168786	3.25	-304.06974133
1.3	-304.09822279	2.0	-304.08937195	3.5	-304.06931247
1.4	-304.09591336	2.5	-304.07545836	4.0	-304.06830300
1.6	-304.09376654	3.0	-304.06985143		

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CHEMICAL COMPOSITION OF ALFALFA AND LEAFY SPURGE AT FOUR PHENOLOGICAL STAGES OF GROWTH

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Leafy spurge (Euphorbia esula) is a long-lived perennial weed estimated to infest over 1 million ha in the northern Great Plains of the United States (1). Leafy spurge primarily infests pasture and rangeland where it severely decreases herbaceous production and livestock carrying capacity (2). Annual losses in herbage and livestock production in North Dakota are estimated at $8.6 million (3).

Efforts to control the rapid spread of leafy spurge have proven to be either too expensive or ineffective. Herbicides can provide partial control of the plant but effective treatment costs are prohibitive for use on wide spread infestations. Biological control methods using insects or pathogens have long-range potential but much research still needs to be conducted before these agents can be efficiently utilized.

A more traditional approach to leafy spurge control has been the grazing of sheep or goats in infested areas. Numerous ranchers are using this method and report various degrees of effectiveness (4). However, there is disagreement concerning the effect of leafy spurge on grazing animals and the forage value of leafy spurge. The objectives of this study were to: a) examine the chemical composition of leafy spurge at four phenological growth stages and four locations in North Dakota, and b) compare leafy spurge to alfalfa (Medicago sativa), harvested at similar growth stages and locations.

Leafy spurge and alfalfa samples were collected in 1990 near Dickinson, Minot, Valley City and Fargo at vegetative (May 15), flowering (June 15), mature (July 15) and regrowth (September 1) phenological stages. Samples were dried, ground and analyzed for % ash, % crude protein (CP), % acid detergent fiber (ADF), % in vitro dry matter digestibility (IVDMD) and % phosphorus (P).

Table 1
Chemical Composition of Leafy Spurge and Alfalfa

Species	Growth stage	% Ash	% Crude protein	% Acid detergent fiber	% in vitro dry matter digestibility	% Phosphorus
Leafy spurge	Vegetative	7.8	27.7	13.0	82.3	0.55
	Mature	7.2	15.2	30.4	60.0	0.34
Alfalfa	Vegetative	10.8	31.7	16.6	83.5	0.45
	Mature	9.4	20.5	26.2	67.4	0.26

Chemical composition of leafy spurge and alfalfa were averaged by vegetative and mature growth stages across the four collection locations. Percentage ash, CP, IVDMD and P decreased in both leafy spurge and alfalfa with advancing maturity. Percentage CP and IVDMD tended to be greater in alfalfa regardless of vegetative stage when compared to leafy spurge. However, P percentage was consistently higher in leafy spurge. Nutrient requirements for lactating 54 kg ewes are 8.4% CP, 58% TDN (similar to IVDMD) and 0.21% P. Both plant species exceed these requirements levels even at maturity.

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Residential Water Preheater Using A Savonius Wind Turbine

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The operation of our system is based on the direct conversion of wind energy to thermal energy by the use of a savonius type wind driven turbine. This conversion is accomplished by using the shaft power developed by the wind turbine to drive a water stirring mechanism. The energy supplied to the stirring mechanism will be converted into thermal energy by the friction between water molecules caused by a moving water paddle and a stationary baffle on the wall of the water stirring mechanism.

The Savonius rotor was invented by a Finnish engineer named Sigurd Savonius in 1924. The design consists of two half cylinders offset as shown in Figure 1.

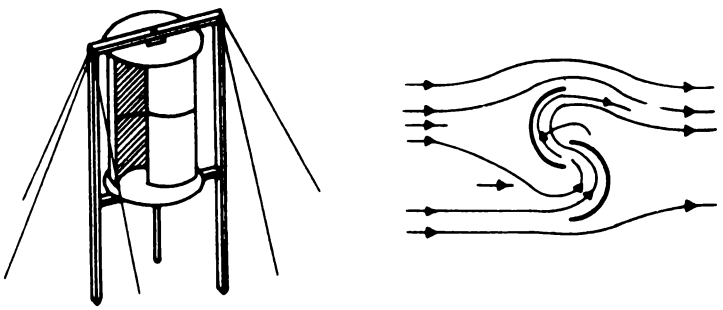

Figure 1. A Typical Savonius Rotor

To optimize system performance, two turbines are used. With two turbines stacked and offset 90°, stall conditions are eliminated at low wind speeds. While one turbine is in the stall postion, the other turbine is directly "catching" the wind.

The water stirring mechanism is comprised of a system of paddles rotating in a tank of water. The water stirring shaft is connected to the Savonius rotor shaft via a transmission to increase the speed of rotation. Friction occurs between the water molecules as the paddles pass baffles in the wall of the tank and the water temperature increases.

This system is fairly inexpensive with material costs expected to be below $250. While there are other wind energy conversion systems able to do the same job as the Savonius, few are as easy and as inexpensive to construct and maintain. The low maintenance aspect of the Savonius turbine lends itself quite well to residential use. A comparison could be made with the Lake Aid Systems turbine design, which is currently sold as a pond aerator.

Chemical and Physical Detection of Fingerprints

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Detection of latent fingerprints can be classified into two categories: physical methods and chemical methods. Physical methods rely on the adherence of an inert material to the fingerprint material (dusting powders), and chemical methods depend on a chemical reaction occurring between a reagent and the fingerprint material (the reagent ninhydrin). Our research focused on investigating the applicability of these methods toward detection via laser induced fluorescence.

Since 1954 investigators have used the ninhydrin chemical treatment as a detection method of fingerprints (1). When reacted with the amino acids present in fingerprint residue, ninhydrin ($C_9 H_6 O_4$) produced a purplish-blue product called Ruhemann's Purple ($C_{18} H_8 O_4 N$). Coupling the Ruhemann's Purple with a metal salt formed a fluorescent compound. Experiments conducted on print material used solutions of ninhydrin and zinc chloride dissolved in 1:4 methanol:freon (1,1,2-trichlorotrifluoro- ethane). The Ruhemann's Purple- zinc chloride complex exhibited a short- lived orange fluorescence under laser examination. The 520-nm wavelength from a Nd:YAG wavelength tunable and pulsed dye laser provided the source of laser light. The ninhydrin- amino acid reaction and the Ruhemann's Purple- zinc chloride reaction required sensitive conditions, including: proper settings of temperature and humidity and a long incubation period. The experiments did not provide reproducible results and could not be easily controlled, even under identical conditions.

Other laser- based techniques that were examined included inherent luminescence of the print material, fluorescent dusting powders, laser dyes in methanol solution, and the Super Glue^R treatment coupled with a laser dye. An Eximer laser with a wavelength of 308-nm and an ultraviolet black light with a wavelength of 320-nm provided the source of illumination for these techniques. The Super Glue^R treatment followed by application of the Coumarin 500 laser dye produced satisfactory results. A polymer, which stabilized the print material, formed between the cyanoacrylate ester of the glue and the polypeptides present in the print residue; water catalyzed the reaction. Development of a device to increase the air current in an enclosed area decreased the required reaction time from several hours to a few minutes. The procedure offered reproducible and effective results on several substrates, including: paper, metal, wood, and black plastic. In conclusion, continued exploration of inherent luminescence of the print and investigation of phosphorescence treatments would be potential experiments leading to detection of fingerprints via laser induced flourescence.

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CHARACTERIZATION OF THE REACTION PRODUCTS FORMED FROM ^{14}C-SULFAMETHAZINEDIAZONIUM TETRAFLUOROBORATE AND BOVINE SERUM ALBUMIN

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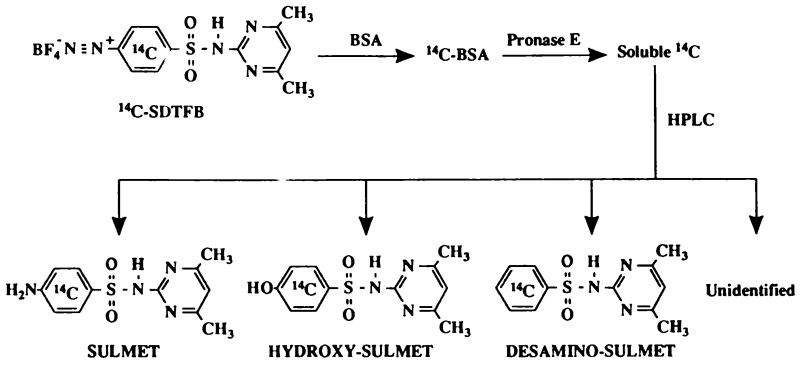
Previous studies indicated that the formation of desaminosulfamethazine [*N*-(4,6-dimethyl-2-pyrimidinyl)-benzenesulfonamide; desamino-Sulmet] from sulfamethazine [4-amino-*N*-(4,6-dimethyl-2-pyrimidinyl)benzene-sulfonamide; Sulmet] in rats was enhanced under high dietary nitrite conditions (1). Later studies demonstrated that a diazonium cation of Sulmet was formed in the gastrointestinal tracts (gut) of rats dosed with ^{14}C-Sulmet and $NaNO_2$ (2). This cation was found to be mutagenic and to serve as the precursor to desamino-Sulmet and insoluble residues in the gut (not removed by exhaustive methanol extraction) (2). Administration of this cation intermediate metabolite as 4-[*N*-(4,6-dimethyl-2-pyrimidinyl)sulfonamido][U-^{14}C]benzenediazonium tetrafluoroborate (^{14}C-SDTFB; figure) in rats effected ^{14}C-labeled insoluble residues to form in the gut of the rats (2). When these insoluble residues were fed to another group of rats, ^{14}C-labeled Sulmet, acetyl-Sulmet, desamino-Sulmet and other unidentified compounds were determined to be present in the blood, liver and skeletal muscle of the recipient rats indicating some of the insoluble residue was absorbed from the gut (2). A subsequent investigation showed that ^{14}C-SDTFB reacted with the model protein, bovine serum albumin (BSA), *in vitro* to yield an insoluble product(s) (3). Hence, the purpose of this study was to characterize those insoluble reaction products formed from ^{14}C-SDTFB and BSA.

^{14}C-SDTFB (3 µmol) was reacted with BSA (120 mg) for 30 min. (3.3 ml reaction volume; 0.1 M phosphate buffer; pH 8; 37°C). At the end of the incubation period, the solution was adjusted to pH 7, 15 ml of methanol was added and the insoluble ^{14}C-activity (^{14}C-BSA) was removed by centrifugation at 3000 x g (30 min.). After removal of the supernatant, the precipitate was washed twice with 15 ml of methanol followed by re-centrifugation. ^{14}C-Activity was measured using liquid scintillation counting. The methanol washed ^{14}C-BSA was incubated with 0.242 international units of Pronase E (a broad spectrum proteolytic enzyme) in a 0.04 M phosphate buffer (pH 7.5). Following incubation at 37°C for 20 hours, 90 ml of methanol was added to the mixture. The mixture was then centrifuged at 3000 x g for 30 min. and the supernatant removed. The soluble ^{14}C-labeled products resulting from enzyme hydrolysis were isolated by reverse-phase high pressure liquid chromatography (C-18 column; water-methanol gradient) and identified by proton nuclear magnetic resonance (^{1}H-NMR), gas chromatography mass spectrometry (GC-MS), infrared spectrometry (IR) and/or fast atom bombardment mass spectrometry (FAB-MS).

When ^{14}C-SDTFB was incubated with BSA approximately one-third of the total ^{14}C-activity was bound to the BSA and enzyme hydrolysis resulted in complete conversion of ^{14}C-BSA to ^{14}C-labeled methanol soluble products. Three products totaling 72±6.6% (mean ± S.D.) of the ^{14}C-activity in the mixture after enzyme hydrolysis were identified; the remaining 28±6.6% was uncharacterized (figure). Sulmet (41±3.8%) and desamino-Sulmet (24±2.5%) were identified by comparing their ^{1}H-NMR, GC-MS and IR spectra with those of reference compounds and by co-chromatography of their N^1-methyl derivatives. Hydroxy-Sulmet [4-hydroxy-*N*-(4,6-dimethyl-2-pyrimidinyl)-benzenesulfonamide] (8±0.8%) was identified by interpretation of its ^{1}H-NMR, GC-MS and FAB mass spectra. These findings indicated that ^{14}C-SDTFB reacted with BSA *in vitro* to form products similar to those found in the gut of rats dosed with ^{14}C-SDTFB and also those dosed with ^{14}C-Sulmet and $NaNO_2$.

Figure



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FRACTAL DIMENSION ANALYSIS OF FLY ASH DEVELOPMENT FROM COAL COMBUSTION

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The conditions at the surface of a burning coal or char particle affect the rate of combustion and the formation of products and unwanted by-products. The inorganic constituents of coal, primarily sodium silicates and sodium sulfates, pass through the combustion zone as solids, liquids, or vapors and ultimately react or condense to form fly ash particles. In industrial pulverized-coal boilers, these particles may be transported to the heat-exchange surfaces of the boiler, insulating them and thereby decreasing the thermal efficiency of the boiler. During combustion, the char surface morphology is constantly changing as the carbon burns away. A recently-developed experimental technique, fractal analysis using physisorption, was used to measure the development of char surface morphology during combustion.

The fractal dimension is a measure of surface ruggedness and varies from the topological dimension of 2 to the Euclidean dimension of 3. To determine the fractal dimension of a surface, a series of different-sized molecules may be adsorbed onto the sample, producing different effective surface areas due to the greater accessibility of smaller molecules to surface intricacies.

A synthetic coal was prepared in order to study the interactions of coal combustion in a system less complex than actual coal but having similar combustion characteristics. Prepared samples were burned in a laminar-flow furnace at 1173 K and 1773 K and quickly quenched with nitrogen at residence times of 0.1 second, 0.5 second, and 1.5 seconds. Each sample (two unburned coals and six chars) was then analyzed using a dynamic flow adsorption instrument which allows adsorbate and carrier gas to pass through a set of matched thermal conductivity detectors. Five different gases were used as adsorbates: nitrogen, carbon dioxide, ethane, propane, and n-butane, with helium as the carrier gas. The monolayer coverage was determined with the Brunauer-Emmett-Teller (BET) adsorption model (1), and a fractal dimension for each sample was found using a relationship developed by Avnir (2). The results of this fractal analysis are shown in the following table.

Sample	Combustion Temp (K)	Residence Time (sec)	Sample Size (g)	Fractal Dimension
1	Synthetic Coal	-	0.6319	1.89±0.49
2	Synthetic Coal	-	0.6576	2.10±0.28
3	1173	0.1	0.6142	2.70±0.83
4	1173	0.5	0.1568	2.85±0.30
5	1173	1.5	0.1816	2.47±0.72
6	1773	0.1	0.3089	2.81±0.46
7	1773	0.5	0.0253	1.98±1.15
8	1773	1.5	0.3071	2.26±1.84

The fractal dimension of the synthetic coal particles is close to 2, indicating a smooth, two-dimensional plane. As the particles burn, the carbon matrix is removed and the remaining minerals form small beads on the char surface, increasing surface ruggedness and thus fractal dimension. Finally, as the carbon matrix completely burns away and the remaining minerals coalesce, the fractal dimension decreases.

Large inaccuracies in the fractal dimensions of samples 7 and 8 are due to exceeding the instrument minimum of the volume of gas adsorbed. An additional difficulty in the analysis is that of determining the correct cross-sectional areas of the adsorbate molecules. The current state of knowledge rests with the predictions of McClellan and Harnsberger (3), which are based upon work completed before the concept of fractal surfaces appeared in the literature.

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HEIGHT OF THE LAURENTIDE ICESHEET ALONG NORTH FLANK OF HIGHWOOD MOUNTAINS: MONTANA

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Introduction: Calhoun (1) documented evidence that a lobe of the Laurentide Icesheet reached as far south as the Highwood Mountains in north central Montana. The ice formed a barrier which blocked all drainage from the Great Falls Basin resulting in formation of Glacial Lake Great Falls. Calhoun further described the Shonkin Sag, an ice-marginal channel immediately to the north of the Highwood Mountains, as the glacial lake outlet. Based on outlet channel elevations the level of the lake has been calculated to have been between 3700 and 3900 feet. Maps of the glacial lake (1) are frequently based on the elevation of the floor of the Shonkin Sag channel, which is approximately 3700 feet.

Clausen (2) described evidence for large floods which crossed high level drainage divides throughout the Missouri River drainage basin. Clausen (3) further described evidence for a progressive sequence of asymmetric drainage divides in which the drainage basin of each Missouri River tributary is younger than the drainage basin of the tributary immediately downstream. This relationship holds for all Missouri River tributaries north of the Niobrara River in Nebraska, upstream as far as the Arrow Creek drainage basin in north central Montana. The Shonkin Sag channel drained into Arrow Creek. The systematic sequence of asymmetric drainage divides begins, or ends, at the outlet of Glacial Lake Great Falls.

This progressive sequence of asymmetric drainage divides, cut in easily-eroded bedrock, suggests that catastrophic failure of the dam impounding Glacial Lake Great Falls may have been responsible for formation of most present-day landforms in the Missouri River drainage basin. If correct, the volume of water involved must have been much greater than that accounted for in previous descriptions of Glacial Lake Great Falls. The purpose of this study was to determine the height of the ice dam responsible for the formation of Glacial Lake Great Falls.

Method of Study: This project studied the north flank of the Highwood Mountains to determine the highest elevations where glacial deposits from the Laurentide Icesheet could be found. First, a reconnaissance trip was made to observe the Shonkin Sag and to look for obvious evidence of Laurentide glacial deposits between the Shonkin Sag and the Highwood Mountains. Second, based on preliminary trip evidence and land access considerations, detailed investigation was made of the Square Butte area, just east of the Highwood Mountains, and the Harris Mountain area on the northwest flank of the Highwood Mountains. In both areas efforts were made to find the elevation of the highest glacial erratics which could definitely be attributed to the Laurentide Icesheet. All elevations in this study were determined in the field using the most recent United States Geological Survey 7.5 minute topographic map of the region. All elevations on these maps are given in feet. Elevations for highest glacial erratics presented in this paper were estimated using elevations of visible reference points marked on the detailed topographic maps. Errors of up to 50 feet are possible.

Results of Study: The top of Square Butte, a laccolithic intrusion located just east of the Highwood Mountains, reaches an elevation of 5684 feet. The highest Laurentide erratics found in the Square Butte area were at an elevation of 4050 feet. Harris Mountain, located on the northwest flank of the Highwood Mountains, is separated from the main Highwood Mountains by a 4300 foot divide known as the Gap. Highest elevations on Harris Mountain, just west of the Gap, are 5083 feet and on Gossack Mountain, just east of the Gap are 5202 feet. Laurentide glacial erratics were found up to an elevation of 4020 feet in the valley of Highwood Creek on the southwest side of Harris Mountain and up to an elevation of 4100 feet, south of the town of Big Sag, on the northeast side of Harris Mountain. The presence of Laurentide erratics on both sides of the Gap and the nature of the landform suggested ice might have crossed the divide. A search was made in the Gap, but no Laurentide erratics could be located.

Analysis of Results: This study investigated two small, but distinct, areas on the north flank of the Highwood Mountains. The highest Laurentide deposits were found at an approximate elevation of 4100 feet. Elevations of the highest Laurentide erratics at both locations are consistent with each other suggesting ice may not have reached higher elevations. The presence of Laurentide erratics on both ends of the Gap, and the form of the divide, do suggest, but do not require, that ice crossed through the Gap. If ice did cross through the Gap, the ice would have exceeded an elevation of 4300 feet. No Laurentide erratics could be found in the Gap to confirm this hypothesis. Additional work is needed to check other areas to determine if Laurentide erratics can be found at elevations higher than 4100 feet.

Presence of Laurentide glacial erratics at elevations up to at least 4100 feet indicates the ice dam was at least 200 to 400 feet higher than previously described. If the elevation of the ice exceeded 4300 feet, as suggested by inconclusive evidence in the Gap area, the ice dam may have been as much as 400 to 600 feet higher than previously described. In either case estimates of the volume of water impounded in Glacial Lake Great Falls need to be significantly revised. Catastrophic failure of the dam impounding Glacial Lake Great Falls released much larger volumes of water than previously recognized.

References:

1. Calhoun, F.H.H. (1906) *U.S. Geol. Surv. Prof. Paper* 50, 62p.
2. Clausen, E. (1989) *Proc. N. D. Acad. Sci.* 43, 40
3. Clausen, E. (1990) *Proc. N. D. Acad. Sci.* 44, 55
4. Alden, W.C. (1932) *U.S. Geol. Surv. Prof. Paper* 174, 133p.

OLIGOCENE LAGOMORPHS OF THE BRULE FORMATION OF NORTH DAKOTA

Diane Wretling *
Department of Earth Science, Minot State University, Minot, ND 58701

In the 1880's, Cope (1) made the first collections of fossils from the Oligocene deposits of North Dakota. These sediments are today included in the White River Group, comprised of the Chadron Formation and the overlying Brule Formation. Stone (2) considered the Chadron Formation to be Chadronian (early Oligocene) and the entire Brule Formation to be Orellan (middle Oligocene); it is his opinion that has been most widely accepted. However, some authors (3,4) have suggested that at least a portion of the Brule Formation is Whitneyan (late Oligocene). Although collections have been made by several workers (3, 5, 6) no detailed analysis of the mammalian fauna has been made. Only the oreodonts (7) and the cricetid rodent *Eumys* (4) have been treated in a systematic way. Further analysis of the mammalian fauna may provide evidence on whether any Whitneyan aged sediments exist in North Dakota, and where the Orellan/Whitneyan boundary should be drawn. Lagomorphs are abundant in collections from the Brule Formation in North Dakota and as such may provide information on this problem.

The specimens in this study are from the collection of Mr. Dean Pearson of Scranton, North Dakota. His locality is in the lower Brule Formation on White Butte in Slope County. This horizon is the same level that Douglass (5) described as bed 6 of his "Middle White River" and it correlates to bed 4A of Skinner (3). This would be within the lower portion of the Dickinson member in the terminology of Stone (2). A total of 35 specimens were examined of which 27 were lower jaws or portions of lower jaws. Because of the greater number and better preservation of lower jaws they formed the basis of this study. As identified in the literature the most important characteristics for identifying Oligocene lagomorphs are tooth morphology, especially the lower third premolar (P/3), the nature of the diastema, the position of the incisive swelling, and tooth size.

A single specimen (CB5-002) has a ramus characteristic of *Megalagus* as described by Wood (8), with a smooth and rounded crest of the diastema and the incisive swelling extending to below the first lower molar (M/1). The P/3 of this specimen has a prominant external reentrant angle which divides the tooth into almost equal columns. It has no internal reentrant angle and the external side in somewhat compressed. These are characteristics which Walker (9) considered diagnostic of the Megalaginae of which the only genus is *Megalagus*. There are three described species of this genus (10) which are distinguishable only by skull characters and relative hypsodonty. Without additional, and more complete material a definitive assignment is not possible, but the specimen can be referred to *Megalagus* sp. cf. *M. turgidus* because of the stratigraphic context.

The remaining 26 specimens are similar to each other, the ramus has a sharp crest along the diastema and the incisive swelling extends posteriorly, ending below the M/2 or M/3. This is indicative of the Paleolaginae (8), of which the only genus is *Paleolagus*. The P/3's can be divided into two types. In one, there is a strong internal and external reentrant angle with a persistant enamel isthmus connecting the trigonid and talonid, this is typical of *Paleolagus haydeni*. The second type has a strong external reentrant angle and a prominent enamel isthmus on the internal side. The specimens with this P/3 style also show a similar enamel connection on the P/4-M/2. Dice and Dice (11) identified this feature as a later wear stage of *Paleolagus haydeni,* and thus, all 26 specimens can be assigned to this species.

Megalagus turgidus has been reported from Orellan faunas of the Great Plains (10) but probably also occurs in the Whitneyan. *Paleolagus haydeni* has a similar stratigraphic and geographic distribution although it may also be present in the Chadronian (10). The presence of these species suggests an Orellan age for the lower Brule Formation at White Butte, but the limited sample available does not answer the question of presence or absence of Whitneyan sediments in the White River Group of North Dakota.

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(2) Stone, W.J. (1972) NDGS Misc. Ser. #50, 123-132.
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(4) Kihm, A. J. (1990) N.D. Acad. Sci. Proc. 44, 69.
(5) Douglass, Earl (1908) Carnegie Mus. Ann. 5, 211-288.
(6) Hoganson, J.W. and Lammers, G.E. (1985) N.D. Acad. Sci. Proc. 39, 15.
(7) Schultz, C.B. and Falkenbach, C. H. (1986) Bull. Amer. Mus. Nat. Hist. 139, 1-498.
(8) Wood, A.E. (1940) Trans. Amer. Phil. Soc. 28(3), 1-362.
(9) Walker, M.V. (1931) Trans Kansas Acad. Sci. 34, 122-124.
(10) Dawson, M.R. (1958) Univ. Kansas Paleo. Contrib., 1-75.
(11) Dice, L.R. and Dice, D.S. (1935) Papers Mich. Acad. Sci. Proc. 20, 455-463.

O B I T U A R Y

Joe K Neel, Sr

12 June, 1915 -- 22 June, 1990

Joe K Neel, Sr, professor emeritus of Biology at the University of North Dakota died at the age of 75 in Grand Forks. Dr Neel was a pioneer in studies of sewage lagoons. He was well known throughout the world as an expert in limnology, the study of lakes. He was the author of many articles on topics such as streams, reservoirs, water pollution, waste treatment and aquatic invertebrates.

Dr Neel received a bachelor's and a Masters degree from the University of Kentucky. He then attended the University of Michigan, receiving a doctorate degree in 1947. He worked for thirteen years with the Water Pollution Control Division of the U S Public Health Service. In 1963 he worked as director of Potamological Institute, University of Louisville. He joined the faculty at the University of North Dakota in 1966, where he served as chairman of the Department of Biology twice, retiring in 1981. He was an active member of the ACADEMY since 1969, becoming an Emeritus member in 1981.

George C Wheeler

1897 - 18 February, 1991

Dr George C Wheeler, an internationally renowned myrmecologist (ant specialist) died in Silver Springs, Florida. Born in Bonham, Texas, Dr Wheeler received his undergraduate training at Rice Institue, Houston. He completed his doctorate at Harvard University and taught at Syracuse University before coming to the University of North Dakota in 1926. He headed the Department of Biology at the University of North Dakota for 37 years. He was president of the ACADEMY in 1933.

The Wheelers published "The Ants of North Dakota" in 1963 and "The Amphibians and Reptiles of North Dakota" in 1966. After leaving UND in 1967, they moved to Reno, Nevada, where they held appointments at the Desert Research Institute of the University of Nevada. There they published "Ants of Deep Canyon" in 1973 and "The Ants of Nevada" in 1986.

The Wheelers moved to San Antonio, Texas, and studied ants on their own, publishing in professional journals. Later they moved to Silver Springs where he was given a courtesy appointment in zoology at the University of Florida. He continued writing for professional journals and he and his wife participate in seminars.

C O N S T I T U T I O N
of the
NORTH DAKOTA ACADEMY of SCIENCE
(Founded 1908, Official State Academy 1959)

ARTICLE I - Name and Purpose

1. This association shall be called the North Dakota Academy of Science.

2. The purpose of this association shall be to promote and conduct scientific research and to diffuse scientific knowledge.

ARTICLE II - Membership

1. Membership in the North Dakota Academy of Science shall be composed of persons active or interested in some field of scientific endeavor. Candidates for membership may be proposed by any active member of the Academy by submitting the candidate's name to the chairman of the Membership Committee for approval. Specific categories of membership shall be defined in the bylaws of the Academy.

2. Annual dues for the various categories of membership shall be determined by the members present at the Annual Meeting.

ARTICLE III - Officers

1. The Officers of the Academy of Science shall be a President, President-Elect, and the Secretary-Treasurer who shall perform the duties usually pertaining to these offices. The President-Elect shall be chosen by ballot at the Annual Meeting and will hold the office for one year and then assume the office of President for one year. The Secretary-Treasurer shall be appointed for a three-year term by the Executive Committee.

2. The Executive Committee, consisting of the above-named officers, the retiring President, and three members-at-large, shall have charge of the ordinary executive duties. The members-at-large shall be elected for a three-year term on a rotating basis.

ARTICLE IV - Meetings

1. There shall be an Annual Meeting each year held at such time and place as the Executive Committee may determine.

2. Special meetings shall be called by the President upon the request of ten percent of the active members. Only matters specified in the call can be transacted at a special meeting.

3. Ten percent of the active members shall constitute a quorum at the Annual Meeting. Special meetings require twenty percent of the active members for a quorum.

ARTICLE V - Miscellaneous

1. In the event of dissolution of the Academy, any remaining assets shall be distributed to organizations organized and operated exclusively for educational and scientific purposes as shall at the time qualify as exempt organizations under Section 501(c) (3) of the Internal Revenue Code of 1954.

2. No substantial part of the activities of the academy shall be the carrying on of propaganda, or otherwise attempting to influence legislation, and the Academy shall not participate in or intervene in, any political campaign on behalf of any candidate for public office.

3. No part of any net earnings shall inure to the benefit of, or be distributable to, Academy members or officers, or other private persons, except that the academy may authorize the payment of reasonable compensation for services rendered.

ARTICLE VI - Amendments

1. This Constitution may be amended at any Annual Meeting of the Academy by a two-thirds vote. Proposed amendments shall be submitted in writing to the Secretary who shall send them to the members at least two weeks before the meeting at which such amendments are to be considered.

2. Bylaws may be adopted or repealed at any regular meeting by a two-thirds vote.

B Y - L A W S
of the
NORTH DAKOTA ACADEMY of SCIENCE

1. The Academy's official guide for parliamentary procedure shall be the "Standard Code of Parliamentary Procedure" by Alice F. Sturgis. (1965 Revision)

2. The annual dues shall be determined by a two-thirds vote at an Annual Meeting. These dues are payable January 1 of each year. (1965 Revision)

3. Members shall be dropped from the active list on December 31 following the nonpayment of dues during the membership year commencing the previous January 1. A member may return to the active e list by paying the current year dues and a membership renewal charge of $5.00. (1975 Revision)

4. Every member in good standing shall receive a copy of the annual Proceedings of the North Dakota Academy of Science. (1965 Revision)

5. Special offices such as Historian may be created by the unanimous vote of the members at the Annual Meeting. (1965 Revision)

6. The Executive Committee shall annually appoint an Academy representative to the National Association of Academies of Science and to Section X (General) of the American Association for the Advancement of Science. (1979 Revision)

7. The Committee structure of the Academy shall be as follows, the President appointing the members and chairpersons for all except the Executive Committee:

   a. Executive Committee
   Membership: Past-President, President, President-Elect, Secretary-Treasurer, three members-at-large. Three-year terms.

   Duties: The Executive Committee shall be the governing board of the Academy, responsible only to the membership. It shall arrange for programs, approve committee appointments, be responsible for the fiscal affairs of the Academy, and transact such business as necessary and desirable for function and growth of the Academy.

   b. Editorial Committee
   Membership: Three members. Three-year terms.

   Duties: The Editorial Committee shall develop and recommend to the Executive Committee the Academy publication program and policies. It will assist the Editor in reviewing manuscripts for the Proceedings.

   c. Education Committee
   Membership: Seven members, two of whom shall be high school teachers. Five-year terms.

Duties: The Education Committee shall work with high school students and teachers in the state, in visitation programs, Science Talent Search programs, and other programs to stimulate an interest in science by the youth of the state. It shall operate the Junior Academy of Science program and administer the AAAS high school research program.

d. Denison Awards Committee
Membership: Six members. Three-year terms.

Duties: The Denison Awards Committee shall have as its prime duty the judging of student research and paper competitions, both undergraduate and graduate, and any other similar competitions. The committee shall also maintain the criteria to be used in the judging and selection of papers, such criteria to be circulated to prospective competitors. (1985 Revision)

e. Necrology Committee
Membership: Three members. Three-year terms.

Duties: The Necrology Committee shall report to the annual meeting on those departed during the preceding year. Obituaries may be included in the minutes of the annual meeting and/or published in the Proceedings.

f. Nomination Committee
Membership: The five most recent past-presidents.

Duties: The Nominating Committee shall propose a slate of at least two nominees for each of the offices as needed. The committee report shall be submitted to the President prior to the annual meeting as well as reported to the membership at the appropriate time for action.

g. Resolution Committee
Membership: Three members. Three-year terms.

Duties: The Committee on Resolutions shall prepare such resolutions of recognition and thanks as appropriate for the annual meeting. Further, the Committee shall receive suggested resolutions for the membership and transmit such resolutions and the Committee recommendation to the membership.

h. Membership Committee
Membership: Unlimited number, appointed annually.

Duties: The Membership Committee shall promote membership in the Academy. It shall conduct an annual canvass of the Institutions of Higher Education, Government Agencies, and other related organizations for the purpose of providing opportunity for prospective members to join the Academy. Further, this Committee shall make recommendations to the Executive Committee of potential candidates for emeritus and honorary memberships.

8. The Nominating Committed shall be responsible for all nominations to elective office and shall be required to advance at least two names for each open position. Academy members shall have been encouraged to suggest nominees to the committee prior to the Committee submitting its report. A ballot, incorporating brief biographical information, shall be distributed by the Secretary-Treasurer to all members prior to the Annual Meeting. Those ballots may be returned by mail, or in person at the Annual Meeting, until the announced deadlines. The results of the election shall be announced at the Annual Meeting.

9. Categories of Membership:
a. Active members shall be persons interested or actively participating in some scientific endeavor. Active members may participate in all activities of the Academy.

b. Student members shall be graduate or undergraduate College students in some field of science. Student members may participate in all activities of the Academy, with the exception of holding office.

c. Sustaining members are persons or organizations interested in the activities of the Academy. Sustaining members may participate in all activities of the Academy, with the exception of voting or holding office. Sustaining members may be of three types: Individual, Corporate, or Institutional. (1965 Revision) This bylaw is implemented by the following action of the Executive Committee (10-25-85):

There shall be two categories of Corporate Sustaining Membership, Patron members and Sponsor members. The annual membership fee shall be $100 for Patron members and $50 for Sponsoring members. Benefits accruing to Corporate Sustaining Members include:

1. Positive public relations through the support of science and technology in North Dakota.
2. Preference in mounting commercial displays at the annual meetings of the Academy.
3. Early access to research results and early awareness of research programs through first hand association with scientists and engineers.
4. Improved commercial opportunities through association with members, institutions, and other sustaining members.
5. Improved future commercial opportunities through exposure to students contemplating careers in science or technology.

Until action is taken otherwise, the Corporate Sustaining Membership fees shall be placed in the North Dakota Science Research Foundation for the support of scientific research.

d. Emeritus Membership. Any member in good standing upon formal retirement is eligible for emeritus membership. Nominations may be forwarded to the Membership Committee by any member, and it shall be the responsibility of the membership committee to review the membership list for possible candidates. The Executive Committee shall approve nominations. Emeritus members shall retain all rights of active members but will be exempt from payment of dues. (1973 Revision)

e. Honorary Membership. The Academy may recognize, by awarding honorary membership, any person (nonmember or member) who has in any way made an outstanding contribution to science. It shall be the responsibility of the Membership Committee to be aware of individuals whom it would be fitting for the Academy to honor in this fashion. Any member may submit nominations along with supporting data to the Membership Committee. Approval of nominations shall be by a two-thirds majority of those attending the annual meeting. (1973 Revision)

10. The President, with the approval of the Executive Committee, shall appoint members to serve on ad hoc committees. Reports of ad hoc committees shall be presented to the Executive Committee or to the annual meeting. Ad hoc committees serve only during the tenure of the president who appointed them. (1965 Revision)

11. The Executive Committee shall appoint an Editor who shall edit the PROCEEDINGS. The Editor shall be appointed for a three-year term. The salary of the Editor shall be set by the Executive Committee. (1975 Revision)

12 The annual dues shall be $12.00 per year for professional members, with $2.00 designated for the North Dakota Science Research Foundation, and $5.00 per year for student members. (1985 Revision)

13. The Executive Committee is empowered to charge a publication fee of authors of up to $10.00 per page. (1965 Revision)

14. All student research participants shall receive a properly inscribed certificate and be invited to the dinner as the guests of the Academy. (1965 Revision)

15. All activities of the Academy, including grant applications, are to be handled through the Academy Offices from now on. (1966 Revision)

16. The Executive Committee of the North Dakota Academy of Science is instructed to establish a J Donald Henderson Memorial Fund and that the Committee administer this fund and that the proceeds from this fund be used to promote science in North Dakota. (1967 Revision)

17. The fiscal year of the North Dakota Academy of Science, for the purpose of financial business, shall be January 1 to December 31. (1973 Revision)

18. The Academy establishes the North Dakota Academy of Science Achievement Award, to be awarded periodically to an Academy member, in recognition of excellence in one or more of the following:
    a. Nationally recognized scientific research.
    b. Science education.
    c. Service to the Academy in advancing its goals.

    The Nominating Committee will administer the selection process, will develop a separate funding source for a monetary award, and will develop, for Executive Committee approval, the criteria for the award. (1988 Revision)

19. The North Dakota Science Research Foundation is established as an operating arm of the Academy. The purposes of the Foundation are to (1) receive funds from grants, gifts, bequests, and contributions from organizations and individuals, and (2) to use the income solely for the making of grants in support of scientific research in the State of North Dakota. Not less than 50% of the eligible monies received shall be placed in an endowment from which only the accrued interest shall be granted.

    The Foundation shall be responsible for soliciting the funds for the purposes described. The Foundation funds shall be in the custody of the Secretary-Treasurer of the Academy and shall be separately accounted for annually.

    The Foundation Board of Directors shall be comprised of five members of the Academy, representing different disciplines. Members shall be appointed by the President for staggered five year terms, and the chairperson of the Board shall be appointed annually by the President. The Board shall be responsible for developing operating procedures, guidelines for proposals, evaluation criteria, granting policies, monitoring procedures, and reporting requirements, all of which shall be submitted to the Executive Committee for ratification before implementation.

    The Foundation shall present a written and oral annual report to the membership of the Academy at each annual meeting, and the Secretary-Treasurer shall present an accompanying financial report.

Revised May 1989

NORTH DAKOTA ACADEMY of SCIENCE
Officers and Committees for 1990-91

EXECUTIVE COMMITTEE

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Minot State University
Minot, ND 58701 857-3160

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USDA Biosciences Research Laboratory
North Dakota State University
Fargo, ND 58105 239-1247

Roy Garvey, Secretary-Treasurer -93
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Fargo, ND 58105

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Grand Forks, ND 58202

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Dennis Disrud -93
Minot State University

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North Dakota State University

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ND Parks & Recreation Department

Forest Nielsen, Chair -94
USDA Human Nutrition Research Center

David Davis -95
USDA- Biosciences Research Lab

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University of North Dakota
Executive Committee Liaison

Om Madhok -92
Minot State University
Science Fair Liaison

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National Science Week

Ron Royer -93
Minot State University
Science Educator Newsletter

Mike Burton -94
Agassiz Jr High School, Fargo
Science Olympiad

Marcia Steinwand -94
Robinson High School

Jerome Knoblick -95
Jamestown College
AAAS Mini-Grant Coordinator
Junior Academy Liason

NORTH DAKOTA ACADEMY of SCIENCE
Officers and Committees for 1990-91

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Dale Zieman Fort Berthold	-92	Robert Crackel Minot State University	-92
Doug Munski University of North Dakota	-93	Daniel Mott Dickinson State University	-93

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Om Madhok Minot State University			

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Gary Clambey North Dakota State University	Vernon Feil USDA- Bioscience Research Laboratory
Myron Freeman Dickinson State University	Carolyn Godfread Bismark
Janet Hunt Human Nutrition Research Center	Charles Turner University of North Dakota
Charles Lura, Chair NDSU - Bottineau	Michael Thompson Minot State University

L O C A L A R R A N G E M E N T S C O M M I T T E E -- M i n o t

Clark Markel, Chair Minot State University	Om Madhok Department of Biology
Eric Clausen Department of Earth Sceince	Michael Thompson Department of Biology

FINANCIAL and MEMBERSHIP STATEMENT 1 January - 31 December 1990

A. BALANCE SHEET

	1989 Item	1989 Total	1990 Item	1990 Total
I. ASSETS				
Operating Accounts				
Checking	611.27		1741.74	
Savings	1625.74		2232.93	
Savings Certificates	5000.00	7237.01	4000.00	7974.67
Trust Accounts				
Scholarship Principal	16505.83		17166.26	
Research Foundation	7159.60	23665.43	8514.57	25680.83
TOTAL ASSETS		30902.44		33655.50
II. LIABILITIES				
December Operations	121.06			
Advanced Dues	1285.00	1406.06	585.00	585.00
Restricted Purpose Funds				
Scholarship Principal	16505.83		17166.26	
AAAS Research Grant			1900.00	
Research Foundation	7159.60		8514.57	
Cash	2008.28	25673.71		27580.83
TOTAL LIABILITIES		27079.77		28165.83
III. ACCUMULATED SURPLUS		3822.67		5489.67
IV. CHANGE in SURPLUS		-1554.12		1667.00

B. OPERATING CASH FLOW

	1989	1990
CASH on HAND 1 January	10213.29	7237.01
CASH RECEIPTS for Year	11851.51	21346.83
TOTAL RESOURCES Available	22064.80	28583.84
CASH DISBURSEMENTS	14827.79	19808.65
CASH BALANCE 31 December	7237.01	8775.19
Increase over Year	-2976.28	1538.18

C. MEMBERSHIP STATEMENT

	Emeritus	Student	Professional	Total
1 January, 1990	58	53	290	401
31 December, 1990	59	61	290	410
Net Change	1	8		9
Dues paid 1/1/91	59	17	57	133

D. OPERATING RECEIPTS

	1989 Item	1989 Total	1990 Item	1990 Total
DUES				
Reinstatements	50.00		90.00	
Current Year	1657.00		2005.00	
Next Year	1285.00	2992.00	585.00	2680.00

SUBSIDIES				
NDSU	1000.00		1000.00	
UND	1000.00		1000.00	
Minot State	200.00	2200.00	200.00	2200.00
ANNUAL MEETING				
Registration Fees	2810.00		2191.00	
Am Chem Soc, Red River VS	300.00		350.00	
Assocn ND Geographers	50.00			
N D Geological Survey	100.00		100.00	
Sigma Xi -- UND	50.00		50.00	
Sigma Xi -- NDSU			150.00	
Sigma Xi -- Minot	50.00			
NDSU Engineering			772.04	
NDSU Coop Sponsorship	100.00	3460.00		3613.04
AWARDS PROGRAM				
AAAS Sec Schl Research Grant			1900.00	
Scholarship Dividends	481.78	481.78	475.20	2375.20
PUBLICATION SALES	123.00	123.00	102.00	102.00
INTEREST on SAVINGS	491.65	491.65	203.34	
SMITS GRANT	2103.08	2103.08	17896.92	17896.92
T O T A L I N C O M E		11851.51		28867.16

E. OPERATING DISBURSEMENTS

	1989		1990	
	Item	Total	Item	Total
ANNUAL MEETING				
Speakers	973.83		1122.07	
Meals	1856.30		1929.39	
General Expenses	733.90	3564.03	876.76	3928.22
AWARDS PROGRAM				
AAAS Sec Schl Research Grants	900.00		700.00	
Dunbar Award	175.00			
Denison Awards	450.00		400.00	
Abbott Scholarships	200.00	1725.00		1100.00
PUBLICATIONS				
Editors Fee	250.00		750.00	
Proceedings	2586.65	2836.65	3133.37	3883.37
MISCELLANEOUS				
Fidelity Bond	26.00		26.00	
AAAS Delagate	1000.00		911.73	
NAAS Dues	42.30	1068.30	41.50	979.23
PROGRAM OPERATIONS				
Junior Academy			350.00	
Committee Travel	55.80	55.80	121.55	471.55
OFFICE EXPENSES				
Postage	403.16		550.56	
Post Office Box Rent	39.00		39.00	
Telephone	6.38			
Duplicating	208.70		208.42	
Supplies	349.01		259.01	
Clerical Staff	170.00		92.50	
Sec Treasurer Fee	1200.00	2376.25	50.00	1199.49
SMITS PROGRAM	3201.75	3201.75	16798.24	16798.24
T O T A L D I S B U R S E M E N T S		14827.78		28360.10

F. SCIENCE RESEARCH FOUNDATION

	1989	1990	CHANGE
Balance 1 January	5909.01	7159.60	1250.59
Donations from Members	296.50	270.00	-26.50
Allocations from Dues	544.00	438.00	-106.00
Organization Memberships	100.00	250.00	150.00
Interest Accrued	310.09	396.97	86.88
Balance 31 December	7159.60	8514.57	1354.97

G. SCHOLARSHIP FUND

		1989	1990
CASH INCOME			
SDGE Dividends		267.50	270.00
PinWest Dividends		214.28	
Iowa Southern Inc			205.20
T O T A L		481.78	475.20
CASH EXPENSE			
Denison Awards		450.00	400.00
Junior Academy Awards			350.00
Dunbar Award		175.00	
Abbott Scholarships		200.00	
Stock Purchase			265.22
T O T A L		825.00	1015.22
N E T I N C O M E		-343.22	-540.02
	1983		
ASSETS			
SDGE Shares	250.00	289.48	302.00
Price	18.50	45.13	43.63
Value	4625.00	13064.23	13176.26
Iowa Southern, Inc Shares			120.00
Price			33.25
Value			3990.00
Money Fund		3441.60	0.00*
Investment Value SubTotal	4625.00	16505.83	17166.26
Operating Account		2008.28	0.00*
T O T A L	4625.00	18514.11	17166.26
CHANGE in TOTAL ASSETS		801.48	-1347.85
INVESTMENT VALUE CHANGE		1144.70	660.43

* Used in purchase of Iowa Southern shares, 6/90 *

Respectfully Submitted

Roy Garvey

Roy Garvey
Secretary-Treasurer

Date: 17-Jan-91

PAST PRESIDENTS
and
Location of the Annual Meeting
of the
NORTH DAKOTA ACADEMY of SCIENCE

1909	M A Brannon	Grand Forks
1910	M A Brannon	Fargo
1911	C B Waldron	Grand Forks
1912	L B McMullen	Fargo
1913	Louis VanEs	Grand Forks
1914	A G Leonard	Fargo
1915	W B Bell	Grand Forks
1916	Lura Perrine	Fargo
1917	A H Taylor	Grand Forks
1918	R C Doneghue	Fargo
1919	H E French	Grand Forks
1920	J W Ince	Fargo
1921	L R Waldron	Grand Forks
1922	Daniel Freeman	Fargo
1923	Norma Preifer	Grand Forks
1924	O A Stevens	Fargo
1925	David R Jenkins	Grand Forks
1926	E S Reynolds	Fargo
1927	Karl H Fussler	Grand Forks
1928	H L Walster	Fargo
1929	G A Talbert	Grand Forks
1930	R M Dolve	Fargo
1931	H E Simpson	Grand Forks
1932	A D Wheedon	Fargo
1933	G C Wheeler	Grand Forks
1934	C I Nelson	Fargo
1935	E A Baird	Grand Forks
1936	L R Waldron	Fargo
1937	J L Hundley	Grand Forks
1938	P J Olson	Fargo
1939	E D Coon	Grand Forks
1940	J R Dice	Fargo
1941	F C Foley	Grand Forks
1942	F W Christensen	Fargo
1943	Neal Weber	Grand Forks
1944	E A Helgeson	Fargo
1945	W H Moran	Grand Forks
1946	J A Longwell	Fargo
1947	A M Cooley	Grand Forks
1948	R H Harris	Fargo
1949	R B Witmer	Grand Forks
1950	R E Dunbar	Fargo
1951	A K Saiki	Grand Forks
1952	Glenn Smith	Fargo
1953	Wilson Laird	Grand Forks
1954	C O Clagett	Fargo
1955	G A Abbott	Grand Forks
1956	H B Hart	Jamestown
1957	W E Cornatzer	Grand Forks
1958	W C Whitman	Fargo
1959	Arthur W Koth	Minot
1960	H J Klosterman	Fargo
1961	Vera Facey	Grand Forks
1962	J F Cassel	Fargo
1963	C A Wardner	Grand Forks
1964	Fred H Sands	Fargo
1965	P B Kannowski	Grand Forks
1966	Paul C Sandal	Fargo
1967	F D Holland, Jr	Grand Forks
1968	W E Dinusson	Fargo
1969	Paul D Leiby	Minot
1970	Roland G Severson	Grand Forks
1971	Robert L Burgess	Fargo
1972	John C Thompson	Dickinson
1973	John C Reid	Grand Forks
1974	Richard L Kiesling	Fargo
1975	Arthur W DaFoe	Valley City
1976	Donald R Scoby	Fargo
1977	Om P Madhok	Minot
1978	James A Stewart	Grand Forks
1979	Jerome M Knoblich	Aberdeen, SD
1980	Duane O Erickson	Fargo
1981	Robert G Todd	Dickinson
1982	Eric N Clausen	Bismark
1983	Virgil I Stenberg	Grand Forks
1984	Gary Clambey	Fargo
1985	Michael Thompson	Minot
1986	Elliot Shubert	Grand Forks
1987	William Barker	Fargo
1988	Bonnie Heidel	Bismark
1989	Forrest Nielsen	Grand Forks
1990	David Davis	Fargo
1991	Clark Markell	Minot

E M E R I T U S

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CALLENBACH, John A	North Dakota State University	FARGO	ND	58105
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CASSEL, J Frank	U S Air Force Academy	COLORADO SPRINGS	CO	80840
CORNATZER, William E	2033 North Washington Street	BISMARCK	ND	58501
DAFOE, Arthur W	515 Third Street North East	VALLEY CITY	ND	58072
DEBOER, Benjamin	312 Alpha Avenue	GRAND FORKS	ND	58203
DINGA, Gustav P	Concordia College	MOORHEAD	MN	56560
EDGERLY, Charles G M	1317 Eighth Avenue South	FARGO	ND	58103
FISK, Allen L	1122 Avenue B West	BISMARCK	ND	58501
FOSSUM, Guilford O	1828 Cottonwood Street	GRAND FORKS	ND	58201
FRANK, Richard E	1010 Boyd Drive	GRAND FORKS	ND	58203
HOEPPNER, Jerome J	2518 Nineth Avenue North	GRAND FORKS	ND	58203
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HOLLAND, Jean H	4686 Belmont Road	GRAND FORKS	ND	58201
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KOENKER, William E	Whippoorwill Lane	CHAPEL HILL	NC	27514
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LOW, Frank N	2511 Saint Charles Avenue	NEW ORLEANS	LA	70130
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MELDRUM, Alan	512 Columbia Road	GRAND FORKS	ND	58203
MCMAHON, Kenneth J	North Dakota State University	FARGO	ND	58105
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SCOBY, Donlad R	North Dakota State University	FARGO	ND	58105
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SUMMERS, Lawrence	University of North Dakota	GRAND FORKS	ND	58202
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BATES, Mark B	Apt 301	FARGO	ND	58103
BROSSART, Beth	314 Third Avenue South East	EAST GRAND FORKS	MN	56721
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CURTISS, Gene C, Jr	1121 Fifth Avenue South West	MINOT	ND	58701
CURTISS, Randy	Apartment 4	GRAND FORKS	ND	58201
DEES, Bonnie A	Rural Route 1 Box 430	GARRISON	ND	58540
DELBORGO ADAMS, Ann M	3625 East Burdick Expressway #2	MINOT	ND	58701
DORMANEN, Dean L	809 Third Street North	FARGO	ND	58102
DWIGHT, Wesley J	Apartment 15	FARGO	ND	58102
EICHHORST, Jean	570 Carleton Court # 102	GRAND FORKS	ND	58203
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ELLIOT, Mark	University of North Dakota	GRAND FORKS	ND	58202
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FROELICH, Stacie J	University of North Dakota	GRAND FORKS	ND	58202
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HAUG, William O, Jr	235 Northridge Hills Court	GRAND FORKS	ND	58201
HENJUM, Dan	2521 Villa Drive # 105	FARGO	ND	58103
HOGANSON, Shelly	722 Belmont Road	GRAND FORKS	ND	58201
HOPKINS, Charles	1917 Nineth Street North West	MINOT	ND	58701
JUDKINS, Wayne	10 Country Acres Trailer Court	MINOT	ND	58701
KANE, Ronald M	1017 Eleventh Avenue N W	MINOT	ND	58701
KIM, Tahnee M	525 Park Street # 5	MINOT	ND	58701
KOHL, Clint	540 Carleton Court # 204	GRAND FORKS	ND	58203
KOTTSICK, Kori V	Minot State University	MINOT	ND	58701
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KUSTERS, Hans C	Apartment 204	GRAND FORKS	ND	58203
LEADBETTER, Larry	717 Princeton Park	GRAND FORKS	ND	58203
LEADBETTER, Mary	717 Princeton Park	GRAND FORKS	ND	58203
LEWIS, Terry	317 Twenty Fourth Avenue North	FARGO	ND	58102
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MEINKE, Troy	North Dakota State University	FARGO	ND	58105
MOK, Teck S	110 State Street Number 14	GRAND FORKS	ND	58201
MORLEY, James A	Apartment # 6	GRAND FORKS	ND	58203
MUDDERMAN, Dennis	University Station	GRAND FORKS	ND	58202
MUNSKI, Laura	University of North Dakota	GRAND FORKS	ND	58202
MCGILLIVRAY, Gerald	15 University Avenue East	MINOT	ND	58701
NICHOLAS, Joseph W	University of Georgia	ATHENS	GA	30602
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PLUM, Lori A	290 F Court	FARGO	ND	58102
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S T U D E N T S

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PROFESSIONAL

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BALSBAUGH, Edward	North Dakota State University	FARGO	ND	58105
BALTISBERGER, Richard	University of North Dakota	GRAND FORKS	ND	58202
BARBER, Roberta	University of North Dakota	GRAND FORKS	ND	58202
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BERRYHILL, David L	North Dakota State University	FARGO	ND	58105
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BLUEMLE, John P	University of North Dakota	GRAND FORKS	ND	58202
BOBILYA, Dennis J	Human Nutrition Research Center	GRAND FORKS	ND	58202
BODE, Ann M	University of North Dakota	GRAND FORKS	ND	58202
BOLONCHUK, Willaim W	University of North Dakota	GRAND FORKS	ND	58202
BRAUNER, John F	Jamestown College	JAMESTOWN	ND	58401
BREKKE, David	University of North Dakota	GRAND FORKS	ND	58202
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CLAUSEN, Eric N	Minot State University	MINOT	ND	58702
COLE, Duane	University of North Dakota	GRAND FORKS	ND	58202
COLLINS, Charles C	North Dakota State University	FARGO	ND	58105
CONNELL, Marvin D	2606 Fifth Avenue North	GRAND FORKS	ND	58203
COWARDIN, Lewis M	310 Sixteenth Avenue North East	JAMESTOWN	ND	58401
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ERICKSON, Duane	North Dakota State University	FARGO	ND	58105
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FORSMAN, Nels	University of North Dakota	GRAND FORKS	ND	58202
FRANCKOWIAK, Jerome D	North Dakota State University	FARGO	ND	58105
FREEMAN, Myron L	Dickinson State University	DICKINSON	ND	58601
FUNKE, B R	North Dakota State University	FARGO	ND	58105
GABRIELSON, David A	North Dakota State University	FARGO	ND	58105
GABRIELSON, Vicki J	North Dakota State University	FARGO	ND	58105
GARVEY, Roy	North Dakota State University	FARGO	ND	58105
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GOOS, Robert J	North Dakota State University	FARGO	ND	58105
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GREENWALD, Stephen M	101 East College Street	VALLEY CITY	ND	58072
GROENEWOLD, Gerald	University of North Dakota	GRAND FORKS	ND	58202
GROTH, Larry	U N D Lake Region	DEVILS LAKE	ND	58301
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HASSETT, Debra	University of North Dakota	GRAND FORKS	ND	58202
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HOLLOWAY, Harry	University of North Dakota	GRAND FORKS	ND	58202
HOWELL,	University of North Dakota	GRAND FORKS	ND	58202
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JOHNSON, William T	Human Nutrition Research Center	GRAND FORKS	ND	58202
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JUHL, Nylah	University of North Dakota	GRAND FORKS	ND	58202
KANNOWSKI, Paul B	University of North Dakota	GRAND FORKS	ND	58202
KANTRUD, Harold A	Route 7	JAMESTOWN	ND	58401
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KELLEHLER, James J	University of North Dakota	GRAND FORKS	ND	58202
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KNOBLICH, Jerome	233 Fourteenth Avenue North East	JAMESTOWN	ND	58401
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KNULL, Harvey	University of North Dakota	GRAND FORKS	ND	58202
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KRAFT, Donlad J	Bemidji State University	BEMIDJI	MN	56601
KRAUSE, Daniel J	North Dakota State University	FARGO	ND	58105
KRESS, Warren D	North Dakota State University	FAGRO	ND	58105
KRUGER, Robert M	Mayville State University	MAYVILLE	ND	58257
KRUPINSKY, Joseph M	Agriculture Research Service	MANDAN	ND	58554
KUIPERS, Gilbert	Valley City State University	VALLEY CITY	ND	58072
KUMAR, Girish	University of North Dakota	GRAND FORKS	ND	58202
LAMBETH, David O	1909 Twentieth Avenue South	GRAND FORKS	ND	58201
LARSON, Linda	University of North Dakota	GRAND FORKS	ND	58202
LARSON, Omer R	University of North Dakota	GRAND FORKS	ND	58202
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LIPP, William V	3024 North Tenth Street # 19	FARGO	ND	58102
LOBDELL, Frederick	University of Wisconsin	OSHKOSH	WI	54901
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LONG, William M	University of North Dakota	GRAND FORKS	ND	58202
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LUKASKI, Henry C	Human Nutrition Research Center	GRAND FORKS	ND	58202
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MADHOK, Om P	Minot State University	MINOT	ND	58702
MANSKE, Llewellyn	North Dakota State University	FARGO	ND	58105
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MATTHIES, Donald	University of North Dakota	GRAND FORKS	ND	58202
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OWENS, Thomas	University of North Dakota	GRAND FORKS	ND	58202
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Citations refer to page numbers in this volume of the PROCEEDINGS. Those page numbers followed with an asterisk * are those communications where the author made the oral presentation at the Academy meeting.

THE OFFICIAL STATE ACADEMY 1958

(Founded December 1908)

PROGRAM

Eighty-Third Annual Meeting

25 - 26 APRIL, 1991

INTERNATIONAL INN
Minot

O U T L I N E o f M E E T I N G

Thursday, 25 April

12:00- 6:00 pm	Registration	
1:20- 4:40 pm	Geo - Data Processing	(SYMPOSIUM)
1:20- 2:40 pm	A Roger Denison Competition	(Graduate Papers)
1:20- 4:40 pm	A Roger Denison Competition	(Undergraduate Papers)
3:20- 5:00 pm	Nutrition	(Contributed Papers)
3:20- 5:00 pm	Perspective	(Contributed Papers)
6:00- 7:00 pm	No Host Social Hour	
7:00- 8:30 pm	Academy Banquet	
8:30 pm	Academy Lecture	

Friday, 26 April

7:30-11:40 am	Registration	
8:00-11:20 am	From Human Genome to Protein Engineering	(SYMPOSIUM)
8:00-11:40 am	Junior Academy of Science	
8:00- 9:00 am	Biological Sciences	(Contributed Papers)
9:00- 9:40 am	Problem Solving	(Contributed Papers)
10:00-11:40 am	Material and Biosciences	(Contributed Papers)
11:45- 1:15	Business meeting and Luncheon	(**Free to members** with pre-registeration)
1:30- 3:40 pm	Science Teaching in the Higher Education Environment	(SYMPOSIUM)
2:30- pm	Executive Committee Meeting	(**New Officers**)

GENERAL INFORMATION

Meeting Location: All meeting activities will occur at the International Inn in Minot.

Parking: Parking will be available on site.

Registration: The registration desk will be open between 12:00 and 6:00 pm on Thursday, 25 April, and from 7:30 to 11:40 am on Friday, 26 April.

Business Meeting: The annual business meeting will occur during the no charge to members luncheon, Friday at 11:45 am.

Breaks: Breaks are scheduled for Thursday (3:00 pm) and Friday (9:40 am). Refreshments will be served at no cost to all attending the meeting.

Social Hour: The social hour is scheduled from 6:00 to 7:00 pm, Thursday Refreshments will be served at no cost to those attending.

Banquet: The annual Academy Banquet will be held starting at 7:00 pm on Thursday evening. Awards will be presented immediately following the dinner and before the Academy Lecture. Advance ticket purchase is required, preferably through the pre-registration form enclosed with the meeting materials.

Luncheon: A free luncheon is provided to members of the Academy on Friday at 11:45 am. It is held in conjunction with the annual business meeting of the Academy. Pre-registration is required.

Hotels/Motels: A list of area motels can be found in the "The Magic of Minot City Map" included with these meeting materials. Reservations should be made directly with the hotel/motel of your choice, using the telephone numbers provided on the list or by returning the "Reservation card" included with these meeting materials. Registrants are urged to act promptly as there are many competing activities in Minot this week and weekend.

Tours: Dr Gordon Berkey will lead a tour entitled "Early Morning Bird Walk" from 6 to 8 am Friday, 26 April. Meet in the lobby of the International Inn. Transportation will be provided.

Voting: Ballot boxes will close at 10:30 am on Friday. Results of the election will be announced at the Business Luncheon. Members may vote by mail or in person, using their mail ballot.

T O U R

The Local Arrangements Committee has provided a tour to an area point of interest for those attending the meeting.

Dr Gordon Berkey will lead a tour entitled:

"Early Morning Bird Walk"

from 6 to 8 am Friday, 26 April

Meet in the lobby of the International Inn.

Transportation will be provided.

Thursday, 25 April

Registration: 12:00 - 6:00 pm, Lobby of International Inn

GEO - DATA PROCESSING (Symposium)

Presiding: Jack Hammen, Grand Forks. Room: Executive

1:00 pm Analytical Capabilities of a Geographic Information System
Jack Hammen*, Department of Geography, UND, Grand Forks

1:30 pm Optimization Classing: A Method of Mitigating Inacuracy in Computer Mapping and Geographic Information Systems
Mohammad Hemmasi*, Department of Geography, UND, Grand Forks

2:00 pm Oil and Gas Field Mapping in North Dakota
Lynne Ridl*, Bureau Land Management, Dickinson, ND

2:30 pm On the Issue of Interagency Standards in Geographic Information Systems
M G Ulmer*, USDA Soil Conservation Service, Bismark, ND

3:00 pm B R E A K

3:20 pm Spectral Mixing Models for Quantitative Surface Mapping
Grady Blount*, Department of Space Studies, UND, Grand Forks

3:50 pm The Determination of Above-Ground Biomass Through the Use of Multispectral Analysis
Paul E Nyren* and Bob D Patton
Central Grasslands Research Center, Streeter, ND

4:20 pm Geo-Processing for Geophysical Research
Will Gosnold*, Department of Geology, UND, Grand Forks

A RODGER DENISON COMPETITION (Graduate)

Presiding: Room: Minot

1:20 pm Host Specialization in Cochliobolus Sativus, a Fungus Causing Root Rot of Wheat and Barley. Ronald Koech* and R W Stack, NDSU, Fargo.

1:40 pm Response of Chronically and Acutely Ovariectomized Gilts to Gonadotropin Releasing Hormone (GnRH). K Plaine*, S Moench, R M Weigl and J E Tilton, NDSU, Fargo.

2:00 pm Spectroscopy and Photochemical Studies of Citrate Complexes of Iron(III). Ahmad B Rezvani*, J George Brushmiller, Harmon B Abrahamson, UND, Grand Forks.

2:20 pm The use of Magnetite as a Catalyst for the Chemical Vapor Deposition of Carbon on Carbon Fibers. R E Zielinski* and D T Grow, UND, Grand Forks.

A RODGER DENISON COMPETITION (Undergraduate)
Presiding: Room: Candlelite

1:20 pm Wind Energy Convergent System. J Bahr*, C Foo, B Johnson, W Lui, NDSU, Fargo.

1:40 pm Deprotonization of Acetic Acid. Gene Curtiss*, MSU, Minot and Mark Gordon, NDSU, Fargo.

2:00 pm Chemical Composition of Alfalfa and Leafy Spurge at Four Phenological Stages of Growth. D Fox*, D Kirby, J Caton and R Lym, NDSU, Fargo.

2:20 pm Residential Water Preheater Using a Savonius Wind Turbine. S Crane, D Hanson*, T Martinson, T Petrick, NDSU, Fargo.

2:40 pm Chemical and Physical Detection of Fingerprints. JeNell Pederson* and Gergory D Gillispie, NDSU, Fargo.

3:00 pm * * * B R E A K * * *

3:20 pm Identification of the Reaction Products Formed from ^{14}C-Sulfamethazinediazonium Tetrafluoroborate and Bovine Serum Albumin. L A Plum*, G D Paulson and V J Feil, USDA/BRL, Fargo.

3:40 pm Fractal Dimension Analysis of Fly Ash Development from Coal Combustion. W M Vossen* and D K Ludlow, UND, Grand Forks.

4:00 pm Height of the Laurentide Icesheet Along North Flank of Highwood Mountains: Montana. Sandra K Washek* and Eric Clausen, MSU, Minot.

4:20 pm Oligocene Lagomorphs of the Brule Formation of North Dakota. Diane Wretling*, MSU, Minot.

PERSPECTIVES (Contributed Papers)
Presiding: Dale Howard Room: Minot

3:20 pm Personnel Supply and Demand in the Clinical Laboratory: A North Dakota Perspective. Rose Morgan, MSU, Rebecca Hill*, St Joseph Hospital, and Delores Wood, Trinity Medical Center, Minot.

3:40 pm Implementation of NSF Instrumentation and Laboratory Improvement Grant at the University of North Dakota Department of Chemical Engineering. Douglas K Ludlow*, John Erjavec and Dana T Grow, UND, Grand Forks.

4:00 pm AIDS and Drugs: A Study of Minot State University Freshmen Rose Morgan* and Garnet Cox, MSU, Minot.

4:20 pm As Assessment of Undergraduate Place Name Knowledge Concerning the Middle East and North Africa. D C Munski*, UND, Grand Forks

4:40 pm A Pilot Study of Undergraduate General Knowledge in Geography at the University of North Dakota. L B Munski*, J Williams and D C Munski, UND, Grand Forks.

NUTRITION (Contributed Papers)

Presiding: William Siders Room: Maple Leaf - International

3:20 pm The Effects of Dietary Boron, Vitamin D_3, and their Interaction on Glycolytic Metabolites in Chicks. Karen D Muessig*, UND, and Curtiss D Hunt, USDA/ARS/HNRC, Grand Forks.

3:40 pm Minimization of Trihalomethane Formation in Drinking Water. Shahin Rezani* and Eng Seng Lim, UND, Grand Forks.

4:00 pm The Modification of Rat bone Mineral Composition by Changes in Dietary Arginine, Methionine, Boron and Potassium. T R Shuler* and F H Nielsen, USDA/ARS/HNRC, Grand Forks.

4:20 pm The Frequency Distribution of Somatotype in a Sample. W A Siders*, H C Lukaski, W W Bolonchuk and C B Hall, USDA/ARS/HNRC, Grand Forks.

4:40 pm Possible Evidence of Scurvy in a Prehistoric Skeleton from the Northeastern Plains. J A Williams*, UND, Grand Forks.

T h u r s d a y E v e n i n g A N N U A L B A N Q U E T

6:00 pm No - Host Social Hour Pool Area

7:00 pm Annual Banquet of the Academy Norse - Viking Room

8:00 pm Awards Presentations

8:30 pm Academy Lecture Norse - Viking Room

A C A D E M Y L E C T U R E

Science and the Media Ask: What Killed the Dinosaurs?

by

Richard A KERR

Science Writer
Research News Section
SCIENCE

Dr Kerr has covered the Cretaceous-Tertiary extinction controversy for ten years for SCIENCE while writing almost 400 stories covering the breadth of the earth and planetary sciencs including earthquake prediction, staratospheric ozone, greenhouse warming, weather forcasting, El Nino, and planetary rings.

Friday, 26 April

Registration: 7:30 - 11:40 am Lobby of International Inn

FROM the HUMAN GENOME to PROTEIN ENGINEERING (Symposium)

Presiding: Kevin D Young, Grand Forks Room: Executive Room

8:00 am Techniques and Applications of Human Genomic Mapping
Kevin D Young*, UND School of Medicine, Grand Forks, ND

8:45 am Computer Aided Manipulation of Gene and Protein Sequence Data
Dianne Kube*, UND School of Medicine, Grand Forks, ND

9:40 am B R E A K

10:00 am Analysis of Two Major Applications in Protein Engineering
Charles S Craik*, University of California, San Francisco, CA
(Video tape presentation)

NORTH DAKOTA JUNIOR ACADEMY of SCIENCE

Presiding: Jerome Knoblich, Jamestown Room: Candlelite

8:00 am Introduction

8:30 - 11:40 am High School Student competition papers. A separate schedule will be available at the registration desk.

BIOLOGICAL SCIENCES (Contributed Papers)

Presiding: Donna Bruns Stockrahm Room: Maple Leaf - International

8:00 am Aging Black-Tailed Prairie Dogs from North Dakota by Eye Lens Weight. Donna M Bruns Stockrahm and Bobbi Jo Dickerson*, MSU, Moorhead, MN, and Robert W Seabloom, UND, Grand Forks.

8:20 am Titanoides Primaevus, the First Described Paleocene Mammal from North Dakota. Allen J Kihm, MSU, Minot, and Joseph H Hartman, EERC/UND, Grand Forks.

8:40 am The Vascular Flora of Eddy, Foster and Wells Counties, North Dakota. T T Meinke* and W T Barker, NDSU, Fargo.

9:00 am Evaluation of Chemical and Cultural Practices for Control of Fusarium Root Rot in Spruce. John van Ells* and Robert W Stack, NDSU, Fargo and Bottineau.

9:20 am A Preservative Solution to Replace Formaldehyde in Bottled Specimens of Plants and Fungi. R W Stack*, NDSU, Fargo

MATERIAL and BIOSCIENCES (Contributed Papers)

Presiding: David Davis Room: Maple Leaf - International

10:00 am Frequency Dependent Characteristics of Fatty Acid Films on Silicon. Md Shah Alam*, NDSU, Fargo, Spencer L Buckner and V K Agarwal, MSU, Moorhead, MN.

10:20 am Metabolism of Metribuzin in Somaclonal Variants of Tomato. K Breiland*, D G Davis, H R Swanson, D S Frear and G Secor, USDA/ARS/BRL and NDSU, Fargo.

10:40 am Isolation and Characterization of Agrobacterium Tunefaciens from beta Vulgaris for Enhanced Transformation of Sugarbeet. J D Eide*, G A Smith and C A Wozniak, USDA/ARS/NCSL, Fargo.

11:00 am Characterization and Pathogenicity of Rhizoctonia from Soybean Berlin Nelson* and Ilhan Kural, NDSU, Fargo.

11:20 am Detection of an Immunorelated Peptide in Cultured Tissues of Higher Plant Species. C A Wozniak*, USDA/ARS/NCSL, Fargo.

BUSINESS MEETING and MEMBER's LUNCHEON

Presiding: Clark Markell, President Room: Norse

11:45 am

Reports

Secretary	--	Roy Garvey
Education Committee	--	James Waller
Denison Award Committee	--	John Brauner
Editorial Committee	--	Claude Schmidt
Necrology	--	Benjamin DeBoer
Treasurer	--	Roy Garvey
Science Research Foundation	--	Virgil Carmichael
North Dakota Space Grant Program	--	Wood / Wyckoff

New Business

Resolutions

SCIENCE TEACHING in the HIGHER EDUCATION ENVIRONMENT (Symposium)

Presiding: Clark Markell, Minot Room: Executive

1:30 pm Microscale Organic Experiments in the Undergraduate Curriculum
J M Knoblich*, Department of Chemistry, Jamestown College

1:50 pm Computer-Driven Laser-Videodisc Imagery in Planetary Geology
DeWayne Martin*, Division of Science, Minot State University

2:10 pm Biogeochemical Cycles: One Approach to Multidisciplinary Science
Clark Markell*, Division of Science, Minot State University

2:30 pm Biogeochemical Cycles: Representative Results from Science Teacher Research Projects
Robert Crackel*, Division of Science, Minot State University

2:50 pm B R E A K

3:10 pm Writing to Learn in General Education Geology Courses
Eric N Clausen*, Division of Science, Minot State University

3:30 pm Build a Better Mousetrap and . . . . .
Michael B Thompson*, Division of Science, Minot State University
Paul J DeWaal Malefyt, Surrey High School, Surrey, ND

THE NORTH DAKOTA ACADEMY OF SCIENCE
P.O. Box 5567, University Station, Fargo, ND 58105

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Glen Statler, Fargo (- 93)

To Be Elected 26 April, 1991

President-Elect (To become President 1992 - 1993)

Member of Executive Committee (1991 - 1994)

NEW EXECUTIVE COMMITTEE MEETING

2:30 Friday, 26 April

Minot Room

ORGANIZED 1908 -- STATE ACADEMY 1958

THE NORTH DAKOTA ACADEMY OF SCIENCE

P.O. Box 5567, University Station, Fargo, ND 58105

S U S T A I N I N G M E M B E R S

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This annual meeting of the Academy is supported by gifts from the following Societies and Organiations:

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University of North Dakota

The ACADEMY gratefully acknowledges the financial support provided by the sustaining members listed above, which significantly supports the ACADEMY's programs of science research and education.

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