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80th ANNUAL MEETING

April 28-30, 1988

Bismarck, North Dakota

(Joint Meeting with South Dakota Academy of Science)

Editor's Notes

The Proceedings of the North Dakota Academy of Science was first published in 1948, with Volume I reporting the business and scientific papers presented to the fortieth annual meeting, May 2 and 3, 1947. Through Volume XXI, the single yearly issue of the Proceedings included both Abstracts and Full Papers. Commencing with Volume XXII the Proceedings were published in two Parts. Part I, published before the annual meeting, contained an Abstract of each paper to be presented at the annual meeting. Part II, published later, contained full papers by some of the authors.

Commencing in 1979 with Volume XXXIII of the Proceedings of the North Dakota Academy of Science, a new format appeared. The Proceedings changed to an 8½ x 11 format, it is produced from camera-ready copy, and it is issued in a single part prior to the annual meeting (*i.e.* in mid-April). Each presentation at the annual meeting is represented by a full page "Communication" which is more than an abstract, but less than a full paper. The communications contain 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 80th Annual Meeting of the North Dakota Academy of Science is a joint, integrated meeting with the South Dakota Academy of Science. While the program is joint, it was agreed that each Academy would publish its own Proceedings in order to maintain continuity of publication. Thus, this Proceedings includes only those student papers and professional papers emanating from North Dakota, but also all symposia papers.

The first section of this volume of the Proceedings contains all 25 papers presented in the four symposia at the 1988 annual meeting of the Academy. The papers are presented in the same sequence as presented at the meeting, and are numbered as they appeared in the meeting program.

The second section of this volume of the Proceedings contains 40 of the 91 communications presented in the Professional section of the 1988 annual meeting of the Academy. 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 numbered in the sequence in which they appear in the meeting program.

The third section of this volume contains 14 collegiate communications, representing all those papers presented in the A. Rodger 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 the student competitors were required to prepare a communication similar to those prepared by their professional counterparts, these communications were not subject to review prior to publication herein. The Denison Awards Committee judged the oral presentation and the communication in arriving at their decision for the first place and runner-up awards in both the graduate and undergraduate competition. The collegiate communications are numbered in the sequence in which they appear in the meeting program.

Readers may locate papers by presentation number within the major sections of these Proceedings or by referring to the author index in this volume for a page reference.

This issue of the Proceedings includes copies of the constitution and bylaws of the Academy, and lists of the officers, committee membership, and the entire membership.

A. William Johnson
Editor

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NORTH DAKOTA ACADEMY OF SCIENCE

I. Rules for Preparation of Proceedings Communication

1. Each paper presented at the annual meeting of the Academy must be represented by a communication in the Proceedings, including A. Rodger Denison student research competition papers.
2. Only communications intended for presentation at the annual meeting will be considered for publication. They must present original research in as concise a form as possible. Quantitative data should be presented with statistical analysis (i.e., means with standard errors). Papers which merely summarize conclusions or ideas without supporting data are discouraged and will not normally be accepted. The communication should include the purpose of the research, the methodology, results, and conclusions.
3. **Authors are encouraged to utilize the full space available in order to provide sufficient information to fully describe the research reported.**
4. Communications must be prepared on the special blue-line form and sent, with three legible xerox copies, by first class mail to the Secretary, North Dakota Academy of Science, Box 8123 University Station, Grand Forks, ND 58202. The form must not be folded; a cardboard backing should be used to avoid damage. The Proceedings will be published by direct photo-offset of the submitted communication. No proofs will be prepared.
5. All typing, drawing and secured art or photographic materials must be within the boundaries of the blue-line form. Consult the example on the reverse side of the special form for proper style (i.e., titles, authors, address, tables, figures, references, indentations, headings, and punctuation). *Indicate the author to present the communication by an asterisk (*) after that person's name.*
6. Tables, diagrams, and photographs are acceptable provided they are secured to the special form and do not occupy a total area of more than 100 square centimeters.
7. Only essential references should be cited, and should be indicated in the text by numerals and quoted at the end of the communication. Up to three authors' names may be cited in full; with four or more authors only the first should be cited. The following form of citation should be used:

   Journals: Neary, D., Thurston, H. and Pohl, J.E.F. (1973) Proc. N.D. Acad. Sci. 40, 83. (Abbreviate titles.)

   Books: Batsone, G.F., Blair, A.W. and Slater, J.M. (1971) A Handbook of Pre-natal Paediatrics, pp. 83-90. Medical and Technical Publishing, Lancaster.

   Individual chapters in books: Farah, A.E. and Moe, G.K. (1970) in The Pharmacological Basis of Therapeutics, 4th edition (Goodman, L.S. and Gilman, A., eds.), pp. 677-708. Macmillan, New York.

   Conferences and symposia: Rajewsky, M.F. (1973) Abstr. 2nd Meeting European Association for Cancer Research, Heidelberg, Oct. 2-5, pp. 164-5.

8. Use a typewriter with elite type and with a carbon or good quality black silk ribbon. Single space and begin paragraphs with a 3 space indentation. Special symbols, not on the typewriter, must be hand lettered in black ink. Dot matrix type is not acceptable.
9. Abbreviations: Only standard abbreviations should be used, and should be written out the first time used with the abbreviation following in parentheses.
10. Titles: 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 as 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.
11. Session Assignment: In order 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.
12. 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.

II. 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 on the details of methods and procedures.
2. Academy members represent a variety of scientific disciplines; therefore, speakers should avoid "jargon" and briefly explain or define such specialized terminology as may be judged to be indispensable to the presentation.
3. Projectors for 2" x 2" slides only will be available in all session rooms. Opaque projectors will NOT be provided. Only slides which can be read easily on projection should be used. Authors who desire suggestions for preparation of slides are referred to Smith, Henry W. 1957. "Presenting information with 2 x 2 slides." Agron. J. 49. pp. 109-113.
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.

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on

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               Bismarck, ND

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               George M. Vandel III
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               SD Department of Game, Fish and Parks
               Pierre, SD

(1)   THE ENDANGERED SPECIES ACT: A MANDATE AND MECHANISM FOR PROTECTION

Mark P. Dryer,* Fish and Wildlife Biologist
U.S. Fish and Wildlife Service
Bismarck, North Dakota

Concern for endangered species in the United States was evident as early as 1903 when the first Federal Wildlife Refuge was established to protect and preserve the rare brown pelican. Growing support for the protection of endangered species culminated with passage of the Endangered Species Act in 1973. With changes made in 1978 and 1982, it remains in force today. New amendments are expected when the Act is up for reauthorization in 1988.

The purposes of the Act are to: (1) provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, (2) provide a program for the conservation of such endangered and threatened species, and (3) achieve the purposes of the treaties and conventions set forth in the Act. The U.S. Fish and Wildlife Service goals in meeting these purposes are to (1) list as endangered or threatened all species qualifying under existing authorities, (2) provide protection for listed species and assist Federal agencies in insuring that the proposed actions do not jeopardize the continued existence of listed species or destroy or adversely modify critical habitats, and (3) effect the recovery of endangered species and remove from the list when their future well being is reasonably secure.

Few environmental laws have been more misunderstood than the Endangered Species Act. When Congress inacted it, the goal of the law was to prevent the extinction of rare animals and plants. Over the years, many people have developed the misconception that the Act is the only law of the land and was designed to stop all Federal projects. Actually the Endangered Species Act is a "people" act designed to ensure the continuation of rare species for the benefit of the American people.

(2)   RARE FISH IN THE UPPER MISSOURI RIVER BASIN

Charles R. Berry, Jr.*
U.S. Fish and Wildlife Service and
Department of Fish and Wildlife
South Dakota State University
Brookings, South Dakota

Three fish are recognized as rare by most states in the Missouri River basin. The pallid sturgeon (Scaphirhynchus albus) is a member of a primative group of fish that have cartilagenous rather than bony skeletons, and bony plates in the skin rather than scales Weight and length can exceed 27 kg and 2 m. It has a flattened, shovel-shaped snout and long slender tail. The toothless, protrusible mouth with 4 barbels is under and far behind the nose. The fish is similar in appearance to the common shovelnose sturgeon (S. platorynchus). They feed on insects and small fish, and require large, turbid, free-flowing rivers, especially preferring pools below sand bars. Reproduction is believed to occur in the spring but little is known about the biology of the pallid sturgeon. Only one or two specimens are reported per year by commercial fishermen, anglers, or fishery biologists working on the Missouri River.

The sturgeon chub (Hybopsis gelida) reaches a maximum size of about 7.5 cm. Little is known about the biology of the fish because it has never been collected in large numbers. It is found in the main stem of the free-flowing Missouri River, and in major tributaries such as the White, Cheyenne, Grand and Little Missouri Rivers in South Dakota. It has been found in swift current over gravel bottoms and is well adapted for life in turbid waters because it has small eyes and taste buds on the head, body and fins.

The sicklefin chub (Hybopsis meeki) is in many ways like the sturgeon chub. It is rare throughout the upper Missouri basin and has been captured only from the Missouri River where it inhabits channels with strong current and sand or gravel bottoms. It grows to about 10 cm in length, but little is known about the biology of the fish.

Causes for decline of the three rare fish can only be speculated because little is known about their habitat needs. In general, major causes are 1) inundation of riverine habitat by the reservoirs, and 2) change in structure and hydrology of the remaining riverine habitat because of regulated flows. Studies should be initiated to determine the status and distribution of the rare fishes, and once populations are located, studies of an artificial propagation and habitat needs should be initiated.

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    Wyoming. Masters Thesis. University of Wyoming, Laramie, Wyoming, USA.

(3)   THE WESTERN PRAIRIE FRINGED ORCHID (PLATANTHERA PRAECLARA SHEVIAK AND BOWLES)
IN THE GREAT PLAINS, WITH PARTICULAR REFERENCE TO NORTH DAKOTA

Alexis J. Duxbury*
North Dakota Game and Fish Department
Bismarck, North Dakota 58501

The Western Prairie Fringed Orchid (Platanthera praeclara Sheviak and Bowles) is a recently described species formerly treated in synonymy with Platanthera leucophaea (Nutt.) Lindl. The two taxa, although similar in gross morphology, are readily separated by differences in floral characteristics including flower size; petal and sepal shape; fragrance; and column structure (Sheviak and Bowles 1986). As a result of the latter characteristic the taxa differ in their pollination mechanics and are effectively isolated from one another. Moreover, the species are largely allopatric, overlapping only at the interface of their respective ranges.

Platanthera praeclara is one of the few orchid species affiliated with the tallgrass prairie region of North America. Reported from nine states in the central United States and one Canadian province -- North Dakota, South Dakota, Minnesota, Iowa, Kansas, Nebraska, Oklahoma, Missouri, Wyoming, and Manitoba -- the species' range, with minor exception, coincides with the Bluestem Prairie and Nebraska Sandhills Prairie regions identified by Kuchler (1975). In North and South Dakota the original range of the species is known to have included the Sheyenne Delta on the western edge of the Glacial Lake Agassiz Basin and the southern half of the Big Sioux River Valley, respectively. (Bowles and Duxbury 1986; Ode 1985).

Despite its expansive range, records indicate widespread habitat destruction has resulted in the precipitous decline of the species' distribution and abundance. At present approximately 35 extant populations are known, including two major population centers: one in North Dakota and one in Minnesota. Outside of these two centers, populations are generally small, isolated, and occur on prairie remnants in highly-fragmented landscapes. The species is presumed extirpated in Wyoming and was last reported in South Dakota 71 years ago. Conversion of native prairie to cropland, drainage, overgrazing, cessation of fire, and intensive mowing are among the specific threats historically and currently facing the orchid.

The western prairie fringed orchid is a perennial herb, overwintering as a fusiform tuber. In bloom the orchid reaches a maximal height of about 2½ feet. The flowering culm is relatively stout and bears seven to twenty, showy, white flowers at its apex. Total length of the inflorescence is approximately six inches. Flowers are bilaterally symmetrical and spurred, with the lower lip of each flower split into three, roughly triangular, elaborately fringed, segments. Flowers are moth pollinated (Sheviak and Bowles 1986). Several investigators have pointed out the numerous ways the species is adapted to the prairie environment. These include its ability to exist in a near-dormant vegetative state for one or more years, and positive response to fire.

In North Dakota the orchid grows in subirrigated, prairie swales of the Sheyenne Sandhills, and is associated with rich, calcareous, seasonally-inundated, soils. Typically, the species occurs in what Manske (1980) termed the Carex lanuginosa-Calamagrostis inexpansa-Juncus balticus habitat type, and blooms the first half of July. The Sheyenne population is found in the vicinity of McLeod, largely on the public lands administered by the U.S. Forest Service. Livestock grazing is the prevailing land use on these lands. Systematic surveys indicate the population, while diffuse and fragmented, is extensive, consisting of several ill-defined subpopulations and outliers. Orchid population trends, impacts of grazing, and the effects of ongoing management practices, remain undetermined.

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Sheviak, C.J. and M.L. Bowles. 1986. The prairie fringed orchids: a pollinator isolated species pair. Rhodora 88:267-290.

(4)   BENEFITS OF NORTH DAKOTA'S NONGAME INCOME TAX CHECKOFF FOR RARE SPECIES AND NATURAL AREAS

Randy L. Kreil*

North Dakota Game and Fish Department
Bismarck, North Dakota 58501

The 1987 North Dakota Legislature passed a bill that provided for the establishment of a nongame wildlife and natural areas fund using monies obtained through a voluntary income tax checkoff program. The income tax checkoff program will be administered by the North Dakota State Tax Department and contributed funds will be transferred to the North Dakota Game and Fish Department for use in nongame and natural area programs.

The establishment of such a funding mechanism will allow the North Dakota Game and Fish Department to expand and intensify its activities in the area of nongame wildlife managment. Prior to the establishment of this program, limited funding sources were available for non-harvestable species of fish and wildlife; with the exception of federally listed endangered or threatened species. In addition, the income tax checkoff program allows transfer of some funds to other agencies for the protection and preservation of natural areas in North Dakota.

The actual impact of the nongame tax checkoff program on rare species conservation remains to be seen. However, the potential exists for significant increases in research, management, and protection for species considered to be rare or of special concern in North Dakota. Additional benefits are anticipated to result from an increased public awareness of rare species and their requirements for survival.

(5)   RARE WETLAND FLORA OF THE DAKOTAS

Gary E. Larson*
Biology Department, South Dakota State University
Brookings, SD 57007-0595

Among the vascular plants that inhabit wetlands of North and South Dakota, few can truly be considered rare except on a statewide or regional basis. Plants of rare occurrence in wetlands of our two states are generally more common in other parts of their range. Consequently, we currently have no wetland plants classified as rare, threatened or endangered on a national or worldwide basis. Rarity among our wetland plants is usually explainable in terms of one or more of the following factors: (1) The Dakotas are peripheral to or even separated from the main distributional range of the species so that representatives occur here as outpost or disjunct populations. This is the case for most of our regionally rare wetland plants, many of which can be interpreted as relicts of past glacial climates. (2) The rather specific habitat requirements of many rare species are seldom realized in prairie wetlands. Factors such as instability of water levels and harsh water chemistries, as deterined by modern climatic conditions and edaphic factors, have a great impact on the ability of many wetland plants to survive in the northern plains. Regionally rare species are mostly restricted to the unusual sites where environmental conditions are and probably have long been relatively static. Examples of wetland types featuring these conditions are widely scattered calcareous fens and rare archaic bogs that are found mainly in the glaciated prairie region of the Dakotas. (3) Some wetland plant species now considered rare may actually be more common than floristic data indicate, i.e. more extensive field investigation might reveal new localities for poorly documented taxa. This is most apt to be true for inconspicuous plants easily overlooked in the field. (4) A few of our rare wetland taxa are recent introductions that have become established at one to several sites in the region. Some of these show promise of spreading further within our region and ultimately will no longer be classified as rare.

Rare plants are often reliable indicators of unique environments that support other rare biota. For this reason, it is of value to conduct thorough studies of areas where rare plants are encountered and to consider these areas for preservation.

(6)   FOUR ENDEMIC PLANTS OF THE NORTHERN GREAT PLAINS

David J. Ode*
Natural Heritage Database, Wildlife Division
South Dakota Department of Game, Fish and Parks
Pierre, South Dakota 57501

Nearly all vascular plant species inhabiting the northern plains have widespread distributions that extend well beyond the limits of the Great Plains physiographic province (1). Four plant taxa that have relatively restricted ranges within the northern plains are: Barr's Milkvetch (Astragalus barrii Barneby), Dakota Wild Buckwheat (Eriogonum visheri A. Nels.), Secund Bladderpod (Lesquerella arenosa var. argillosa Rollins & Shaw), and Silver-mounded Candleflower (Cryptantha cana (A. Nels.) Payson). Field, herbarium and literature research indicate that all of these species inhabit mostly barren rock outcrops or sparsely vegetated rangeland where plant competition is low and plant succession is slowed or prevented by rapid erosion or harsh soil conditions.

Barr's Milkvetch is a long-lived perennial that is primarily restricted to the upper White and Cheyenne River drainages in southwestern South Dakota and the Powder River drainage of northeastern Wyoming and southeastern Montana. Within South Dakota it has been reported for only seven localities in Fall River, Shannon and Pennington counties. In Wyoming it has been collected from sixteen stations in Campbell, Johnson, Natrona, Niobrara, Sheridan, and Weston counties (2). In Montana it has been reported from ten sites in Big Horn, Carter, Powder River, and Rosebud counties (3).

Dakota Wild Buckwheat is a summer annual restricted to mostly barren badlands scattered across a ten county area of western North and South Dakota. This includes the South Dakota counties of Corson, Jackson, Meade, Mellette, Pennington, Perkins and Ziebach; and the North Dakota counties of Grant, Montrail, and Sioux. Recent field surveys have located forty-five populations across the range of the species (4, 5).

Secund Bladderpod is an annual or short-lived perennial that ranges across a thirteen county area of northwestern Nebraska, southwestern South Dakota and northeastern Wyoming. Sixteen localities have been reported from the South Dakota counties of Custer, Fall River, Lawrence, Meade, Pennington, and Shannon. Three specimens have been collected from the Wyoming counties of Crook and Niobrara (2), and at least five sites have been reported from the Nebraska counties of Box Butte, Dawes, Scotts Bluff, Sheridan and Sioux (6).

Silver-mounded Candleflower is a long-lived perennial that ranges from northeastern Colorado, up through eastern Wyoming, the Nebraska panhandle and southwestern South Dakota to southeastern Montana. It has been collected from at least thirty locations in the Wyoming counties of Big Horn, Campbell, Converse, Fremont, Goshen, Laramie, Niobrara, Platte, and Weston (2). In Nebraska it has been reported from the following counties: Banner, Box Butte, Cheyenne, Dawes, Deuel, Garden, Kimball, Morrill, Scotts Bluff, Sheridan, and Sioux (6). Cryptantha cana has been collected from six localities in the Colorado counties of Logan, Weld and Washington (7). It has also been found at five sites in Fall River County, South Dakota; and in two areas of Carbon County, Montana (3).

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(7)   Hesperia dacotae (Skinner) [Hesperiidae, Lepidoptera]
A North Dakota Distribution Update, with Information on Three New Population Complexes,
Including First Records From Southwest of the Missouri River

Ronald Alan Royer*
Division of Science, Minot State University
Minot, North Dakota 58701

Since its description in 1911 from specimens taken near Volga, South Dakota, and Grinnell, Iowa, Hesperia dacotae has also been reported from Illinois, Minnesota, North Dakota and southern Manitoba. In many original localities it is extinct. Now known to be somewhat more widespread than earlier thought, H. dacotae was proposed for but not granted threatened species status. It remains restricted to not more than 50 individual remaining prairie locations throughout its range. McCabe (1981) reported 13 North Dakota sites for the species.

A medium-sized hesperiine skipper (wingspan ranges 2.4 - 3.2 cm), Hesperia dacotae is among the most variable in marking. Males from the same locality may be almost entirely without dark scaling above (excepting the stigma) or very dark and cloudy. Females are even darker, tending in some individuals virtually to chocolate brown. Usually the undersurface of the male is a granular golden, reminiscent of its more common congener Hesperia ottoe. As in that species there is but a faint tendency toward the usual VHW patterning of the genus Hesperia. The male genitalia are distinctive, bearing an extraordinarily elongate uncus and a bifurcate gnathos that are quite different from those of other Hesperia.

A reliable indicator of possible occurrence in western North Dakota is the combination of Purple Coneflower (Echinacea angustifolia) and Needle and Thread (Stipa comata) in rolling undisturbed prairie. The larval foodplant is variously reported, Andropogon scoparius (Little Bluestem) being said (Scott, 1986) to be the favorite. Females oviposit indiscriminately. The species flies from mid-June through early July. Males characteristically nectar and perch on coneflower heads on windward slopes (generally near summits) of low prairie hills and also seek females downslope in grassy swales.

Today Hesperia dacotae is known from only one locality in Iowa, perhaps two or three dozen spots in South Dakota and Minnesota, and sixteen separate locations in North Dakota. Few of these "strongholds" exceed a section of land. Dana (personal communication) indicates that not more than four Minnesota population complexes include more than 1,000 acres. One site near Karlsruhe, in McHenry County, North Dakota, according to McCabe (1981) encompasses 1,500 acres. Before 1986, most known sites were considerably smaller, with the two smallest in North Dakota being four and six acres and a mean extent of less than 270 acres.

A Ward County, North Dakota, habitat complex, discovered by the author in 1986, occupies at least 1,000 acres. Two subsequently discovered North Dakota complexes, one in McKenzie County and another in the Killdeer Mountains in Dunn County each occupy more than all other population complexes heretofore known for North Dakota. These are also the first records ever for the species southwest of the Missouri River. These populations offer the possibility of extensive study of Hesperia dacotae in "metapopulations" possibly similar to those in the species' pre-agricultural range. They also support the likelihood of eventual discovery of the species in Montana and Wyoming. McCabe (1977, 1981) reports that this species is associated with the shorelines of glacial lakes in North Dakota. Dana (personal communication) reports no such association in Minnesota, and new localities bring the universality of that association into question.

■ Previously Reported Site   ○ New Population Complex
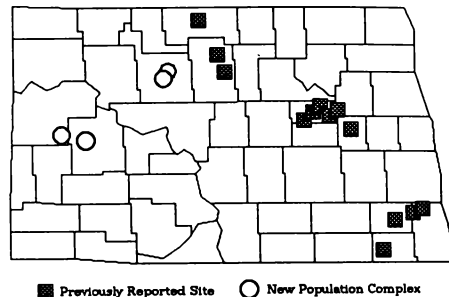
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(8)   Status, Distribution, Production and Factors Limiting Productivity of Interior Least Terns
        and Piping Plovers along the mainstem Missouri River, South Dakota, 1986-1987.

Monica J. Schwalbach* and Kenneth F. Higgins
Cooperative Fish & Wildlife Research Unit, SD State University
Brookings, South Dakota 57007
and
George M. Vandel III
SD Department of Game, Fish and Parks, Division of Wildlife
Pierre, South Dakota 57501

In 1985 the U.S. Fish and Wildlife Service listed the interior least tern (Sterna antillarum athalossos) as endangered and the piping plover (Charadrius melodus) as endangered or threatened over all of its breeding range, under the Endangered Species Act of 1973, as amended. In SD interior least terns have been listed as state endangered and piping plovers as state threatened.

This study was conducted by the Cooperative Fish and Wildlife Research Unit with the U.S. Fish and Wildlife Service, South Dakota State University, South Dakota Department of Game, Fish and Parks, and the Wildlife Management Institute cooperating. The study objectives were to (1) survey the breeding populations and distribution of least terns and piping plovers along the mainstem Missouri River and its major western tributaries in SD, (2) document production, (3) determine nesting habitat characteristics, and (4) identify factors affecting productivity.

The study area included the Missouri River from the ND state line to Ponca State Park, NE, and the lower reaches of the Grand, Moreau, Cheyenne, and White rivers. Nesting areas were located by ground and aerial surveys. Population censuses were conducted, and areas were visited periodically throughout the nesting seasons to estimate production. Biological information collected at each site included number of adults, number of pairs, number of flightless young, number of fledglings, number of nests (active and inactive) and number of eggs per nest. The flotation method of determining embryo developmental stage in tern eggs was used to estimate incubation stage for each clutch (Hays and LeCroy 1971), and to determine nest initiation, hatching, and fledging dates. Annual turnover rates were computed by using the formula presented by Erwin et al. (1981).

A total of 253 and 367 adult least terns were censused in 1986 and 1987, respectively, and 187 and 197 adult piping plovers were censused in 1986 and 1987, respectively. Least terns and piping plovers utilized a total of 83 sites during the two years, which includes 24 sympatric sites in 1986 and 41 sympatric sites in 1987. Nesting areas on the Gavins Point and Fort Randall reaches were typically sparsely vegetated sandbars. Oahe Reservoir nesting sites were usually sparsely vegetated sand and gravel beaches or points, although three sites in 1986 were parking lots where plovers nested, and two sites in 1987 were islands. One-year turnover rates ranged from 0.57 to 0.78 for least terns, and from 0.55 to 1.00 for piping plovers. Tern and plover turn-over rates were high, probably because of the ephemeral quality of nesting habitat, coupled with a high amount of recreational activities occuring on sites during the nesting season. Due to record high water levels on the mainstem Missouri River throughout the May to August nesting period in 1986, production was poor for both species that season. Production improved in 1987, and generally was moderate to good for both species. However, tern and plover production was poor both years on the Fort Randall Dam to Springfield, SD, river reach.

The distribution and production of least terns and piping plovers on the mainstem Missouri River in South Dakota is largely determined by the relation of nesting habitats to water levels. Fluctuations in water levels affect the amount of beach and sandbar habitat available for nesting. Untimely discharge of water from Fort Randall and Gavins Point dams can cause inundation of colony sites during the nesting season. Vegetative encroachment of sandbars caused by reduced sandbar scouring further limits habitat availability. Human disturbance of nesting areas is also a factor affecting tern and plover distribution and productivity. Predation is a limiting factor but the degree of its impact remains uncertain.

Until the populations of terns and plovers recover to the extent suggesting delisting, nesting areas should receive annual monitoring and protection efforts. Water discharge plans at Missouri River mainstem dams should also include provisions for tern and plover production. Posting and patrol of active colonies could reduce the impacts of human disturbance. Continued surveys and additional studies will enable agencies to make sound management decisions for protection of these rare species.

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SYMPOSIUM

on

PALEONTOLOGY OF NORTH AND SOUTH DAKOTA

Presiding: Jolene Richardson
              ND Paleontological Society
              Minot, ND

37. Paleoenvironmental Interpretation of the Turner Sandy Member of the
     Carlile Formation, Southwestern Black Hills
              Michael B. Leite*
              Department of Geology and Geophysics
              University of Wyoming
              Laramie, WY

              Don J. Richardson and Jolene E. Richardson
              Velva, ND

38. Unusual Stratigraphic Occurrences of Plesiosaurs from the Late Cretaceous
     of the Black Hills Area, Wyoming and South Dakota
              James E. Martin
              Museum of Geology and Black Hills Natural Sciences Field Station
              SD School of Mines & Technology; South Dakota Geological Survey
              Rapid City, SD

              Allen J. Kihm*
              Department of Earth Sciences
              Minot State University
              Minot, ND

39. A Plesiosaur With Stomach Contents from the Pierre Shale (Late Cretaceous)
     of South Dakota: A Preliminary Report
              James E. Martin
              Black Hills Natural Sciences Field Station and Museum of Geology
              SD School of Mines & Technology; South Dakota Geological Survey
              Rapid City, SD

              Lois E. Kennedy*
              Black Hills Natural Sciences Field Station
              SD School of Mines & Technology
              Rapid City, SD

40. Oligocene Faunal Additions and New Localities for North Dakota
              George E. Lammers*
              Manitoba Museum of Man and Nature
              Winnipeg, Manitoba, Canada

              John W. Hoganson
              North Dakota Geological Survey
              Grand Forks, ND

41. Carnivora from the Ellensburg Formation (Miocene) of Central Washington
              James E. Martin
              Museum of Geology, SD School of Mines & Technology
              South Dakota Geological Survey
              Rapid City, SD

              Allen R. Tedrow*
              Museum of Geology, SD School of Mines & Technology
              Rapid City, SD

42. Chronology of the Beaver Creek Shelter, Wind Cave National Park, South Dakota
              James E. Martin and Rachel C. Benton*
              Museum of Geology, SD School of Mines and Technology
              South Dakota Geological Survey
              Rapid City, SD

              Robert A. Alex
              Archaeological Research Center
              Rapid City, SD

(37)   PALEOENVIRONMENTAL INTERPRETATION OF THE TURNER SANDY MEMBER
           OF THE CARLILE FORMATION, SOUTHWESTERN BLACK HILLS

Michael B. Leite*
Department of Geology and Geophysics
University of Wyoming, Laramie, WY 82071

Don J. Richardson and Jolene E. Richardson
Velva, ND 58790

The Turner Sandy Member of the Carlile shale exposed in the Black Hills of South Dakota and Wyoming comprises about 50 m of ledge-forming silica-cemented coarse sandstone and interbedded dark shales. This study is concerned with the depositional environments and paleoecology of the Turner as interpreted from exposures in the southwestern Black Hills. Locality 1, the Edgemont locality, is located in sections 17 and 20 of T. 9 S., R. 1 E., Fall River County, South Dakota. Locality 2, the Pedro locality, is located in section 6 of T. 45 N., R. 62 W., Weston County, Wyoming.

Teeth of selachian fishes have been found in abundance in local concentrations in sandstones in the lower part of the Turner sandy member. The selachian fauna of locality 2 has been reported previously (1). We report here the selachian fauna from locality 1, which is composed of the following species:

> *Ptychodus* cf. *P. anonymus* Williston 1900
> *P. whipplei* Marcou 1858
> *P. polygyrus* Agassiz 1843
> *Squalicorax falcatus* (Ag.) Cappetta 1973
> *Lamna appendiculata* (Ag.) Woodward 1910
> *L. semiplicata* Agassiz 1843
> *Scapanorhynchus rhaphiodon* (Ag.) Williston 1900

The Turner sandy member is Turonian (earliest Late Cretaceous) in age as indicated by the molluscan fauna. This selachian fauna is very similar to other Turonian age faunas reported from the Carlile and temporal equivalents in the Rocky Mountain region (1,2,3).

The sandstone of the Turner member is typically cross-stratified and coarse grained and forms beds from 3 to 30 cm thick. Measurements of crossbed dip directions indicate strong unidirectional currents from the north, northwest, or northeast. Concentrations of fish teeth occur in thin layers at the tops of these beds. Tops of beds at locality 2 are also marked by symmetrical standing-wave ripples.

The vertical sequence of sedimentary structures and grain size distribution suggests that there was periodic influence of strong winnowing currents (possibly storm generated) on sediment with variable but generally low concentration of fish teeth. We have estimated the degree of winnowing by computing the density of coarse (>2.0 mm) fish tooth debris in layers interpreted as lag deposits and comparing those counts with similar counts from the non-winnowed lower parts of the same beds. Computed lag concentration factors of from 1.7 to 20 in layers 0.3 to 4.0 cm thick suggest that winnowing of from 1 to 32 cm of original sediment is sufficient to account for the observed thickness and tooth density in the lag deposits. However, this procedure necessarily assumes uniform pre-winnowing tooth debris density; these figures should therefore be regarded only as estimates.

Variation in fish tooth density throughout stratigraphic sections of the Turner has provided insights into post-depositional erosional processes that acted on an original sediment that was presumably more uniform with respect to this parameter. This technique is useful in estimating stratigraphic completeness only if parts of the section can be assumed to have the properties of the original pre-winnowing sediment and if those parts are present in adequate thickness to permit accurate counts. The Turner sandy member appears to be well suited for this purpose. Further development of this technique will hopefully lead to methods of evaluating completeness of other stratigraphic sections.

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(38)   UNUSUAL STRATIGRAPHIC OCCCURRENCES OF PLESIOSAURS FROM THE LATE
CRETACEOUS OF THE BLACK HILLS AREA, WYOMING AND SOUTH DAKOTA

James E. Martin
Museum of Geology and Black Hills Natural Sciences Field Station
SD School of Mines & Technology;
South Dakota Geological Survey
Rapid City, SD 57701

and
Allen J. Kihm*
Department of Earth Sciences
Minot State University
Minot, ND 58701

INTRODUCTION: In keeping with the theme of the symposium to promote the discipline and to
disseminate paleontological information in the region, two unusual stratigraphic occurrences of
plesiosaurs are noted herein. In the Black Hills area, most plesiosaur specimens have been collected
from the Pierre Shale or Niobrara Formation. Specimens from older shales are more rare; only a
couple specimens such as the plesiosauroid, Alzadasaurus riggsi Welles (1943), have been documented.
Last year, two new specimens from the older shales were recovered: one from the Newcastle Sandstone
and one from the Carlile Shale.

OCCURRENCES: Mr. Monte Raber, of N.L. Baroid Company, notified the senior author of a skeleton
uncovered by mining operations for bentonite west of Colony, Wyoming. Upon inspection, it became
apparent that a plesiosaur had been exposed. Much of the specimen had been removed by the stripping
operation; approximately a fourth of the skeleton remained. The authors, Raber, and Mr. Wade Winters,
who was enrolled in the Black Hills Natural Sciences Field Station program, excavated the plesiosaur.
One of the most important aspects of the discovery is the stratigraphic position; the creature
occurred in the Newcastle Sandstone (Albian), 36.5 feet above a thick bentonite called the A-bed or
Newcastle bentonite in pit number 595. Here, the Newcastle Sandstone is thick, preserved in a
northerly trending anticline. The sandstone thins along the limbs according to the studies conducted
by Raber. The plesiosaur, therefore, lies high in the Newcastle Sandstone and is the only plesiosaur
skeleton found in this lithostratigraphic unit.
    Preparation of the specimen is incomplete, but a short-necked plesiosaur (Pliosauroidea) appears
to be represented by part of the rib cage, partial girdle, propodial, and an articulated string of
vertebrae. In addition, numerous sharks teeth of the "Lamna-Cretolamna" morphotype were found
scattered throughout the sandstone.
    The second occurrence of a plesiosaur is in the Carlile Shale (Turonian) in South Dakota. While
field checking a thesis investigation of the invertebrate assemblages from the Turner Sandy Member
by Mr. J.F. Sawyer, the senior author found a poorly preserved plesiosaur propodial weathering from
a concretion. The specimen was found 10 feet below the top of the Turner in a concretionary horizon
which commonly contains the invertebrates, Scaphites whitfieldi and Inoceramus-type pelecypods. At
this locality in Fall River County, the Turner Sandy Member is 49 feet thick.

DISCUSSION: These two specimens represent rare occurrences of plesiosaurs in these strata. The
specimen from the Newcastle Sandstone represents the first pliosauroid from the Albian of North
America. The specimen from the Turner Sandy Member is one of the few Turonian plesiosaurs from
North America (Welles, 1962). When analysis of these new specimens is completed, they may provide
additional information concerning the distribution and evolution of these marine creatures.

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(39)   A PLESIOSAUR WITH STOMACH CONTENTS FROM THE PIERRE SHALE (LATE
            CRETACEOUS) OF SOUTH DAKOTA: A PRELIMINARY REPORT

James E. Martin
Black Hills Natural Sciences Field Station and Museum of Geology,
SD School of Mines & Technology;
South Dakota Geological Survey

and
Lois E. Kennedy*
Black Hills Natural Sciences Field Station
SD School of Mines & Technology
Rapid City, SD 57701

INTRODUCTION: Occurrences of fossil vertebrates with stomach contents are rare. Those of marine carnivores are more common than those of terrestrial taxa; however, less than thirty occurrences are known world wide (Massare, 1987). Previously in South Dakota, stomach contents (or at least vertebrate remains in the abdominal region) have been found only in two mosasaurs, South Dakota School of Mines 10876 and SDSM 10439, (Martin 1982; Martin and Bjork, 1987) and in a plesiosaur, ?Styxosaurus browni, American Museum of Natural History 5803, (Brown, 1904; Massare, 1987) from the Pierre Shale. The occurrence reported herein represents the second known plesiosaur with stomach contents from the Pierre Shale and the fifth known such specimen in the world (see Massare, 1987).

OCCURRENCE: On the last day of the Field Paleontology course sponsored by the Black Hills Natural Sciences Field Station, the junior author located a partial plesiosaur skeleton in the upper portion of the Gammon Ferruginous Member (late Campanian) of the Pierre Shale. The locality, the Conger Ranch Locality, lies along the southern Black Hills, in beds which were tilted by and away from the Black Hills uplift and exposed by subsequent erosion. Most of the skeleton is enclosed in a large concretion; however, some portions such as vertebrae, a portion of a paddle, and isolated teeth occur in the adjacent shale. The senior author, in determining the extent of the specimen, noted fish remains within a series of ribs. The position and composition of these remains were suggestive of stomach contents, and before winter set in, the portions of the specimen around the concretion were collected.
   During excavation and after preparation by the junior author, it was noted that mixed with the fish remains were 6 small, black gastroliths, ranging from 9 to 34 mm (measured along their long axes). From the casts, 9 fish vertebrae and numerous other portions of distorted bone were recovered.

DISCUSSION: The discovery of this specimen containing gastroliths associated with fish remains reinforces the contentions of most earlier workers that fish were a common component of plesiosaur diet and that the stones were utilized in the digestive process. This specimen is one of the few plesiosaurs reported from the Gammon Ferruginous Member of the Pierre Shale and is only the second known plesiosaur from the Pierre Shale containing gastric residues. Additional data will be forthcoming once the specimen is completely collected and analyzed.

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(40)   OLIGOCENE FAUNAL ADDITIONS AND NEW LOCALITIES FOR NORTH DAKOTA

George E. Lammers*   John W. Hoganson
Manitoba Museum of Man and Nature   and   North Dakota Geological Survey
190 Rupert Avenue   University Station
Winnipeg, Manitoba, Canada   Grand Forks, North Dakota   58202
R3B 0N2

Brief reports were presented to meetings of the North Dakota Academy of Science in 1985 and 1986 co-authored by John Hoganson of the Geological Survey and Allen Kihm of Minot State. The first presentation with Hoganson summarized the fauna as known at that time and the paleoecology of the Dickinson Member (informal usage) of the Brule Formation. The second paper with Kihm gave a more complete faunal list as well as the biochronology of the Oligocene sediments in North Dakota.

Additions to the faunal list of Kihm and Lammers (86) include Ictalurus (Amiurus), Trionyx, Agnotocastor, Hyaenodon crucians, H. horridus, and a Perictine dog. None of these animals represent new animals to the Orellan age, but are additions to the Oligocene fauna of North Dakota. Brontotheriid is included in the 1986 faunal list, but two new localities for the brontothere without stratigraphic control in the Little Bad Lands (canine tooth; sec. 29, T138N, R97W) and White Butte (sec. 32, T139N, R97W), just southeast of South Heart (a vertebra collected by Larry Leagne) represent a northern extension of Chadron remains. Chadron-age sediments exist at these localities but have proven barren in the past. The vertebra, quite water worn, may have come from above the Chadron contact and represent reworking.

Several new localities have produced vertebrate remains found as float. They have been quite limited and poorly preserved. Accurate diagnosis and assignment to mammal ages will only be possible on collecting additional material. The most prolific new site is West Rainy Butte, Slope County, sec. 19, T135N, R98W in what is currently called the Killdeer Formation. Rhinoceros lower jaws have been found there as float and are very poorly preserved. We intend to search for additional material from this butte and nearby sites to tie down this little-known formation suspected to be Whitneyan and/or Geringian. The above leads to two major objectives: to search for and locate productive Chadron localities and to determine the age of the Killdeer Formation, if indeed it is of the same age everywhere, or if it represents more than one stratigraphic unit.

(41)   CARNIVORA FROM THE ELLENSBURG FORMATION (MIOCENE)
OF CENTRAL WASHINGTON

James E. Martin
Museum of Geology, SD School of Mines & Technology
South Dakota Geological Survey

and
Allen R. Tedrow*
Museum of Geology, SD School of Mines & Technology
Rapid City, SD 57701

INTRODUCTION: Although the Ellensburg Formation was named in the late nineteenth century for deposits which overlie the Columbia River Basalt, very few vertebrate fossils from the formation have been described. Most described fossil vertebrate specimens are those of horses; only a few carnivores have been mentioned. Martin (1979) mentioned the occurrence of Pliotaxidea from sediments that were originally mapped as Ellensburg Formation. Additional investigation suggests that this unit may be younger than the type Ellensburg Formation and is the subject of a study now underway by Martin and V. Standish Mallory. A mustelid originally described as Beckia grangerensis Bryant (1978) was one of three carnivore specimens that have been preserved for scientific investigation through the efforts of the late George Beck, who for many years taught at Central Washington State University. The other two specimens are the subject of this paper.

Epicyon sp.

LACM 10664, left dentary with C, alveolus for P_1, P_2-M_1, and broken M_2 and ascending ramus; from LACM (Los Angeles County Museum) locality 6449, found in talus at southern entrance of Yakima Canyon, Washington. The only sedimentary unit in the area is the Selah Member of the Ellensburg Formation, which lies below the Pomona Basalt.

The dentition exhibits the enlarged P_4 and reduced anterior premolars as is characteristic of Epicyon-Osteoborus line, although there is some question as to the degree of specialization of these features in these genera. O. diabloensis and O. littoralis from California have been recently considered species of Epicyon (a generic name applied to the Aelurodon saevus Group by Baskin, 1980) because they lack "derived features of the dentition" necessary to distinguish Aelurodon and Osteoborus. In particular, they lack the essentially single-cusped anterior premolars. LACM 10644 exhibits enlargement of the P_4, and the premolars retain the accessary posterior cuspules, suggesting assignment to Epicyon. The specimen appears to represent a similar evolutionary grade as that of the California species. The measurements: P_2, A-P=9.0mm, T=5.6; P_3, A-P=10.6, T=6.8; P_4, A-P=16.9, T=10.1; M_1, A-P=28.1, T=11.7, indicate a small to medium-sized species.

Pseudaelurus sp.

LACM 10655, right dentary with alveolus for C, P_3-M_1, and broken ascending ramus; from LACM locality 6432, northwest of Buena, Washington, found in the spoil piles of the Roza water canal.

This specimen is similar to species of Pseudaelurus in possession of a talonid on M_1. It lacks the P_{1-2}, possesses a crowded dentition, a distinct metaconid on M_1, a relatively short diastema, and is relatively large: P_3, A-P=14.0, T=6.8; P_4, A-P=19.0, T=8.4; M_1, A-P=23.7, T=9.8. LACM 10655 is somewhat unusual in that the carnassial notch terminates sharply rather than being anteroposteriorly expanded.

DISCUSSION: The Clarendonian age of the Ellensburg Formation was based primarily upon the stage of evolution of horses (Stock, in Buwalda and Moore, 1930, p. 17; Smiley, 1963, p. 202). However, some question persists as to the nomenclature and precise age of the formation. This specimen of Pseudaelurus adds little to the resolution of the age as the genus persists from the Barstovian to the Hemphillian. Epicyon, as recognized by J.A. Baskin (1980) and R.H. Tedford (per. comm.) is known only from the Clarendonian. The locality from which the specimen was derived is very low in the Ellensburg Formation and may suggest that the basal portion of the formation is Clarendonian. Additional specimens from throughout the formation are required before the age(s) of the entire formation may be completely understood.

These specimens represent the first records of these carnivores in Washington, extending their known geographic ranges northwesterly.

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(42)   CHRONOLOGY OF THE BEAVER CREEK SHELTER, WIND CAVE NATIONAL PARK, SOUTH DAKOTA

James E. Martin
Museum of Geology, SD School of Mines and Technology;
South Dakota Geological Survey

Robert A. Alex
Archaeological Research Center

and
Rachel C. Benton*
Museum of Geology, SD School of Mines and Technology
Rapid City, SD 57701

INTRODUCTION: In Wind Cave National Park, South Dakota, the succession of sediments in the Beaver Creek Shelter represents the most complete Holocene section known in the Black Hills. Twenty-two stratigraphic levels have been discovered extending through 4.77 meters of interbedded, poorly consolidated breccias primarily formed by rock fall, sandstones, and siltstones. Within these sediments occur plant, gastropod, vertebrate, and archaeological remains; abundant charcoal is scattered throughout the deposit, although it may be concentrated in discrete layers or in archaeological features. Enough charcoal was obtained for radiocarbon dating. The dates were provided through the courtesy of Wind Cave National Park, Richard Klukas, Research Biologist.

CHRONOLOGY: The radiocarbon dates indicate that almost the entire Holocene is preserved in the Beaver Creek Shelter. During 1985, the upper eleven stratigraphic layers were excavated. Two units were composed of charcoal and a third consisted of a fire hearth. From the uppermost charcoal unit, horizon 4, a radiocarbon date of 1750 $\pm$ 60 years BP (Beta-13825) was obtained; charcoal from horizon 7 was dated at 2220 $\pm$ 70 years BP (Beta-13826). Horizon 11, the fire hearth produced a date of 3870 $\pm$ 70 years BP (Beta-13827) and a chert biface (Martin and Abbott, 1986).
    Excavations in 1986 began below the level of the hearth and extended almost three meters in depth in order to survey the site and determine its potential. Four radiocarbon dates were obtained during 1986: 3940 $\pm$ 170 years BP (Beta-19059) from horizon 12, 4010 $\pm$ 100 years BP (Beta-19060) from horizon 13, 4710 $\pm$ 110 years BP (Beta-19061) from horizon 14, and 5500 $\pm$ 150 years BP (Beta-19066) from horizon 15. Two projectile points were found but are not of diagnostic morphology.
    During 1987, excavation continued, and one meter grid unit (0-1W, 1-2S) was excavated to a level of 4.77 meters within an ancient rock fall, horizon 22. From almost a meter above the bottom in the level of the rock fall, a date of 9380 $\pm$ 300 years BP (Beta-22271) suggests that the entire Holocene section is preserved at the Beaver Creek shelter. This radiocarbon date and those following were obtained as excavations proceeded: 5500 $\pm$ 80 years BP (Beta-23712) and 5740 $\pm$ 110 years BP (Beta-24068) from horizon 15, 6220 $\pm$ 100 years BP (Beta-23715) and 6720 $\pm$ 100 years BP (Beta-24067) from horizon 17. All of these latter dates are from various archaeological features or cultural horizons encountered during the excavation. In addition to the many flakes, fire-cracked rock, and hearths with abundant ash, two additional projectile points were found from horizons 11 and uppermost 14. These points are indicative of the McKean Cultural Complex which existed during the Middle Archaic Period.
    From the archaeological specimens encountered, the stratigraphy, and the radiocarbon dates, it appears that the cultures from the Early Archaic Period appear at the site approximately 6720 years ago, and the cultural levels extend upward at least to 3870 years BP and probably to the top of the section. Therefore, occupation of the shelter includes the transition from Early to Middle Archaic Periods (4,500-5,500 years BP), a poorly known interval in the northern Great Plains. As a result, the shelter has the potential of providing information on the culture of the Early Archaic Period in the southern Black Hills and the nature of the transition between Early and Middle Archaic Cultures.
    Concomitant with the cultural change, the climatic trends during the Holocene in the southern Black Hills may be documented for the first time. The previously described climatic intervals of Antevs (1955) and Bryson et al. (1970) are encompassed by the dates derived from the site. Therefore, the Beaver Creek Shelter is a site where concepts of these climatic intervals and their effects may be evaluated.

SUMMARY: Based on radiocarbon dates extending from 9400 to 1750 years BP, the Beaver Creek Shelter contains the first stratified succession in the Black Hills containing a depositional history through much of the Holocene. For the first time, the change in environment, faunal communities, and human occupation may be documented in this region.

Antevs, E. (1955) Amer. Antiquity, 20:317-335.
Bryson, R.A., Baerreis, D., and Wendland, W. (1970) in Pleistocene and Recent Environments of the
    Central Great Plains, (Dort, W. and Jones J.K., eds.) Univ. Kansas Press, Spec. Publ., 3:1-433.
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SYMPOSIUM

on

CONSERVATION MEASURES OF THE FOOD SECURITY ACT OF 1985

Presiding: Allen Fisk
              Bismarck, ND

86. Introduction to the Food Security Act of 1985
              Norman Kempf*
              Soil Conservation Service, USDA
              Bismarck, ND

87. The Key Role of Highly Erodible Land Determinations in Implementation
     of the Conservation Provisions of the Food Security Act of 1985
              Norman Kempf*
              Soil Conservation Service, USDA
              Bismarck, ND

88. Soil Surveys - How They Are Made and Their Use in Identifying Wetlands
     and Highly Erodible Land
              Sylvester C. Ekart*
              Soil Conservation Service, USDA
              Bismarck, ND

89. Procedure for Making Wetland Determinations
              C. M. Vicuna*
              Soil Conservation Service, USDA
              Huron, SD

90. Pilot Wetland Evaluation Project in the Red River Valley
              David Dewald*
              Soil Conservation Service, USDA
              Bismarck, ND

91. Conservation Planning Techniques and the Food Security Act of 1985
              Jay D. Fuhrer*
              Soil Conservation Service, USDA
              Bismarck, ND

92. Geographic Information Systems and the Food Securities Act
              Denis E. Mudderman*
              Geography Department
              University of North Dakota
              Grand Forks, ND

(86)   **INTRODUCTION TO THE FOOD SECURITY ACT OF 1985**
                        BY NORMAN KEMPF[*]

The Food Security Act of 1985 was passed with broad support from public, agriculture, conservation, and environmental groups. This act had its birth in the concern that large areas of virgin grasslands were being converted to cropland in Montana and Colorado. Senator Melcher of Montana and Senator Armstrong of Colorado proposed Sodbuster Legislation several times before the concept gained support in 1985.

The purpose of this act as stated in 7 CFR Part 12 published on September 17, 1987 is to remove incentives for persons to produce agricultural commodities on highly erodible land or wetlands. In order to accomplish these goals, four general provisions were developed.

1. Conservation Reserve Program – Provided ten year rental programs and cost share for cost of converting highly erodible fields to grass, trees or wetlands.

2. Sodbuster – Discouraged persons from cultivating land which was not planted to a commodity crop at least one year during the period 1981 through 1985.

3. Swampbuster – Discouraged persons from destroying wetlands.

4. Conservation Compliance – Provided for the conservation treatment of all highly erodible cropland by January 1, 1995.

The above provisions set forth eligibility requirements which must be met by all persons who wish to participate in specific benefits offered by the USDA.

(87)   **THE KEY ROLE OF HIGHLY ERODIBLE LAND DETERMINATIONS IN IMPLEMENTATION**
            OF THE CONSERVATION PROVISIONS OF THE FOOD SECURITY ACT OF 1985
                           BY NORMAN KEMPF[*]

The Conservation Reserve Program, Sodbuster, and Compliance Provisions of the Food Security Act were developed to protect highly erodible land. Soils information is necessary to first identify highly erodible soils. All soils mapped can be grouped into either highly erodible or non-highly erodible.

For the Conservation Reserve Program a field must have been cropped at least two years during the period 1981-1985 and be at least 2/3 highly erodible soil.

The Sodbuster Provision prohibits the planting of a commodity crop on land which is over 1/3 highly erodible soil and was not planted to a commodity crop at least one year during the period 1981-1985 unless they have a conservation plan in place which is approved by the conservation district.

The Compliance Provision applies to highly erodible lands which were planted to a commodity crop at least once during the period of 1981-1985. Any field that is at least 1/3 highly erodible must have a conservation plan developed and approved by the conservation district before a commodity crop is planted in 1990. The plan must be applied by January 1, 1995.

(88)   SOIL SURVEYS – HOW THEY ARE MADE AND THEIR USE IN IDENTIFYING WETLANDS
                          AND HIGHLY ERODIBLE LAND

Sylvester C. Ekart*, State Soil Scientist
USDA, Soil Conservation Service
Bismarck, N.D. 58502

Soils are related to distinguishable landform features, such as a dune, hill, knoll, swale, depression, or ridge. Soil surveys are made by exposing a soil profile on a selected landform. The excavation is usually to a depth of about five feet. The soil profile is examined to determine the kind and number of horizons (layers), color, texture, structure, and other features. Soils of like profile features are named, for example the Barnes soil series. The name assigned to a soil series generally is a local place name. An example is the Barnes soil series named for Barnes County, North Dakota or the Williams soil series named for Williams County, North Dakota. After a landform and its associated soil profile have been examined, the extent of the soil is delineated on an aerial photograph. The steps in making a soil map from exposed and examined soil profiles are illustrated in slides.

Because soil maps and soil descriptions record the kind of soil, the slope of the land, and identify the landform, many predictions can be made about the soil's behavior. For example, those soils identified as occurring in depressions and that exhibit features of wetness are said to be "Hydric Soils." Hydric soils developed under hydrophytic vegetation in a condition of saturation or ponding during part or all of the growing season. They most often are wetlands in an undisturbed setting. Conversely, soils occurring on a ridge or knoll that have steep slopes are subject to water erosion if the natural cover is removed. These steep soils may be designated "Highly Erodible Land" if the steepness of the slope and the length of the slope meet certain criteria.

(89)   PROCEDURE FOR MAKING WETLAND DETERMINATIONS

C. M. Vicuna*
Soil Conservation Service
Huron, South Dakota 57350

Wetland, as identified by the Food Security Act (FSA), is land that meets hydric soil criteria and is saturated or inundated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of hydrophytic vegetation.

Hydric soil criteria, defined in the "Hydric Soils of the United States 1985" (1) are based on organic content, saturation, ponding, and flooding. Prevalence of hydrophytic vegetation is based on a visual estimate or a transect. In either case, plants are identified and the plant indicator group is determined from the state wetland plant list (2).

Wetland determinations may be done in the office using soil survey maps, aerial photos, ASCS slides, National Wetland Inventory Maps, and other resources. Field determinations are made, if needed, to verify office determinations and when requested by a landowner.

Converted wetlands are those that have been altered to remove wetland characteristics and make production of agricultural commodities possible. There are several exemptions that allow production of ag commodities on converted wetlands. These include: wetlands that were converted prior to December 23, 1987; artificial wetlands; irrigation induced wetlands; farming under natural conditions; minimal effect determinations; and third party alterations.

1. USDA, Soil Conservation Service. 1985. Hydric Soils of the United States 1985.

2. USDA, Fish and Wildlife Service. 1986. Wetland Plants of the State of South Dakota 1986.

(90)   PILOT WETLAND EVALUATION PROJECT IN THE RED RIVER VALLEY

David Dewald*
State Staff Biologist
Soil Conservation Service
Bismarck, ND

The wetland provisions of the 1985 Food Security Act (FSA) requires a landowner/operator to have a wetland determination made prior to the manipulation of a wet area. The wetland determination is based on two criteria which make up the wetland definition for the wetland conservation provisions of FSA, hydric soils, and hydrophytic vegetation. Since many farmers clean out their drainage ditches in the fall after harvest, a wetland determination was needed prior to the activity. SCS was inundated by requests from farmers for these determinations in the Red River Valley in the fall of 1987 due to the dry conditions and the early harvest.

A pilot project was implemented to make wetland determinations in the Red River. Four member teams were placed in each of the six Red River Valley counties to make a wetland evaluation on the cropland acres. Soil survey maps, Agricultural Stabilization and Conservation Service (ASCS) color aerial slides, Fish and Wildlife Service National Wetland Inventory (NWI) maps and color infrared photography were reviewed by team members to make the evaluations. The evaluations were made section by section, township by township. For continuity in making the evaluations, a system was developed which considered the number of observations on five to six years of ASCS slides, occurrence on NWI maps, and color infrared photography. Climatic conditions were also considered.

(91)   CONSERVATION PLANNING TECHNIQUES AND THE FOOD SECURITY ACT OF 1985

Jay D. Fuhrer*
USDA Soil Conservation Service
Bismarck, N.D.

The Food Security Act of 1985 (FSA) has greatly increased the number of conservation planning acres and decision makers which the Soil Conservation Service (SCS) assists. One-on-one conservation planning was utilized at the Bismarck Field Office for the Conservation Reserve Program (CRP) on sign-ups 1-3, which ended August 15, 1986. The strengths of small group planning and computers were combined to complete CRP signups 4 and 5 in an accurate and timely manner. Table 1 illustrates the growth in both acres and plans in each subsequent signup.

Small group planning and computers proved highly successful in administrating all aspects of the CRP. Consequently, their next logical use was for the compliance provision of the FSA. The primary, ongoing goal to accomplish for compliance in Burleigh County will be to plan approximately 100,000 plus acres with 400 plus decision makers, all before 1-1-90.

Table 1
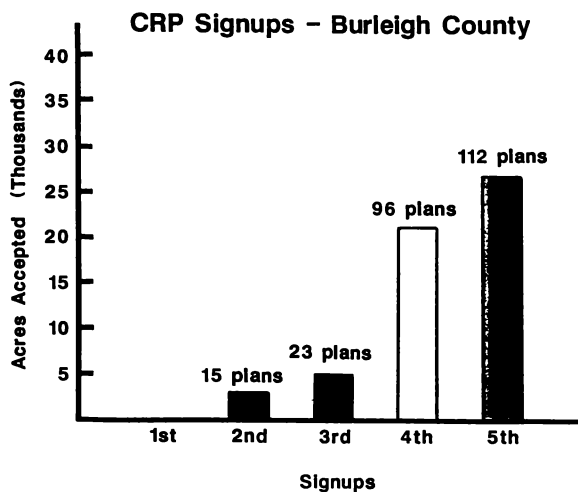
CRP Signups – Burleigh County

(92)   GEOGRAPHIC INFORMATION SYSTEMS AND THE FOOD SECURITIES ACT

Denis E. Mudderman[*]
Geography Department, University of North Dakota
Grand Forks, North Dakota 58202

Effective management of North Dakota land and soils will become ever more important for maintaining the state's strong agricultural economy and protecting North Dakota's contribution to local and world food needs. According to a national inventory by the United States Soil Conservation Service, seven tons of soil per acre per year on uncultivated cropland is lost to erosion and over eight tons lost from cultivated cropland (1). Much of this erosion is concentrated on a small fraction of land. The]985 Food Security Act addresses these problems and mandates the inventory and supervision of these more vulnerable highly erodible soils. In addition to the issues of erodible soils are problems of wetlands and their drainage, land use, and urban development encroaching on productive cropland such as in the Red River Valley. These problems and challenges in resource management, rural development, and planning in North Dakota are complex and made more challenging because of tigher fiscal constraints placed on federal, state, and local agencies. An important new tool that may help address these resource management challenges is geographic information systems (GIS). These computer based systems are designed for the storage, manipulation, analysis, and display of spatial information.

Many of these geographic information systems are large scale or employ expensive software or hardware systems. An approach being developed at the University of North Dakota Geography Department involves application of modest scaled systems and techniques to produce GIS base maps and computed results. These methods are being used to test and set-up base maps that can be used in a range of resource management and rural planning needs. One focus is inventory and management of highly erodible soils. This work will be conducted by the Soil Conservation Service for the state as part of the 1985 Food Security Act. These same tools being developed are also being applied to North Dakota county tax equalization and land use planning.

In the absence of expensive optical scanning systems the tabletop digitizer has proved to be very useful for the production of computer base maps. The greatest limiting factor for tabletop digitizing is human operator error found previously to be a more than exeptable plus or minus 2.78 percent with a 95 percent confidence (2). An important base map for the monitoring under the Food Security Act is the computerization of Soil Conservation Service soil maps. With microcomputer software developed by Dr. Floyd Hickok of the UND Geography Department, whole sections are digitized from the soil maps and in a second step edited and soil type classification codes enterd for each soil area. ASCS field areas which identify cropland and land ownership are also digitized using the system. Computer pen plots and acreage summaries of highly erodible land are computed by fields and ownership. This provides an inventory of soils vulnerable to erosion with computed total acreage of potentially erodible land of concern in the Food Security Act. Through work on behalf of Ramsey and McHenry Counties, base maps are also being produced of county agricultural ownership parcels. When these agricultural parcel base maps are overlayed with soil base maps, soil type areas are computed by property and combined with land valuation schedules for tax equalization. These essential rural land base maps will provide county and local governments added capability in planning and management. Geographic information systems will increasing assist North Dakota policy makers in making decisions, managing resources, and protecting vulnerable soils from erosion.

1. Zinn, Jeffery. (]986) Implementing the Resource Conservation Provisions in the Food Security Act of 1985: A Status Report. Washington, D.C.: Congressional Resarch Service.

2. Mower, Roland D., and Mudderman, Denis E. (]985) Report on Traill County Soil Type Digitizing Project. Grand Forks, North Dakota: University of North Dakota Institute for Remote Sensing.

SYMPOSIUM

on

SCIENCE EDUCATION

Presiding: Clark Markell
               Minot State University
               Minot, ND

93. A Computer-Interfaced Diode Array Spectrophotometer in Undergraduate
     Laboratories
               Bob Crackel*
               Chemistry Department
               Minot State University
               Minot, ND

94. Instructional Use of Computers in Chemistry at MSU
               Stephen L. Lowe*
               Department of Chemistry
               Minot State University
               Minot, ND

95. Status of the Science Olympiad in North Dakota
               Donald R. Scoby*
               Department of Botany/Biology
               North Dakota State University
               Fargo, ND

96. Networking South Dakota Science Teachers
               J. Opbroek
               Science Department
               Mitchell High School
               Mitchell, SD

               W. Hein*, W. Jensen, and G. Peterson
               South Dakota State University
               Brookings, SD

(93) A COMPUTER-INTERFACED DIODE ARRAY SPECTROPHOTOMETER IN UNDERGRADUATE LABORATORIES

Bob Crackel*
Chemistry Department, Minot State University
Minot, N.D. 58701

As an initial step in updating the instrumentation used in undergraduate chemistry courses at Minot State University, the department recently obtained an HP8452 Diode Array Spectrophotometer. The purchase of this instrument serves several purposes. One of these is the replacement of a non-functional recording spectrophotometer. Another is the exposure of students to the use of computer-interfaced instrumentation. Also the performance of the instrument is such that it can be used in faculty-directed undergraduate research.

Some of the features of the instrument which make it attractive for undergraduate laboratories include:

1) A diode array detector with 2 nm resolution that can be used to scan a spectrum from 190 to 820 nm in 0.1 seconds.
2) An interface to a Leading Edge computer which is used to control the instrument's operation.
3) Software which includes programs allowing general scanning, quantitative analysis, and kinetics experiments.
4) A Think Jet printer for obtaining hard copies of experimental data.
5) A thermostattable cell-holder for experiments which require constant temperature.

So far the instrument has been used for laboratories in Instrumental Analysis and Physical Chemistry as well as undergraduate research. The experiments in Instrumental Analysis for which the spectrophotometer was used include: Photometric Titration of Bismuth and Copper with EDTA (1), Spectrophotometric Determination of the pK_a of an Acid-Base Indicator (2), and Determination of the Formula of a Complex Ion (3). In Physical Chemistry the instrument was used for the following experiments: Determination of the Equilibrium Constant: The Acid Dissociation Constant of a Dye Indicator (4) and Reaction Kinetics: The Bromination of Acetone (4). Also an undergraduate research project involving dimerization and aggregation of molecules makes extensive use of the instrument.

(1) A.L. Underwood, Anal. Chem., 26, 1322 (1954).
(2) C.N. Reilley and D.T. Sawyer, Experiments for Instrumental Methods, McGraw-Hill Book Company, New York, 1961.
(3) R.A. Day, Jr. and A.L. Underwood, Laboratory Manual for Quantitative Analysis 5th edition, Prentice-Hall, Englewood Cliffs, N.J., 1986.
(4) H.D. Crockford, J.W. Nowell, H.W. Baird, and F.W. Getzen, Laboratory Manual of Physical Chemistry 2nd edition, John Wiley and Sons, New York, 1975.

(94)   Instructional Use of Computers in Chemistry at MSU

Dr. Stephen L. Lowe*
Department of Chemistry, Minot State University
Minot, N.D. 58701

During the past ten years at Minot State I have used computer programs in my courses in a variety of ways including:

Data handling programs in upper level laboratory courses.   In the past I have utilized my own programs for curve fitting by least squares and for graphing; currently the students have access to commerical programs for the Macintosh.

Tutorial programs. For the course taken by allied health students I wrote programs to help teach scientific notation and logarithms.

Laboratory Simulations.   Examples of these I have used include simple programs which simply print out messages ("Your unknown gave a precipitate with $KMnO_4$... ") and more sophisticated ones such as ENZKIN, a commercially available program, which allows the student to run a series of simulated kinetics experiments on hypothetical enzymes.

My most extensive instructional use of the computer has been in providing trial quizzes as study aids for students.   For several years I used a set of programs called TIPS for this purpose. These programs were available on the HECN network and allowed the instructor to create data files containing multiple choice questions and help messages to be given for questions missed by the student.   While the TIPS programs were fairly satisfactory, I felt that a more user friendly system could be written for a microcomputer and wrote a set of programs for the Apple IIe.

The system developed for the Apple enables students to attempt trial quizzes with a minimum of instructions and includes user friendly programs for instructors with minimal computer knowledge to create their own trial quizzes.   The Apple programs have been marketed under the title "Trial Quiz" through Kinkos Academic Courseware Exchange.

While the Apple version represented an improvement over the TIPS programs, there remained two important problems: the Apple has very slow disk access and poor graphics.   To solve these problems I have developed a new version for the Macintosh which is being used for the first time this quarter.

Student reactions to these trial quizzes have been quite favorable.   In student surveys the feature most frequently listed as most liked is the help messages; the most desired change is simply to provide more trial quizzes.

(95)   Status Of The Science Olympiad In North Dakota

Donald R. Scoby *
Department of Botany/Biology, North Dakota State University
Fargo, North Dakota 58105

The Science Olympiad is an academic interscholastic competition for elementary, junior high, and high school students. Nationally and through state wide tournaments the Olympiad has the potential to: (1) stimulate student interest in science, (2) increase science education visibility and (3) improve community perceptions of science education. The Science Olympiad tournaments are academic interscholastic competitions consisting of a series of approximately twenty-five individual and team events which students prepare for during the year. The competitions follow the format of popular board games, TV shows, and olympic games. The events are balanced between the various disciplines of biology, earth science, chemistry, physics, computers, and technology. There is also a balance between events requiring knowledge of science facts, concepts, processes, skills and applications.

For three years North Dakota State University has hosted the North Dakota State Science Olympiad. The first year teams were selected from the Southeastern area of North Dakota with 20 schools represented. For the second and third years, additional teams were solicited with schools represented from a greater geographical area (Minot and Bismarck).

During the summer of 1987, with funding provided by a Title II grant, five workshops were held at different sites throughout North Dakota. An overall data summary is contained in Table I. The first evening consisted of the history and philosophy of the Science Olympiad, a video tape presentation of the May 1987 North Dakota State Science Olympiad, and a slide presentation covering the events and activities in the Elementary, Junior High, and Senior High Divisions.

The second or morning session consisted of the various teams organizing their involvement and participation in the twelve selected mini-olympiad events. Teams met in the afternoon session to create a potential science olympiad event and to discuss the logistics in establishing a regional and/or an elementary science olympiad in their area. The workshop was concluded by having an awards ceremony. Throughout the workshop we tried to simulate the actual science olympiad which in practice generates a great deal of science enthusiasm and cooperation of a team.

As a result of the workshops, four regional sites have been selected for the Spring of 1988. State competition will be April 23, 1988 at North Dakota State University. The winning team will be invited to participate at the National Science Olympiad, May 21, 1988, at Delaware State University, Dover, Delaware.

TABLE I

Science Olympiad Workshops 1987

Workshop Date	Site	Site Coordinator	Number Preregistered	No Shows	Total Attendance	Requested Credit	No. Taking For Credit
June 26-27, 1987	Valley City, ND	Dennis Horsager	28	6	22	28	22
June 29-30, 1987	Grand Forks, ND	Lee Murdock	15	0	15	10	10
July 10-11, 1987	Bismarck/Mandan, ND	Mike Stoy	26	7	19	22	16
July 17-18, 1987	Dickinson, ND	Myron Freeman	15	5	10	12	7
July 24-25, 1987	Minot, ND	Keith Altendorf & Robert Crackel	25	12	13	22	13
			109	30	79	94	68

(96)   NETWORKING SOUTH DAKOTA SCIENCE TEACHERS

J. Opbroek
Science Department, Mitchell High School
Mitchell, SD 57301

W. Hein,[*] W. Jensen, and G. Peterson
South Dakota State University
Brookings, SD 57007

A telecommunications network of high school science teachers has been developed within South Dakota as a means of increasing the interest and awareness level of the sciences, providing the necessary exchange of information and ideas between high school students and teachers at the participating schools, and increasing the interaction of students and teachers with university faculty. Twenty high schools selected to represent a broad cross section of the state were given modems and software to use with existing microcomputers at each school. Training was provided for each of the participants and each school was allotted funds for long distance telephone calls so the participants could interact with the system microcomputer on a weekly basis.

The core of the conferencing system is a telecommunications package called "Common Ground" developed by the Education Technology Center at the Harvard Graduate School of Education. This software is running on an AT&T PC6300 equipped with hard disk located in the Biology Department at South Dakota State University. Faculty in the Biology, Chemistry, and Physics Departments are active participants in the network.

The network first became operational in October of 1987 and initial usage was limited. A number of cooperative projects were initiated to stimulate usage of the network with the result that the number of users and frequency of use increased to the point where the money budgeted for long distance calls was almost exhausted by February of 1988. Initial support for the project was provided by Title II, 3M Company, and South Dakota State University. Additional funding is being sought to help support the long distance telephone charges and to purchase more modems so additional schools can be added to the network. Faculty at colleges and universities in the Dakotas are invited to participate in the network.

(13)   EFFECTS OF GRAZING SYSTEMS ON WATERFOWL NESTING
IN SOUTH CENTRAL NORTH DAKOTA

K. Sedivec* and W.T. Barker
Animal and Range Sciences Department, North Dakota
State University, Fargo, N.D. 58105

At the Central Grasslands Research Station (CGRS) near Streeter, N.D. range scientists began studies of seasonlong, short duration, twice-over rotation, switchback, and complementary grazing systems in 1981. These studies are continuing. The ongoing range studies have provided the opportunity to compare the nesting success of waterfowl in relation to these grazing treatments. Idle mixed-grass prairie, similar to areas provided by wildlife refuges, was also compared to the grazing systems. The data presented here are part of an ongoing six-year study that has been partially funded by the N.D. Game and Fish Department.

The seasonlong grazing pasture consisted of 129.6 ha, which was grazed continuously for 160 days in 1987 from May 28 to Nov. 4. The short duration system consisted of eight 16.2 ha pastures in which cattle were allowed to graze for 5 days and then rotated to the next pasture. Four complete rotations were carried out in 1987 for 160 days, beginning on May 28. The twice-over rotation system consisted of four 32.4 ha of native grass pastures (replicated twice) which were grazed for two 20-day periods with 60 days of rest between each grazing period. In 1987 the twice-over system was grazed for 160 days beginning on May 28. The switchback system consisted of two 16.2 ha native grass pastures (replicated twice) which were grazed for four 20-day periods with 20 days of rest between each grazing period. In 1987 the switchback system was grazed for 160 days beginning on May 28. The complementary system consisted of three tame-grass pastures and one native grass pasture. Cattle began grazing on April 24, 1987 on a crested wheat grass pasture (12.2 ha) and remained there till mid-May. The cattle were then rotated to a native grass pasture (32.4 ha) and grazed till the second week of September. From the native grass pasture, the cattle were rotated to a Russian wildrye pasture (12.2 ha) where they grazed till mid-October. The cattle grazed altai wildrye (12.2 ha) from mid-October until snow dictates the removal of the cattle, usually mid-November. The idle area was not grazed and consisted of 76.9 ha.

Reported declines of prairie chickens, sharptail grouse, sage grouse, and waterfowl due to intensive grazing pressure are frequent in the literature (1, 2). The major factor implicated in the decline is a reduction of residual cover. In April of 1987 the amount of residual cover on the various range sites was determined prior to vegetation greenup. In late May, 1987, the amount of residual cover was determined at greenup by the Robel method (3). Nest-searching was carried out four times at three-week intervals by pulling a chain between two all-terrain vehicles to locate nests. Nest-searching occurred on all grazing treatments and the idle area and began on May 5, 1987. After a nest was located data were collected to determine site characteristics around the nest, the species nesting, and the stage of development of the nest. Follow-up visits were made to each nest to determine the ultimate success or failure of the nest. Table 1 shows the number of nests located, number of nests per 100 ha, percent apparent success, and percent Mayfield success on the grazing treatments and idle area for 1987. Ten species of waterfowl nested in the idle area and grazing systems. In conclusion, the twice-over rotation had the highest Mayfield success which enables us to conclude that it was the most successful treatment in 1987.

Table 1. Number of nests, number of nests per 100 ha, percent apparent success, and percent Mayfield success on the grazing treatments and idle area in 1987

Treatment	Number of Nests	Number of Nests/100 ha	Apparent Success	Mayfield Success
Seasonlong	78	60.0	62.7	33.3
Short duration	89	69.0	48.2	20.0
Twice-over rotation	119	46.0	63.5	39.9
Switchback	49	76.0	52.2	24.9
Complementary	17	25.0	17.6	7.0
Idle	49	64.0	38.3	14.4
Total	401	55.0	53.3	26.5

1. Kirsch, L.M. et al. (1973) J. Wildl. Manage. 37, 449-453

2. Bue, I.G. et al. (1952) Trans. N. Am. Wildl. Conf. 17, 396-414

3. Robel, R.J. et al. (1970) J. Range Manage. 23, 295-297

(16)   RECENT CHANGES IN THE ETHNOBOTANY OF STANDING ROCK INDIAN RESERVATION

Shelly K. Hoganson*
Department of Geography
University of North Dakota
Grand Forks, ND 58202

Plant use among the Sioux has been greatly reduced and in some cases completely eliminated due to the water infringment caused by the Oahe Dam. This dam has had a considerable impact on the biogeography of the Standing Rock Indian Reservation. As a result of the Pick-Sloan Plan of 1944, the Sioux people were forced to give up their homes in the bottomlands, in violation of their treaty rights of 1868, which stated that congress could not take Indian lands without just compensation and 2/3 of the adult Indian vote. In January 1960, almost 200 Indian families were evacuated from their homes adjacent to the Missouir River and relocated in new homes to pursue new lifestyles on the remaining marginal prairies of their reservation.

Gathering and preserving wild fruits and vegetables for food and medicine especially from the wooded bottomlands was a traditional part of the Sioux culture. There was virtually no compensation for the roots and berries that the people gathered along the river and creek banks on the reservation which are now completely under water (1). Only the tops of some of the trees are left as a reminder that a wooded bottomland once existed. My intentions are to describe the effects of the Oahe Dam on the ethnobotanical resources that were reduced or completely lost due to flooding of these Indian lands.

In Missouri River Basin Investigation (MRBI) report 138 (2), timber, game and wild plants were stated as resources basic to survival of the Sioux of Standing Rock Reservation. The report also stated that by destroying these resources the Indians would be forced to become more dependent on welfare or on a wage-earning income. Traditional Sioux peoples would collect natural medicines and foods for their personal use which in turn preserved their knowledge of ethnobotany of this diverse biogeographical area. After interviewing several Sioux elders, I concluded that the distribution of many plants, due to the flooding of the bottomlands, has been reduced to isolated geographic areas and that many people no longer have access to them. The loss of knowledge of wild plant usage among these people has resulted in an aspect of Sioux culture that is in danger of being forgotten. One example is _Falcata comosa_, commonly referred to as the "ground bean or mouse bean" by the Sioux. In 1919, Melvin Randolph Gilmore made reference to this plant as being utilized for food by the Sioux (3). According to two of the Sioux elders I interviewed, Harry Swift Horse, age 87 from Cannon Ball, North Dakota and Philamein One Feather, age 79 from McLaughlin, South Dakota, this plant no longer is available for use in this region due to the flooding of its habitat, the moist wooded bottomlands along the Missouri River.

The availability of other plant species such as _Shepherdia argentea_ (buffaloberry), _Prunus virginiana_ (chokecherry), and _Prunus americana_ (wild plum), eaten raw or dried and stored for winter use has been greatly reduced. The latter two were also used as medicines. _Vitis vulpina_ (wild grape), which is used for food, dye, medicine and in sacred ceremonies like the Sun Dance has also become quite scarce on the reservation because of the flooding (4,5). Wild grape has become so limited in distribution that many people no longer have access to the plant. In addition, many natural food sources and natural medicines that are still available are being over-exploited due to their limited quantities and restricted areas in which they now grow.

The loss of plants as food and medicinal sources and timber for fuel because of the construction of the Oahe Dam created a socio-economic setback for the Sioux. They could no longer rely on these once widely abundant resources. Therefore, the Sioux were forced to become less dependent on subsistence, which was based directly on natural resources and more dependent on a wage-earning economy off the reservation or to become more dependent on welfare.

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(20)   UPPER CRETACEOUS AND PALEOCENE
NONMARINE MOLLUSCAN PALEONTOLOGY IN THE WILLISTON BASIN

Joseph H. Hartman*
Energy and Mineral Research Center, University of North Dakota
Box 8213, University Station, Grand Forks, North Dakota 58202

The absence of in situ biochronologic control in nonmarine strata in the Williston Basin and else-where in the northern plains has limited our ability to interpret depositional histories and correlate across eroded or covered strata. In addition, few, if any, geologic studies in the United States portion of the basin have attempted to integrate the large number of specific local observations on stratigraphic sections and distinctive lithologies. The myriad of formally and informally named lithostratigraphic units, from coal beds to river channels, indicates a complex puzzle of which the pieces need to be fit together.

The basis for establishing biochronologic control for a considerable percentage of the nonmarine strata in the Williston Basin largely already exists. The eight land-mammal local faunas, about one-third of which have yet to be studied, provide the temporal control for regional and continental-scale correlation. These mammal occurrences are assigned to the Puercan (early), Torrejonian (middle), and Tiffanian (late) Paleocene land-mammal ages, which are represented by one, two, and five localities, respectively. In addition to these temporally significant records, there are over 550 nonmarine mollusk localities. The stratigraphic distribution of these occurrences is biased, in part, by the differences in outcrop extent of the formations in the sequence. The Upper Cretaceous record in the Williston Basin is known almost exclusively from about 30 localities in the Hell Creek Formation of North Dakota. The lower and middle Paleocene are represented by the about 60 localities in the Ludlow and Slope (in part) Formations in North Dakota, equivalent units in Montana, and from lower and middle strata of the Ravenscrag Formation in the eastern Cypress Hills and Big Muddy drainage of Saskatchewan. The upper Paleocene is represented by about 450 localities occurring throughout the Bullion Creek and lower half of the Sentinel Butte Formations in North Dakota, the Tongue River Member of the Fort Union Formation in Montana, and in the upper strata of the Ravenscrag Formation in the Estevan area of Saskatchewan. Upper Paleocene mollusk occurrences are also known from the Slope Formation of south-central North Dakota. Only four mollusk localities, two from each member, are known from the Paleocene/Eocene Golden Valley Formation of North Dakota.

The abundance and widespread distribution of nonmarine mollusk localities throughout the Williston Basin provide the opportunity for relatively precise age assessments of the enclosing strata. Mollusks do not yet, however, provide the precision available with fossil mammals. The evolutionary history of mammalian lineages has received far greater study, though frequently divorced from any well-documented knowledge of stratigraphic successions. To approximate the precision of land-mammal ages, mollusk records need to be placed in well-correlated stratigraphic intervals to evaluate their temporal and biogeographic morphologic variation. Although complex to interpret, integrated historic stratigraphic observations are available and sufficient to construct a framework for molluscan species occurrences throughout most of North Dakota and Saskatchewan. The stratigraphic context is based on thousands of observations, including geologic sections, coal bed records, and geologic mapping. The results of analyzing approximately 700 sections show clearly the difficulty in recognizing and correlating the following situations: 1) Cannonball/Slope contact in south-central North Dakota, 2) Slope/Bullion Creek contact in western and central North Dakota, 3) stratotype of the Fort Union Group (Formation) from Fort Union, 4) across the Nesson Anticline, 5) across the Montana/North Dakota state line, and 6) across the Cedar Creek Anticline. Even with these problems, sufficiently well-correlated strata, spanning nearly the entire Paleocene, occur in the Little Missouri River valley and in the Missouri River valley of central North Dakota. Biochronologic correlation and lithostratigraphic comparisons between these two areas suggest diachronous Slope/Bullion Creek and Bullion Creek/Sentinel Butte contacts, with eastward thinning of both the Slope and Bullion Creek Formations.

Studies underway have begun to integrate the available geologic and paleontologic data of the Williston Basin. The development of a detailed geologic picture will provide a better context in which to solve the specific problems mentioned above. As the Williston Basin includes both the stratotype for the Fort Union Group (Formation) (and thus in essence, the entire North American Paleocene stratigraphic succession) and the type-localities of numerous nonmarine molluscan taxa that are identified throughout western North America, we are obliged to work toward a fuller understanding of the biostratigraphy and lithostratigraphy of so significant a section in our own backyard.

(22)   PEAT INITIATION AND ACCUMULATION DURING THE HOLOCENE, DENBIGH FEN,
McHENRY COUNTY, NORTH DAKOTA

T. J. Malterer* and J. P. Bluemle
University of North Dakota Energy and Mineral Research Center and
North Dakota Geological Survey, Grand Forks, North Dakota 58202
A. J. Duxbury, B. L. Heidel, and C. Godfread
North Dakota Game and Fish Department, Bismarck, North Dakota 58501

The Denbigh Fen is a large (200 ha) peatland in McHenry County, North Dakota (Sec.25, T.155N., R.77W.). It is located in a broad, abandoned meander of the Souris River. Although the regional climate is generally not considered conducive to peat accumulation, peat accumulated as a result of favorable interaction between a local topographic depression and nearby discharging groundwater. The source of groundwater is primarily the sand and gravel of the broad outwash plain to the east and south of the fen; groundwater flows through the permeable outwash and on top of the underlying, nearly impermeable glacial till (1).   Recent research indicates that the fen has abundant calciphilic surface plants and it is unusually calcareous at the peat surface.

In the summer of 1987, the authors probed and sampled numerous sites on the fen. Peat thicknesses ranged from a few centimeters, near the edge of the fen, to 490 centimeters at the deepest site sampled. The unusually thick peat is of considerable scientific interest, considering that the prairie climate regime of the area does not generally favor peat accumulation. Because of the favorable peat-forming environment and resulting peat accumulation, it was thought that the peat could have accumulated throughout the last 10,000 years (Holocene), thus preserving pollen and plant macrofossils.   Interpretation of pollen and plant macrofossils could provide a significant chronological record for reconstruction of past environments and climatic conditions.

In order to reconstruct the history of peatland development, the authors collected a core from the deepest part of the Denbigh Fen. Core materials were identified and selected parts of the core were analyzed by standard U.S. Department of Agriculture characterization methods (Table 1). The core materials indicate that the peatland developed on an abandoned river meander (river-laid sand). Initially, the meander contained a shallow lake that filled, first with mineral-rich lake sediment and then with gyttja. Subsequently, a considerable amount of peat accumulated. A peat sample was collected (485-490 cm) at just above the gyttja-peat boundary. The sample was radiocarbon dated (4790 + 80 years B.P.). The 4790 B.P. date establishes the time of peat initiation and it is assumed that peat has continously accumulated since. The radiocarbon date also allows a calculation of the average annual rate of accumulation. Given 490 cm of peat accumulation over 4790 years, the average annual rate of peat accumulation was 0.102 cm/yr or 10.2 cm/100yr. This is a phenomenally high rate and it rivals peat accumulation rates in the most productive peat-forming environments (3). Because of the shallowness of the initial lake, and the likelihood that it periodically dried up, it is unlikely that the gyttja and lake-laid sediment had uninterrupted accumulation prior to peat accumulation.

Table 1. Physical and Chemical Characterization Data for Selected Peat Core, Denbigh Fen.

Type of Material and Depth (cm)	Sample Depth (cm)	Water Content (wt %)	Bulk Density (g/cm^3)*	Ash Content (wt % 550°C)*	Calcium Carbonate Equivalent (wt %)*
Peat (autochtonous)	0-5	86.6	----	45.0	35.31
0-490	25-45	90.7	0.07	19.1	1.85
	75-95	88.1	0.09	17.4	1.87
	125-145	91.8	0.10	15.6	0.99
	175-195	86.9	0.10	21.2	0.93
	225-245	87.0	0.11	24.1	0.66
	275-295	85.9	0.12	25.6	0.57
	325-345	88.1	0.10	28.2	0.81
	375-395	86.8	0.11	24.3	0.97
	425-445	82.9	0.19	44.3	0.98
	475-490	80.3	0.19	42.3	0.62
Gyttja (allochtonous) 490-585	540-550	68.3	0.68	75.7	3.49
Mineral-Rich Lake Sed. 585-695	620-630	35.4	0.86	92.1	10.16
	680-690	37.1	0.86	96.1	7.93
Sand (river-laid)	695-710	----	----	----	----

* Calculated on an oven-dry basis.

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(24)   AGE OF WHITE RIVER GROUP, SOUTHWEST NORTH DAKOTA,
        DETERMINED BY YELLOWSTONE RIVER INCISION RATES

Eric N. Clausen*
Division of Science, Minot State University
Minot, North Dakota 58701

Clausen (1) presents evidence that White River Group sediments in southwest North Dakota include gravel and cobble size material derived from the Yellowstone River drainage basin. Ashworth (2) documents the presence of fossils, considered to be Orellan in age, in the North Dakota White River Group sediments. Based on faunal correlation Kihm and Lammers (3) suggest the time span of the White River Group (in North Dakota) is, perhaps, 33.0 to 28.0 million years ago (Ma). Clausen (4) argues for a much younger age suggesting the gravel and cobble size material was most likely introduced during a glacial episode, perhaps within the last few million years. The purpose of this paper is to calculate the age of the White River Group sediments in southwest North Dakota based on published Yellowstone River incision rates.

Published incision rates calculated for the Yellowstone River and major tributaries are summarized in Table 1. The highest incision rate (5) was calculated using fission-track ages on zircons in clinker found 300 m above the present-day valley floor. The lowest rates (6) were calculated using fission-track ages on zircons from ash deposits in sands and gravels found 365 m and 400 m above valley floors. Many of the other incision rates were calculated from dated ashes or by correlating river terraces with other terraces containing dated ashes.

Coarse-grained alluvium derived from the Yellowstone River drainage basin underlies fossiliferous units at White Butte in Slope County and the Little Badlands in Stark County. The age of this coarse-grained alluvium can be calculated using the published Yellowstone River incision rates listed in Table 1. For each location an equivalent point downstream in the present-day Yellowstone-Missouri River valley was determined. The elevation of this equivalent point was then subtracted from the elevation of the highest and lowest elevations at each sediment location to determine incision since deposition of Yellowstone River sediments at that site. Ages for the White Butte and Little Badlands alluvium were calculated using the lowest and highest incision rates from Table 1. Age ranges determined for the highest and lowest elevations of alluvium at the two locations are shown in Table 2.

Published Yellowstone River incision rates are not consistent with each other suggesting some or all of the rates may be based on limiting dates, not actual dates for sediments. The incision rates shown in Table 1 represent minimum rates (assuming the radiometric age dating techniques applied are valid and the techniques were correctly applied). Incision rates may be much higher, but can not be lower than those shown in Table 1. The published Yellowstone River incision rates do not support an age range of 33.0 to 28.0 ma for the White River Group sediments in southwest North Dakota. The published Yellowstone River incision rates do support a much younger age for the White River Group sediments in southwest North Dakota.

Table 1

Published Incision Rates for Yellowstone River and Major Tributaries (expressed in meters/10,000 years)

Location	Worker(s)	Rate
Greybull River near Tatman Mtn, Wy.	Ritter (7)	1.83
Bighorn River, Bighorn Basin, Wy.	Palmquist (8)	1.58
Clark's Fork, near Redlodge, Mt.	Reheis and Agard (9)	1.2
Yellowstone River, near Billings, Mt.	Reheis and Agard (9)	1.5
Tongue River at Ashland, Mt	Coates, Naeser and Heffern (5)	3.0
Yellowstone River south of Circle, Mt.	Colton, Naeser, and Naeser (6)	.57
Missouri River south of Flaxville, Mt.	Colton, Naeser, and Naeser (6)	.365

Table 2

Age Ranges Based on Low and High Incision Rates and High and Low Elevations of Alluvium

Location	.365m per 10,000yr	3.0m per 10,000yr
White Butte (high)	14.2 Ma	1.7 Ma
White Butte (low)	10.4 Ma	1.3 Ma
Little Badlands (high)	12.3 Ma	1.5 Ma
Little Badlands (low)	8.2 Ma	1.0 Ma

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(25)   EXCAVATIONS IN HOGBACK RIDGE, NORTH-CENTRAL NORTH DAKOTA

John P. Bluemle*
North Dakota Geological Survey, Grand Forks, ND 58202
Mark L. Lord and Nathan T. Hunke
Geology Department, University of North Dakota, Grand Forks, ND 58202

A spectacular drumlin field encompassing an area of about 1000 km^2 (40km x 25 km) in north-central North Dakota is characterized by an array of about 200 long, linear drumlins (megaflutes). Typically, the ridges are 1 to 3 km long, 0.05 to 0.15 km wide at the base, and up to 10 m high. Length to width ratios generally range between 1:10 and 1:30. Many of the ridges are bordered, on either side, by long, narrow depressions. The largest of the ridges ("Hogback Ridge") is a remarkably straight and symmetrical feature, 27 km long, 60 to 120 m wide, and about 8 m high through most of its length (length to width ratio is about 1:240). Hogback Ridge heads at a glacier-thrust mass and is intimately associated with washboards, some of which onlap the ridge. The drumlin field is closely associated with and occurs immediately behind (upglacier of) an extensive area of ice-thrust topography.

Two backhoe excavations in the Hogback Ridge revealed an intricate array of internal stratigraphic and structural features. Types of sediment found within the ridge include lake deposits (bedded silt and clay), river deposits (sand to gravel), glacial till (gravelly sand, silt, and clay), and bedrock inclusions (sandstone blocks). The bedded sediments tend to dip steeply, either toward or away from the center of the ridge. Numerous small-scale, normal (gravity) faults dip downward away from the center toward the sides of the ridge. Although some original fluvial bedding occurs, most of the water-lain materials appear to have been disturbed by ice movement or collapse during the formation of the ridge. Large (>1m diameter) inclusions of intricately bedded, incompetent material occurring within the other sediments appear to have been frozen at the time they were emplaced. In some blocks of material, delicate primary sedimentary structures are preserved, but in some of the more irregular blocks, they have been destroyed.

Based on study of its internal structures, we infer that Hogback Ridge is primarily constructional and was formed by the transfer of material from the sides (areas that are now sloughs) toward the center. Intact blocks of material suggest that some sediments were frozen while being transported; exposures of irregular, "blobby" sediment suggest transport of other materials in a semi-fluid state, probably under high-pressure pore-water conditions. The ridge probably was initiated in an ice-hollow that formed as fast-moving ice passed over a freshly-thrust mass or other obstruction. An excavation in another of the megaflutes showed that a knob of Tertiary Cannonball Formation sandstone is present at the head of that feature; it could not be determined whether the sandstone knob is in-place and undisturbed or if it had been thrust. Upglacier of the megaflute field, the glacier overrode coarse-grained lake sediment associated with the glacial Lake Souris; this sediment has high groundwater storage capacity. Excess pore-water pressure built up as the ice overrode the glacial sediments and this initiated fluidization of bed material and rapid movement of the ice sheet.

The close and systematic association of Hogback Ridge and other megaflutes with nearby areas of ice-thrust topography indicates a genetic tie; conditions that allowed the glacier to form the thrusts almost certainly also contributed to forming the megaflutes. Major factors involved in the formation of the megaflutes were high porewater pressures beneath the glacier ice, surging or streaming glacial conditions, interbedded permeable and impermeable beds, and the presence of areas of frozen ground near the glacier margin.
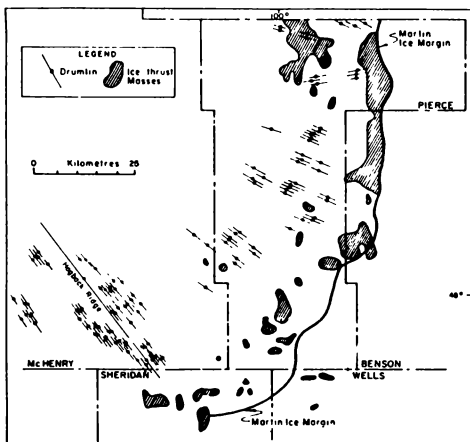

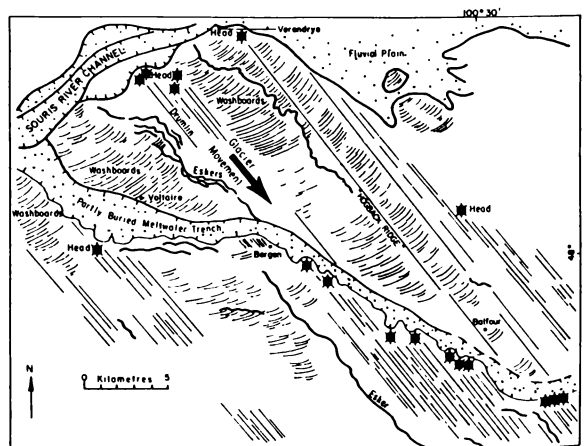Figure 1.   Drumlin fields in north-central Dakota.

Figure 2.   Regional geology in the area of Hogback Ridge.

(27)   TOPOGRAPHIC MAP EVIDENCE FOR CATASTROPHIC FLOODING:
                MISSOURI RIVER BASIN, MONTANA AND NORTH DAKOTA

Eric N. Clausen *
Division of Science, Minot State University
Minot, North Dakota 58701

The hypothesis that catastrophic floods formed the Missouri River valley was proposed more than 120 years ago by General G.K. Warren (1). The hypothesis was further developed by Todd (2) in the early part of this century. Later workers, including Leonard (3), Alden (4), and Flint (5), ignored the catastrophic flood hypothesis and tried to explain landforms in the Missouri River basin with an alternative hypothesis of gradual evolution by normal stream erosion. The geomorphic models for gradual evolution of Great Plains landforms by normal stream erosion have been further refined by many recent workers (6).

An "outrageous hypothesis" was proposed by Bretz (7) to explain landscapes in eastern Washington. Bretz proposed a truly catastrophic flood, which produced a gigantic pattern of anastomosing valleys and channels in the region known as the Channeled Scablands. The debate over Bretz's hypothesis raged on for nearly fifty years, although today the concept is generally accepted (8). Two of Bretz's leading critics (8) were the same Alden and Flint who helped shape the generally accepted geomorphic models for the evolution of landforms in the northern Great Plains.

Flint, unlike Alden, conducted extensive field studies in the Channeled Scablands region (9). Flint explained all of the catastrophic flood features in the Channeled Scabland region as having been produced by streams of normal discharge. Recent workers (10) have noted that Flint's failure to recognize the large-scale catastrophic flood features led to misinterpretations of former ice margins and to misidentification of sedimentary origins.

If Alden and Flint did not recognize catastrophic flood landforms and sediments in the Channeled Scablands region of eastern Washington, would they have recognized catastrophic flood features in the northern Great Plains region? Are generally accepted models of northern Great Plains geomorphic history based on misinterpretations of former ice margins and misidentification of sedimentary origins?

Detailed topographic maps of Montana, North Dakota, and South Dakota provide extensive evidence that catastrophic floods were responsible for virtually all present-day landforms in eastern Montana, southwestern North Dakota, and northwestern South Dakota. Flood landforms are best seen using maps with contour intervals of 20 feet or less. Since flood landforms are gigantic in geographic extent, evidence is best seen by constructing large mosaics of hundreds of 7.5 minute topographic maps. Maps being used in this study are photographically reduced to a scale of 1:384,000.

Mosaics of such greatly reduced 7.5 minute topographic maps have been constructed for most of eastern Montana and western North Dakota. Catastrophic flood landforms on these mosaics are then compared with catastrophic flood landforms in the Channeled Scabland region of eastern Washington or with smaller scale, previously recognized, catastrophic flood landforms elsewhere in North Dakota (11). Flood landforms, which can be identified on the large mosaics, include systems of anastomosing channels comparable in scale to those found in the Channeled Scablands of eastern Washington, streamlined erosional residuals, sequences of high-level divide crossings, extensive flood scoured surfaces, giant spillway trenches where floodwaters breached former drainage divides, large flood-carved escarpments, and labyrinthine complexes where huge sheets of water poured off upland surfaces into spillway trenches.

Huge sheets of water, more than one hundred kilometers in width, were channeled along the margins of the continental icesheet, although at several points floodwaters appear to have crossed morainal areas and spilled onto the icesheet. Virtually all major landforms in western North Dakota and eastern Montana were produced by catastrophic flooding. Preliminary work suggests these catastrophic flood landforms extend into western South Dakota, perhaps as far south as the Pine Ridge Escarpment.

Further evidence for the catastrophic flooding can be obtained from field work. Residual gravels, including cobble and small boulder-size material, are strewn across the surface in the flood area. Flood landforms include narrow valleys and buttes carved in easily eroded claystones. It is unlikely these landforms could have survived the climatic changes associated with a glacial cycle. The catastrophic flooding responsible for modern landforms probably occurred late in the last glacial cycle, perhaps during the collapse of the last continental icesheet.

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(43)   A COMPARISON OF THE CHEMICAL METHODS USED FOR THE MEASUREMENT
OF BLOOD ALCOHOL

James J. Worman *
Asbestos Abatement & Consulting, Inc.
528 Princeton Street
Grand Forks, North Dakota 58201

Over the past decade, states have enacted new laws in order to minimize the problem of drinking alcohol and driving an automobile. In order to enforce these statutes, forensic laboratories developed a series of chemical tests that purportedly accurately analyze for alcohol in the body in a manner sufficient to support the state statute. In general, most states use a value of 0.1 percent alcohol by weight in the blood as an indicator of intoxication. This level is measured by several methods, namely, gas chromatography of a blood sample, gas chromatography of a urine sample, specific enzyme reactions of alcohol in blood, analysis of the alcohol in breath by visible spectroscopy, and analysis of the breath by infrared spectroscopy. A difference in accuracy of the results depends on which analytical method is used.

This study was prompted because reports provided by state laboratories to police departments gave results as a single number with no indication of the probable percent error. In addition, the testimony provided by experts, either for the prosecution or the defense, failed to clarify the accuracy of the individual testing methods. The three most common methods for testing alcohol were used in this study. Infrared analysis of the breath was measured by the Intoxylizer 5000. Blood samples were analyzed by the State of South Dakota Health Department using gas chromatography, and the urine samples were analyzed by the North Dakota State Toxicology Laboratory also using gas chromatography. Seven male and female adults were allowed to consume highpoint beer in a controlled environment until theoretical calculations via the Widmark formula estimated their percent by weight alcohol as approximately 0.1. Blood samples were drawn, urine samples given, and breath analyzed, all within a 15 minute period--45 minutes after the consumption of alcohol. The results of all analyses are shown in Table 1.

TABLE 1: A COMPARISON OF THE METHODS OF ANALYSIS OF ALCOHOL
IN BLOOD

Subject	GC Blood	(+10%)	GC Urine	Intoxylizer 5000	Widmark
	12/31	01/19			
#1	0.09	0.08	0.07	0.10	0.13
#2	0.11	0.10	0.09	0.10	0.12
#3	0.12	0.11	0.11	0.13	0.19
#4	0.12	0.11	0.11	0.10	0.14
#5	0.12	0.11	0.09	0.12	0.18
#6	0.13	0.13	0.11	0.10	0.14
#7	0.12	0.12	0.11	0.13	0.16

The values represent the percent alcohol by weight in the blood. All chemical methods of analysis gave close results. In a court of law, however, and when presenting data of this nature, it is the **difference** in these results that becomes a point of contention.

Methods of analysis will be discussed with regard to experimental procedures used and the potential magnitude of the percent error. This study verifies a potential significant difference in determination of alcohol concentration in the blood depending on the analytical method used. The gas chromatographic method of determining alcohol in the blood is the most accurate method because it is a direct or primary method of analysis while the other methods are secondary. The alcohol concentration in urine and breath are converted to alcohol in the blood by multiplying by a constant factor and this introduces significant error. Reports in the literature estimate that alcohol concentration in breath converted to blood alcohol can vary by as much as +200% from direct GC blood analysis.[1] In addition, it is well established that the GC instrumental method is a more accurate method for quantitative analysis of volatile components than either visible or infrared spectroscopy. It is the opinion of the author that forensic laboratories need to reevaluate their methods of reporting results in criminal cases to include a percent error and confidence level with each result.

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(44)   DETERMINATION OF MANGANESE IN WHOLE BLOOD AND PLASMA USING ZEEMAN GRAPHITE FURNACE AAS

R.L. Sims[*] and D.B. Milne
USDA, ARS, Grand Forks Human Nutrition Research Center
Grand Forks, ND 58202

The determination of manganese concentrations in biological samples has been receiving increased attention in nutritional assessment studies. Thus, rapid and sensitive methods are necessary to accurately measure the very low levels (ng/ml) of manganese present in body fluids such as whole blood and plasma (1,2,3). Analysis by atomic absorption spectrophotometry using electrothermal atomization is a convenient analytical method for determining manganese in blood (4,5). However, there is sample loss by diffusion across the atomizer wall, and many compounds interfere in the analysis when done by classical furnace atomic absorption spectrophotometry (FAAS). The direct method of analysis is prone to severe negative bias caused by interferences from the blood or plasma matrix which suppress the analyte signal. The manganese determination is at a relatively long wavelength, and neither the deuterium nor the tungsten lamp performs optimally for background correction.

This investigation describes and evaluates an improved method for the determination of manganese in whole blood and plasma. The method utilizes the Zeeman effect background correction, stabilized temperature platform furnace (STPF), magnesium nitrate as a matrix modifier, integrated absorbance signals, and pyrolytically coated graphite tubes with L'vov platforms. Whole blood samples were weighed to the nearest one-tenth of a milligram in conical teflon tubes. A dri-block heater with drilled aluminum blocks was used to digest the samples with ultrapure nitric acid and 30% hydrogen peroxide. The samples were diluted with 2% nitric acid prior to analysis. Table 1 shows the furnace program for detecting manganese in blood.

Table 1

Zeeman Furnace Conditions for Manganese Detection

	Dry	Char	Cool	Atomize	Clean	Cool
Step	1	2	3	4	5	6
Temp. °C	130	1400	20	2300	2600	20
Ramp, s	10	10	1	0	1	1
Hold, s	50	20	10	5	4	10
Gas Flow (ml/min)	300	300	300	0	300	300

Quality control consisted of blanks, sample pools, recovery spikes and National Bureau of Standards (NBS) bovine liver and wheat flour reference materials (SRM 1577a and 1567a). The mean analyzed values of 10.3 ± 0.6 µg/g and 10.1 ± 0.5 µg/g compare well with the NBS certified values of 9.9 ± 0.8 µg/g and 9.4 ± 0.9 µg/g, respectively. The mean for the 10.0 ng/ml recovery spikes was 10.5 ± 0.7 ng/ml, and the mean was 5.3 ± 0.4 for an added 5.0 ng/ml.

Analyzed values for manganese concentrations in plasma ranged from 1.10 to 1.35 ng/ml for men and 0.84 to 1.39 ng/ml for women, showing close agreement with recently published data that suggest a value between 0.86 and 1.52 ng/ml. Analyzed values for manganese in whole blood ranged from 8.7 to 10.3 ng/ml for men and 8.6 to 11.3 ng/ml for women. In a number of population studies, mean concentrations of manganese in whole blood were found to lie between 8.4 and 12.2 ng/ml.

Findings indicate that the sensitive Zeeman FAAS method, combined with platform furnace technique, provides accurate and reproducible results for manganese determinations in whole blood and plasma. Used with effective temperature programs and matrix modification, this method allows the analyst to obtain excellent results from difficult biological samples. The advantage of Zeeman/STPF include low background interference, improved temperature stability, and minimal chemical interferences.

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(45)   A HIGH PRESSURE LIQUID CHROMATOGRAPHY METHOD TO MEASURE BROMIDE IN PLASMA

T. Hoesley[*1] and H.C. Lukaski[2]
[1]University of North Dakota, and [2]USDA, ARS, Grand Forks Human Nutrition Reseasrch Center
Grand Forks, ND 58202

Water, the largest single component of the human body and representing about 60% of body weight, is distributed between two distinct body compartments. The intracellular space contains 66% of the total body water, which can not be measured directly. The extracellular space represents about 33% total body water, which can be estimated using isotopes and the dilution principle, and is a useful indicator of nutritional status. Traditionally, radioisotopes of sulfur and bromine were used to predict the extracellular fluid space. Recently, a bromide dilution method using reagent grade sodium bromide was developed to eliminate the exposure to radiation associated with use of radioisotopes (1).

There are a limited number of analytical methods for determining dilute concentrations of bromide in physiological fluids. The standard reference method is fluorescent excitation analysis (FEA; 1). The equipment for this method is not readily available in clinical chemistry laboratories. An alternative to FEA is high pressure liquid chromatography (HPLC) with post-column detection. This approach has broad appeal because the apparatus is common to most analytical chemistry laboratories.

This study describes the development of a simple HPLC assay using electrochemical (EC) and ultraviolet absorption (UV) detection to quantitate bromide concentrations in plasma, and then compares the measured values determined by HPLC methods with those obtained using FEA.

Eleven healthy females aged 40-55 years were given an oral dose (0.15 ml/kg body weight) of a 3% sodium bromide (Sigma Chemical Co.[a], St. Louis, MO) in distilled-deionized water mixed with about 300 ml of distilled-deionized water. Blood samples were obtained before and four hours after ingestion of the bromide. Plasma was collected and aliquoted for analysis by each method. Duplicate samples containing 1.25 ml plasma were analyzed using FEA (1). One half ml of plasma was deproteinized with an equal volume of 3.9 M sulfosalic acid, vortexed, centrifuged, and filtered. Duplicate deproteinized samples were injected onto a strong anion exchange column (Beckman Ultrasil Sax[a], #235347); the separated ions were detected using a potentiostat (Coulochem model 5100A, Environmental Science Assoc.[a], Bedford MA) and an electrochemical (EC) detector (model 5012 wall jet cell with gold electrode, E.S.A.[a], Bedford MA). Duplicate aliquots of deproteinized plasma samples were also injected onto the column for detection of bromide ions using UV absorption (model 166, Beckman[a], Fullerton CA). The operating variables for the chromatographic methods are summarized in Table 1.

Table 1
Operating Conditions for Chromatographic Quantitation of Bromide in Human Plasma

Mobile Phase: 30 mM Potassium Dihydrogen Phosphate	Flow Rate: 1.5 ml/minute
Temperature: Ambient	
Electrochemical Detector: Potential = + 0.1 volt; Gain = 250 μAmps; Response Time = 10 seconds	
Ultraviolet Detector: Wavelength = 195 nm; Range = 0.1 Absorbance Units Full Scale; Rise Time = 2 seconds; Integrator Range = Low	

The response of the EC and UV detectors was linear over a range of sodium bromide standards (0.025 - 0.30 mM). Peak areas determined using EC and UV detectors were highly correlated (0.998 and 0.999, respectively) with bromide concentrations in the range of standards. Analysis of standard additions of a sodium bromide standard solution to plasma samples revealed no difference (p >0.05) between observed and predicted values. The precision of the HPLC method using EC and UV was 3.0 and 3.7%, respectively. Plasma bromide concentrations determined by FEA (0.195 ± 0.004 mM; mean ± SE), EC (0.185 ± 0.004 mM), and UV (0.195 ± 0.006 mM) were similar.

The findings indicate that HPLC with EC or UV detection provides values for plasma bromide concentrations not different from those provided by the FEA reference method. The advantages of the HPLC methods are the reduced blood volume needed for analysis (3 ml for FEA versus 0.5 ml for EC and UV), and the rapidity of the analysis. These factors indicate that either HPLC approach can facilitate the determination of bromide dilution space and hence the estimation of the extracellular fluid space.

[a]Mention of a trademark or proprietary product does not constitute a guarantee or warranty of the product by the United States Department of Agriculture and does not imply its approval to the exclusion of other products that may be suitable.

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(47)   MICROWAVE DIGESTION OF FECAL SAMPLES FOR ELEMENTAL ANALYSIS
            BY INDUCTIVELY COUPLED PLASMA EMISSION SPECTROSCOPY

Gwen M. Schelkoph[*] and David B. Milne
USDA, ARS, Grand Forks Human Nutrition Research Center
PO Box 7166, University Station, Grand Forks, ND 58202

It is necessary to destroy or remove the organic matrix of samples prior to trace element analysis by atomic absorption spectroscopy or by inductively coupled plasma emission spectroscopy (ICPES). Wet ashing with perchloric and nitric acids is a widely used technique for digesting biological samples (1). However, it is relatively time consuming, presents a potential explosion hazard, requires constant operator attention, and often requires large amounts of acid to completely digest the sample. Open vessel work requires special hoods, can lead to corrosion of equipment, is open to potential contamination of the sample, and risks mechanical and volatile loss of the analyte. Recently, the use of microwave energy has been proposed for digesting a variety of materials for trace element analysis (2-7). Studies with biological materials have either utilized open vessels in specially vented systems (2, 7) or have been limited to the analysis of a few specialized types of samples, and limited recovery data (3, 4, 6, 8).

Freeze dried fecal samples from metabolic balance studies were digested using a 600 watt microwave. Samples weighing 0.5 g were enclosed in teflon bombs with a nitric-hydrochloric acid mixture. Approximately 25 minutes were required for the dissolution of 12 fecal samples. Inductively coupled plasma emission spectroscopy analysis of the digestates indicated good agreement for most elements for similar samples digested conventionally with nitric-perchloric acid, and with certified values in NBS Standard Reference Material (Table 1). Recoveries of added elements to the fecal pool were between 92-104%. The precision of repeated analysis was between 0.1 and 9.3% for measured elements.

Table 1

Comparison Between Microwave and Nitric-Perchloric Acid Digestions

Element	Fecal Pool		Citrus Leaves (1572)	
	Microwave[a]	HNO_3-$HClO_4$[a]	Microwave[a]	Certified
Ca, mg/g	37.7 ± 1.3	26.6 ± 0.14	30.9 ± 0.34	31.6 ± 1.0
Cu, µg/g	76.4 ± 1.9	66.5 ± 0.5	16.0 ± 0.45	16.5 ± 1.0
Fe, µg/g	343.4 ± 3.1	323.5 ± 2.8	80.6 ± 1.3	90.0 ± 10.0
K, mg/g	22.2 ± 0.2	18.8 ± 0.1	17.4 ± 0.12	18.2 ± 0.6
Mg, mg/g	10.2 ± 3.0	8.2 ± 2.8	5.7 ± 0.18	5.8 ± 0.3
Mn, µg/g	208.3 ± 3.4	206.0 ± 1.4	21.9 ± 0.77	23.0 ± 2.0
P, mg/g	33.2 ± 0.7	26.6 ± 0.6	1.2 ± 0.06	1.3 ± 0.2
Zn, µg/g	412.1 ± 4.4	395.5 ± 4.2	28.3 ± 1.0	29.0 ± 2.0

[a]Mean ± SD of triplicate determinations

Compared with the open flask hot plate procedure, the microwave method offers considerable advantages in speed and safety. Blank values are lower because less acid is required and the sample is not exposed to a hood environment for long periods of time. The closed system better maintains sample integrity and thus permits the determination of more volatile elements. Thus, the microwave digestion procedure for fecal samples is relatively safe, simple, rapid, precise and accurate.

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(50)   RADON-222 AND RADON-222 DAUGHTER UPTAKE IN THE BODY: EFFECTS OF A
          MASK AND AN ELECTRONIC AIR FILTER ON BISMUTH-214 COUNTS

G.I. Lykken[*,1,2], W.C. Ong[1] and D.P. Patrick[3]
[1]USDA, ARS, Grand Forks Human Nutrition Research Center,
[2]University of North Dakota, Dept. of Physics, and [3]Office of Safety and Environmental Health
Grand Forks, ND 58202

Before entering a room with 253 pCi/L radon and 1.04 working level (an equilibrium mixture of radon decay products at 100 pCi/L) radon progeny, a male subject had baseline whole body counts to determine bismuth-214 body content both regionally, in 16 collimated 12.2 cm strips from head to feet, and totally, in two 16 detector arrays; the counts were corrected for geometry and gamma ray self-absorption. After spending 60 minutes in the room with radon and radon daughters, the subject showered, shampooed, changed into clean hospital greens, and was counted in the whole body counter for 10 minutes, commencing 16 minutes after leaving the radon environment. A second count was obtained 17 to 73 minutes later. In one instance, corrected bismuth-214 (1.76 MeV photopeak) total body counts were obtained, and in a separate instance, regional bismuth-214 counts (609 KeV photopeak) were obtained. This sequence of counts was repeated except that in one instance, the subject wore a filtering mask (3M[a] -9940, TC-21C-239), and in a second series, a fraction of the radon-222 radioactive daughters was removed from the atmosphere over periods of one week or two weeks with an electronic air filter (Honeywell[a] F59A). Increases in net corrected bismuth-214 total body counts upon exposure to the radon environment were 4700 ($T_{1/2}$ eff[b] = 34 minutes) and 3900 ($T_{1/2}$ eff = 117 minutes) with no filter and with a filtering mask, respectively. The net regional counts above baseline changed from 35000 ($T_{1/2}$ eff = 43 minutes) with no filter, to 19000 ($T_{1/2}$ eff = 42 minutes) with a filtering mask, to 9400 ($T_{1/2}$ eff = 63 minutes) with an electronic filter for 60 minute exposures, and later to 9800 ($T_{1/2}$ eff = 71 minutes) for a 92 minute exposure after the air had been filtered electronically for two weeks. In the instance of no filter, the majority of the bismuth-214 counts came from the thorax and chest regions, while in the cases of mask and air filtering, the majority of the counts came from the abdominal region, thigh region, and the head. When unfiltered air was inhaled, the radioactive radon daughters were deposited in the upper respiratory system. In the case of a filtering mask, radon, which is highly soluble in lipids and body fluids, was absorbed into the blood stream through the lungs and transported to fat in the abdominal and thigh regions. When electronically filtered air was inhaled unattached, ionized daughters were deposited in the nasal passages, producing relatively high bismuth-214 counts in the nasal region.

Similar studies as above with guinea pigs showed a 50% reduction in total body bismuth-214 counts after a 24 hour exposure in a sealed cage equipped with two mine respirator filters (Wilson Safety Products[a], R12, TC-21C-142). An 85% reduction in total body bismuth-214 counts was found after a 26 hour exposure in electronically filtered air relative to a 24 hour exposure to the unfiltered radon environment. Respective effective half-lives of the bismuth-214 were 42 minutes for exposure to unfiltered air, 29 minutes after exposure in the sealed filter equipped cage, and 62 minutes for exposure to electronically filtered air. In these tests a control guinea pig that had not been exposed to the radon atmosphere was used to provide baseline counts. These findings are in agreement with Cohn et al. (1).

The longer effective half-lives found after filtering may have been caused by radon ($T_{1/2}$ natural = 3.82 days) absorbed in body fluids and fat which produced bismuth-214 daughters ($T_{1/2}$ natural = 19.7 minutes), rather than by inhaled short lived Rn-222 daughters attached to particulate matter deposited in the respiratory tract.

[a]Mention of a trademark or proprietary product does not constitute a guarantee or warranty of the product by the United States Department of Agriculture and does not imply its approval to the exclusion of other products that may be suitable.

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(116)   PREPARATION OF POLYNAPHTHALENES AND PERYLENE VIA GRIGNARD REACTIONS

Martin B. Jones[*] and Jeffrey H. Banning
Department of Chemistry, University of North Dakota
Grand Forks, North Dakota 58202

Previous accounts have described the synthesis of poly(1,4-; 1,5-; 2,6-; and 2,7-naphthalene)s [1,4-PN; 1,5-PN; 2,6-PN; and 2,7-PN, respectively] via Grignard coupling reactions in the presence of promoters such as bis(acetylacetonato)nickel [Ni(acac)$_2$][1,2] (Yamamoto method) or 1,4-dichloro-2-butene (Taylor method). We now wish to report an extension of these methods to the synthesis of other polynaphthalene isomers and perylene.

The conversion of 1,6-dibromonaphthalene to 1,6-polynaphthalene was accomplished under both Yamamoto and Taylor conditions using commercial magnesium. However, significant differences in analysis and molecular weight (MW)/degree of polymerization (DP) existed for the products of each method (Table 1). Two complementary factors contribute to the greater Br content of 1,6-PN-Y relative to 1,6-PN-T: the synthesis method and the molecular weight. The Yamamoto procedure requires only one of the halogens to be converted to its Grignard adduct, whereas the Taylor method requires the conversion of both halogens to Grignard adducts. Thus, after quenching the reaction, the Yamamoto product should theoretically be capped at both ends with Br, whereas the Taylor product should theoretically be capped at both ends with hydrogen. The lower molecular weight of 1,6-PN-Y results in fewer naphalenediyl rings in the polymer and naturally leads to a higher percentage of Br present. Infrared spectra of 1,6-PN-Y and 1,6-PN-T are quite similar, to themselves and to the starting material, indicating that the gross structural features (e.g., regiochemistry) of each polymer are similar.

Polymerization of 2,3-dibromonaphthalene required the use of "active" magnesium[3] for formation of either the mono- or the bis-Grignard reagent necessary for coupling via the Yamamoto or Taylor conditions, respectively. The products obtained were quite similar (Table 1), although 2,3-PN-Y did contain more bromine, as expected (*vide supra*). Infrared spectra of the polymers indicated that the regiochemistry of the starting material was retained in the products.

1,8-Diiodonaphthalene did not yield a polymeric product under conditions analogous to those employed for preparation of 2,3-PN, likely due to steric interference of the peri positions. However, coupling of the 1,8-bis-Grignard (prepared from 1,8-diiodonaphthalene and "active" magnesium) with 1,8-diiodonaphthalene using Ni(acac)$_2$ as the promoter afforded a modest yield of perylene, uncontaminated with any other $C_{20}H_{12}$ isomer.

In summary, Grignard coupling reactions may be gainfully employed for the preparation of polynaphthalenes with controlled regiochemistry. For monomers with neighboring halogens, "active" magnesium is required to form the Grignard reagents. When steric constraints are too great, polymerization is disfigured, but coupling may still occur to give condensed polycyclic aromatic hydrocarbons.

Table 1. Products of Grignard Coupling Reactions of Dihalonaphthalenes

Starting Material	Product	Yield (%)	%C	%H	%Br	%Cl	MP (°C)	MW[b] (g/mol)	DP[c]
1,6-Br$_2$C$_{10}$H$_6$	1,6-PN-Y	45	75.8	3.6	20.8	0.0	72-155	<1225	5
1,6-Br$_2$C$_{10}$H$_6$	1,6-PN-T	61	83.4	5.4	1.2	5.0	107-151	>5000	95
2,3-Br$_2$C$_{10}$H$_6$	2,3-PN-Y	21	85.7	5.3	2.8	1.0	250-300	>5000	40
2,3-Br$_2$C$_{10}$H$_6$	2,3-PN-T	24	79.1	5.3	<0.2	2.0	270-310	>5000	--
1,8-I$_2$C$_{10}$H$_6$	Perylene[d]	18	--	--	--	--	--	--	--

[a] Y signifies product obtained via the Yamamoto method; T signifies product obtained via the Taylor method.
[b] Determined by GPC results. The number reported represents only the highest observed molecular weights.
[c] Determined from elemental analysis, taking into account one Br capping each end of the polymer.
[d] Identified by comparison with authentic sample using GC.

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(61)   ALTERNATIVES FOR MONITORING ENVIRONMENTAL CHANGE IN COLOMBIA'S
GUAJIRA MINING REGION

Roland D. Mower and Ross D. Keys*
Institute for Remote Sensing and Department of Geography
University of North Dakota
Grand Forks, ND 58202

In 1980, an agency of the Colombian government, CARBOCOL, and a subsidiary of the EXXON Corporation, INTERCOR, concluded an agreement to develop and operate one of the world's largest open-pit coal mines at El Cerrejon located in Colombia's Guajira Peninsula. Since that time, the mine has been undergoing development, and limited production began in 1985. A new port facility, Puerto Bolivar, located at Bahia Portete and a new standard gage railroad connecting the mine to the port are now in the final stages of completion (1). Coal production at El Cerrejon increased from 5 million tons in 1985 to 7.5 million tons in 1986; in 1988 the mine is scheduled to achieve full production at 15 million tons per year. Interestingly, the developers designed the entire enterprise so that coal production could be increased to 25 million tons per year by simply increasing the size of the labor force (2).

The Guajira Peninsula is generally described as a hot, semiarid to arid, tropical lowland (3). Vegetation in the northern portion of the region is mainly thorn tree and desert grass savanna; whereas vegetation near the mine is characterized as sparse montane forest. Soils that support the region's vegetation are mostly aridisols and are characterized by the lack of humus. Evaporation of moisture at the surface has resulted in the accumulation of salt deposits in the drier and hotter areas (4).

Prior to initiation of mining development, the Guajira was one of Colombia's most underpopulated and undeveloped regions. Indeed, suitable infrastructure was lacking for the relatively few who chose to reside in the region. For example, less than one third of the region's roads were paved; likewise, there was inadequate water, sewage disposal, electricity, health care, and educational facilities (5). With the development of the mining operations there has been an influx of approximately 4 thousand permanent workers and an estimated 30 thousand persons attracted by other opportunities (6).

Because of the potential impact of mining and associated activities on the Guajira's fragile environment, a strategy for monitoring change was needed. The Colombian government recognized this need and required INTERCOR to prepare a series of detailed environmental impact assessment documents. As a result, mine operators have a mandated obligation to monitor specified parameters of the environment. The government, in turn, has a vested interest in assuring that INTERCOR performs the required tasks in a suitable manner. In addition to INTERCOR and the Colombian government, other groups throughout the world also are desirous of obtaining data that will enable their independent verification of environmental conditions in selected areas such as the Guajira. In order to meet the needs of all three groups, a multistage data acquisition approach is addressed by this study.

Based upon both library and laboratory research, it appears that three general types of environmental data should be acquired and analyzed. First, detailed in situ data for micro areas should be acquired by mine operators and perhaps, on occasion, by governmental agents if there is a need. Secondly, aerial photography should be collected periodically by responsible governmental agencies so that in situ data can be viewed in a broader context. The mine operator may also find a need for aerial photography for the same purpose. Finally, satellite digital data or imagery can be used by those organizations that do not have access to data generated by neither the mining group nor the Colombian government. Although satellite data often lack the level of detail available through ground-based monitors or aerial photos, sufficient regional information is usually available to make general assessments regarding regional environmental changes.

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(62)   ETHNOGEOGRAPHY OF THE MANDAN AND HIDATSA: 1738-1889

Kenneth C. Dagel*
Department of Geography
University of North Dakota
Grand Forks, ND 58202

Contributions of Native Americans to North American toponyms are significant but relatively unrecognized. Aboriginal peoples, who were more spatially oriented than temporally oriented, provided valuable insights concerning local toponymy to Euro-Americans. North Dakota place-names reflect a rich aboriginal heritage, but much Native American toponymy has been modified or forgotten since 1738. Consequently, there is a low public awareness of past and present distributions of indigenous place-names and what the named sites meant to the native people of North Dakota.

The purpose of this paper is to present the ethnogeography of the Mandan and Hidatsa Indians during the period 1738-1889. It provides not only a listing of place-names, but also examines why the locations associated with those names were so important, and remain important to these tribes. Ethnogeography is vital to the heritage of these particular ethnic groups because it indelibly identifies them with specific locations and how they interacted with the environment at that site. This information becomes increasingly important in an era of land claim confrontations, large government water projects, and questionable farming practices.

Place-names gathered for this research were primarily of Indian origin, either in the original language or the English translation. They were obtained from the historical narratives of explorers, fur traders, and military personnel. Names were also collected from secondary sources written by authors who had access to original journals and Indian informants. Many non-Indian place-names were also collected from these sources for comparative purposes. The list is purposely selective in order to demonstrate how a place-name typology can be applied to ethnogeographical locations. All place-names were classified using the ten-element classification scheme devised by George R. Stewart (1). Place-names classified as descriptive, associative, incident, shift or combinations thereof tend to support the basic premise of the research that toponyms of Native American origin were generated because of perceptual or pragmatic reasons. Also considered was a secondary hypothesis stating that the actual locations having environmentally perceived place-names were and are culture intrinsic. To be culture intrinsic, a place must be so significant to a culture group that its loss would tend to weaken, and possibly destroy, the cultural fabric of the community. Examples of such sites are permanent villages, those sites connected in some way with the performance of religious ceremonies, sites sacred because of ancestral reasons, or sites which are known repositories of food, minerals, and/or earths largely unavailable elsewhere.

Results indicate that 84% of Mandan and 63% of Hidatsa place-names were environmentally perceived, while only 15% of non-Indian place-names were environmentally induced. Secondly, 87% of Mandan and 81% of Hidatsa place-names were culture intrinsic. It could be inferred from these statistics that because indigenous peoples applied predominantly environmentally perceived names to locations in their sphere of influence, they considered themselves more a component of that environment rather than a controller of it. Results also indicate that site name change was practically non-existent for each tribe although variances between tribes did occur.

There are three important implications of this research. First, the realization that the Mandan and Hidatsa were very cognizant of their immediate environment, naming sites in their territory based upon an intimate knowledge of that environment and what value it held for them and their culture. Second, this research immediately stimulates researchers to consider what the present condition of native named locations is and, if a site still exists, whether it is being utilized as originally intended or is no longer important. Finally, the ethnogeographical data collected for this study will serve as a basis for further research by other geographers, anthropologists, and historians.

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(63)   MAPPING NORTH DAKOTA URBAN LANDSCAPES:
THE GRAND FORKS - EAST GRAND FORKS GEOGRAPHIC INFORMATION SYSTEM

Denis E. Mudderman and Bradley D. Kontz[*]
Geography Department, University of North Dakota
Grand Forks, North Dakota 58202

Small metropolitan areas, as those generally found in the upper midwest, present special problems but unique opportunities for development and application of geographic information systems (GIS). Through a cooperative project between the Grand Forks - East Grand Forks Metropolitan Planning Organization and the University of North Dakota Geography Department a geographic information system has been developed for the Grand Forks - East Grand Forks metropolitan area. Funding was provided by the Federal Highway Administration and the Urban Mass Transit Agency. Geographic information systems are computer based systems for the storage, manipulation, analysis, overlaying, and display of spatial information. The Grand Forks - East Grand Forks GIS is the first urban geographic information system in North Dakota and it is unique for its transporation-planning emphasis.

With ~~less~~ _fewer_ resources for hardware, software, development, and general operation, development of geographic information systems in small urban areas must often be modest and cost-effective. As a result, a tool box approach was taken in design of the Grand Forks GIS, and a number of microcomputer and mainframe software packages were incorporated. EPPL7 on a microcomputer and experimentally ODYSSEY on a mainframe computer were the primary geographic analysis software and the heart of the system. Supporting these GIS packages were data base, statistical, and transportation analysis software on a microcomputer, and statistical and computer mapping software on a mainframe. In addition, the system can be linked to external data sources, most importantly data collected by the Planning Department or other city departments on the Grand Forks or East Grand Forks city computers.

Three principal categories of base maps constitute the infrastructure of the system providing the means to input census data, collected data by city blocks such as land use, or street data such as traffic counts, street condition, or accident information. All base maps were constructed with points digitized from one hundred sixty 1:1200 scale city plat maps and merged using section corner control points. For the coordinate system a local plane grid system was established which was tied to the state plane coordiante system. Preparation of base maps constituted a large fraction of the work and took over a year to complete. For 1980 census data, base maps were set up for census block, block group, and traffic analysis zone. All census data is retrievable from computer tape, but the more pertinent items were organized in a microcomputer data base for faster retrieval. For the city block base map, rather than individual lots, areas no smaller than one-half block were used. The larger block areas were considered more practical, but the base map will be expanded to include individual lots. The street base map divides the street system into intersections and street segments (Figure 1). With the transportation-planning emphasis of the system the street base map is the most important and provides through the geographic information system innovative tools for traffic flow and street management.

In the short time that the Grand Forks - East Grand Forks Geographic Information System has been operational much previously collected data has been mapped for the first time. The most important category of newly mapped information is data collected in the 1980 census. (One example is presented in figure 2) which is now helping geographers and planners understand more about the spatial structure of Grand Forks and East Grand Forks.
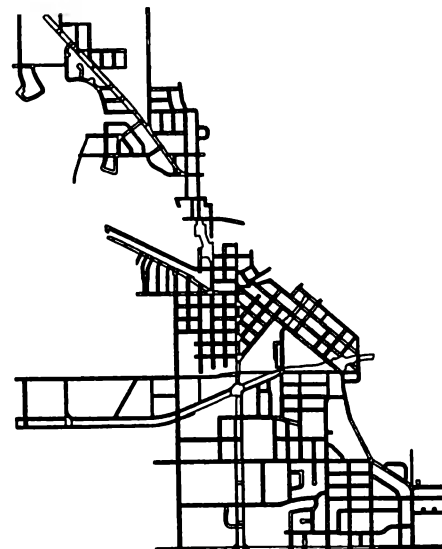

Figure 1: East Grand Forks Street System Base Map.

MEDIAN FAMILY INCOME, 1979

IN DOLLARS

25000 - 40000
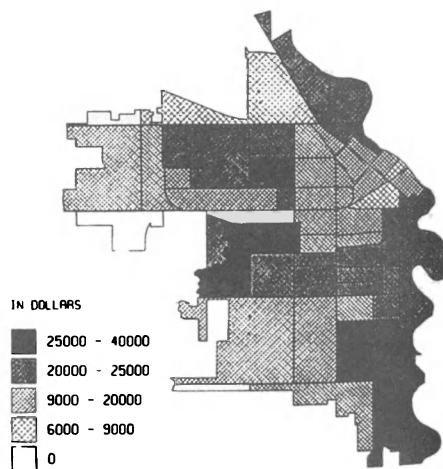20000 - 25000
9000 - 20000
6000 - 9000
0

Figure 2: Grand Forks 1980 Census Block Group Base Map

(64)   AN APPLICATION OF THE ATTRACTION-CONSTRAINED GRAVITY MODEL
TO THE UNIVERSITY OF NORTH DAKOTA'S ENROLLMENT SPATIAL PATTERNS

M. Hemmasi* and D.C. Munski
University of North Dakota
Grand Forks, ND 58202

Enrollment trends increasingly have become concerns of institutions of higher education. As early as 1940 the gravity model was used successfully by Stewart to study patterns of movements of university undergraduates (1). Since then, significant improvements have been made in the model, especially by Wilson (2). Recently, Haynes used an attraction-constrained gravity model to analyze the flow of graduate students into Indiana University (3). A specially modified version of the attraction-constrained gravity model is used in this paper to predict the undergraduate flow to the University of North Dakota (UND) in 1985.

While all gravity models are based upon Newton's initial work, the attraction-constrained gravity model that is employed here has the following general form:

$$\bar{S}ij = [(Hi / Dij) \times Sij] / Sum (Hi / Dij)$$

Here "$\bar{S}ij$" is the expected number of students from county "i" to enroll at UND or "j" in any year and "Hi" is the total number of high school graduates in that county during the preceding four years with "Dij" being the shortest road distance between the largest city in the county and the city of Grand Forks while "Sij" is the actual total number of students who were enrolled at UND during the case study year. "Sum (Hi / Dij)" ensures that the total expected enrollment at UND equals the actual enrollment from counties included in the model. The differences between the actual and predicted enrollment (Sij - Sij) are termed the residuals and can provide information on student enrollment from specific counties.

When the modified model first was used, the simple correlation coefficient between the expected and actual enrollment was r = 0.72 for 50 counties; Slope and Billings counties had insufficient data and Grand Forks County is the destination county itself for flow to UND. Two extreme outliers existed among the residuals: Burleigh County (+8.06 or underpredicted) and Cass County (-14.05 or overpredicted); these two counties were dropped from the second run of this model because of their unique characteristics. Consequently, the correlation coefficient between expected and actual enrollment for the remaining 48 counties increased substantially (r = 0.84). Figure 1 depicts the latter spatial distribution of the residuals.

Positive residuals indicate counties providing more students to UND than expected given their populations and distance from UND. Such positive residuals are found primarily in the northwest, west, and central parts of North Dakota; a possible explanation for this could be successful initial recruiting by UND and attracting transfer students from institutions in these areas. Negative residuals are located in the south and east; this might be explained by the presence of other universities or intervening opportunities. Further analysis of data is necessary.

These preliminary results indicate that the model is capable of predicting successfully student flows between 48 counties and UND. Furthermore, analysis for the years 1975 and 1980, while not discussed here, has produced similar results--an indication the model is consistent. Improved predictability can be achieved through "fine-tuning" the measures used in the model. The implications of this research for enrollment management teams at UND and elsewhere are that they could use this model as a tool in determining the areas needed to be maintained or expanded to enhance recruitment in the future.

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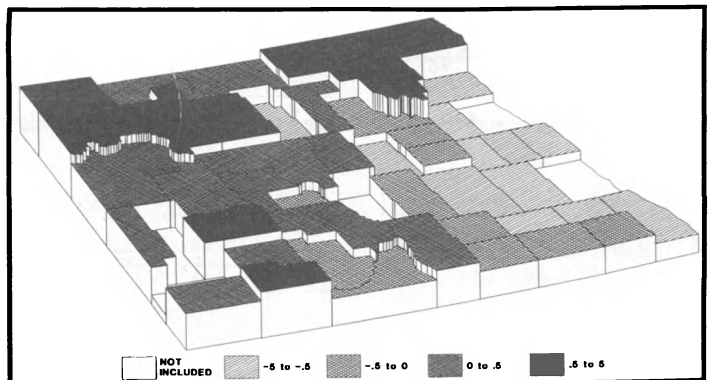3. Haynes, K.E., et al. (1984) Gravity and Transaction Models, Sage, London.

Figure 1. 1985 Percentage error in model prediction of student enrollment at UND.

(65)   COMPOSITE PLACE AWARENESS IN 1987 AT
SOUTH JUNIOR HIGH SCHOOL OF GRAND FORKS, NORTH DAKOTA

D.C. Munski*
Department of Geography
University of North Dakota
Grand Forks, ND 58202

Saveland (1) has urged social studies teachers to use the International Geographical Union's World Basic Place Vocabulary Test as a diagnostic for place awareness. Few educators have heeded his call except in North Dakota.   For a number of years, the International Geographical Union's standardized place name quiz has been used in North Dakota with samples drawn from statewide seventh grade populations to university students (2,3).   The most recent local use of this diagnostic instrument as a test of general geographic location knowledge was during the first annual national Geography Awareness Week.   All the students at South Junior High School in Grand Forks who were present on November 20, 1987, were tested on identifying the place name quiz's 50 basic locations of five oceans, 32 countries, and 13 cities.

Based upon previous studies, five hypotheses were selected to investigate in the 1987 study. Those hypotheses were: 1) bodies of water would be differentiated from land masses; 2) urban places would be identified readily; 3) places in the Third World would be identified least well by all students but worst in grade seven and best in grade nine; 4) ninth graders would have a drop in retention of Western Hemisphere locations taught in seventh grade; and 5) seventh graders would score above the national norm set in 1979.

The test was conducted on the Friday of Geography Awareness Week in 1987 as a concluding activity for that week.   While the students had received more exposure to maps during that five day period, this quiz was more a test of general place name awareness learned before then than it was an examination of that week's geography lessons. The sub-populations consisted of 176 seventh graders, 170 eighth graders, and 144 ninth graders.   Based on a scale of 50, the mean score for seventh graders was 27.15 and for eighth graders it was 29.30 while for ninth graders it averaged 35.50.

Results from this investigation generally supported the five hypotheses when the measure of acceptable competency on an item was set at the level of 70 percent correct for each grade level. Consequently, it was shown that water bodies were differentiated from land masses readily and that Third World places were not readily identified in all grades with seventh graders having done the worst and ninth graders having done the best on these locations.   Furthermore, the average score of the seventh graders was above the national norm.   However, the hypothesis that ninth graders had a lower level of retention of place names of the Western Hemisphere taught in seventh grade was rejected because ninth graders did better than expected.   Also, because urban places were poorly identified (generally below the 70%), that hypothesis was rejected.

Research on the composite place awareness of this group of students is continuing.   Plans are being implemented for testing the pupils at South Junior High again using the International Geographical Union's World Basic Place Vocabulary Test in May of 1988.   This second test will provide additional data for further substantiating the acceptance/rejection of the five hypotheses concerning place awareness in those grade levels.   Finally, the implication of this research is that levels of place name knowledge need to be determined with this type of standardized test before researchers examine the impact of increased map usage in junior high school social studies.

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(68)   STRUCTURAL AND FUNCTIONAL CORRELATES OF EXERCISE AND TRAINING

W.W. Bolonchuk[*1,2], W.A. Siders[2], and H.C. Lukaski[1]
[1]USDA, ARS, Grand Forks Human Nutrition Research Center and [2]University of North Dakota
Grand Forks, ND 58202

Humans of different body structure demonstrate unique capacities of exercise and training responses. Sheldon (1) observed that certain body types reoccur among participants of given athletic activities. Carter (2) examined the somatotypes of Olympic athletes and found that athletes competing in the same event had similar somatotypes. Novak (3) reported differences in body composition and pulmonary function among different groups of male athletes. Schreiber (4) reported the only performance data by somatotype that appear in the literature. This study demonstrated that blood lactate increased more in ectomorphs than in mesomorphs or endomorphs over an eight-week training period. The dependence of function on structure is not a new concept, however, very few data appear in the literature to explain this relationship.

The somatotype of a group of 51 male research subjects at the Grand Forks Human Nutrition Research Center was estimated by the Heath and Carter method. Fat weight (FWT), percent fat, and fat free weight (FFWT) were estimated by hydrodensitometry. Physical work capacity (PWC) was measured by a progressive resistance maximal exercise test on the cycle ergometer. Blood lactate, heart rate, maximum exercise power, maximum oxygen consumption, carbon dioxide production and a selected number of related variables were monitored to determine the metabolic response to the exercise. Results were grouped and analyzed by somatotype dominance.

Table 1
Structural Variables by Somatotype

	N	WT (kg)	HT (cm)	FAT (%)	FWT (kg)	FFWT (kg)	Endo	Meso	Ecto
Endomorph	8	85[a]	181	24.3[a]	21[a]	64	4.4[a]	3.2[a]	1.8[a]
Mesomorph	28	79[a]	175	20.2[b]	18[ab]	64	2.8[b]	4.6[b]	1.7[a]
Ectomorph	15	66[b]	180	13.9[b]	10[b]	58	2.0[b]	2.3[a]	3.9[b]

[ab]Different superscripts indicate significance, $p < 0.05$

Endomorphs were heavier and fatter than mesomorphs and ectomorphs. Mesomorphs had mean fat free weights approximately the same as endomorphs with less fat. Ectomorphs were the lightest and leanest, with the lowest fat free weight.

Table 2
Functional Variables by Somatotype

	Power	VE	A	VO$_2$	VCO$_2$	Heart Rate	Lactate
	kgm/min	ml/min	ml/kg/min	ml/min	ml/min	BPM	mM
Endomorph	1106	81	30.7[a]	2586	2871	171[a]	4.9[a]
Mesomorph	1307	96	38.4[b]	2983	3281	186[b]	6.6[b]
Ectomorph	1260	100	40.7[b]	2710	3247	184[b]	7.4[b]

[ab]Different superscripts indicate significance, $p < 0.05$

The mesomorphic group produced the greatest mean maximum power for the exercise test, 1307 kgm/min. Mean maximum oxygen consumption (VO$_2$), heart rate (HR), carbon dioxide production (VCO$_2$) and expired volume (VE) reflect this powerful effort. However, post exercise lactate production, 6.6 mM was less than that for the ectomorphic group, 7.4 mM. The ectomorphic group produced the next highest maximum power, 1260 kgm/min. Oxygen consumption per unit of body weight per minute (A) was similar to the mean A value for the mesomorphic group's performance and significantly greater than the endomorphic group's performance. These differences in power production and metabolic response may be attributable to the greater fat free weight of the mesomorph than of the ectomorph, 64 kg and 58 kg, respectively. The endomorphic group's response indicated a metabolic response consistent with the lowest mean maximum power, 1106 kgm/min for the exercise test.

These findings indicate that the structure as measured by the somatotype and body composition is positively related to function.

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(69)   VALIDITY OF RELATIVE WEIGHT INDICES FOR PREDICTING PERCENT BODY FAT

W.A. Siders[*1,2], H.C. Lukaski[1], C.B. Hall[1] and W.W. Bolonchuk[1,2]
[1]USDA, ARS, Grand Forks Human Nutrition Research Center and [2]University of North Dakota
Grand Forks, ND 58202

Measurement of human body composition is an important factor in assessing nutritional status. Although many diverse methods of measurement are available (1), they suffer limitations that restrict their use outside of the laboratory. Traditional laboratory methods are expensive and require skilled technicians, while field methods can be unreliable. An alternate approach is the use of indices calculated using standing height (H in meters), and body weight (W in kilograms) to provide a quantitative measure of body composition (2). The purpose of this study was to investigate the relationship between commonly used weight-height indices and reference body composition estimates determined by hydrodensitometry (3) in a sample of 293 females and 300 males aged 18-73 years. The candidate indices included W/H, W/H^2 (Body Mass Index or Quetelet's Index), W/H^3, $W/H^{1/3}$ (Ponderal Index) and $W^{1.2}/H^{3.3}$ (2).

Table 1
Percentage Distribution of Normal, Overweight and
Obese Classifications Over a Range of Percent Body Fat

| | % Body Fat | | | | | | | | |
	<10	15	20	25	30	35	40	45	>45
Normal									
Female	-	4	18	32	32	11	3	-	-
Male	29	38	25	4	4	-	-	-	-
Overweight									
Female	-	3	9	17	40	29	3	-	
Male	6	25	31	24	13	1	-	-	-
Obese									
Female	-	-	-	-	-	11	-	67	22
Male	-	-	9	9	23	45	9	5	-

Table 2
Correlations Between Compositional Variables
and Relative Weight Indices

	Age	Body Weight	Body Height	% Fat	Fat Mass	Fat-Free Mass
W/H	.144	.969*	.507*	.167	.616*	.743*
Female	.240*	.968*	.228*	.622*	.870*	.598*
Male	.186	.968*	.327*	.585*	.795*	.721*
W/H^2	.255*	.826	.185	.368*	.729*	.512*
Female	.317*	.856*	-.057	.673*	.857*	.420*
Male	.271*	.845*	.028	.662*	.820*	.530*
W/H^3	.344*	.541*	-.208*	.541*	.747*	.176
Female	.364*	.676*	-.332*	.667*	.774*	.214*
Male	.330*	.638*	.281*	.676*	.763*	.284*
$H/W^{1/3}$	-.338*	-.532*	.216*	-.524*	-.714*	-.185
Female	-.355*	-.656*	.349*	-.660*	-.746*	-.213*
Male	-.331*	-.624*	.296*	-.648*	-.726*	-.294*
$W^{1.2}/H^{3.3}$	.327*	.621*	-.111	.508*	.758*	.261*
Female	.355*	.726*	.265*	.673*	.803*	.264*
Male	.317*	.695*	-.206*	.682*	.789*	.344*

W= body weight (kg) H= body height (m)   *p <0.0001

When using the W/H^2 index (Body Mass Index or BMI), Bray (4) proposed that it should be adjusted for age. He defined overweight as a BMI between the high end of normal to less than 5 units above normal, and obese as greater than 5 units above normal. The mean percent body fat for the normal classification was 24.5% ± 5.5 for females and 13.3% ± 5.2 for males. The means for the overweight classification were 32.4% ± 5.3 for females and 18.2% ± 5.8 for males. The means for the obese classification were 42.4% ± 6.1 for females and 30.6% ± 5.9 for males. Fourteen percent of the normal females had greater than 30% body fat (see Table 1). Also, 12% of overweight females had less than 20% body fat. In the obese classification, 11% of the females had 30-35% body fat and 18% of the males had less than 25% body fat.

Table 2 shows the correlation coefficients between the body composition variables and the weight-height indices. The W/H^3 index had the highest correlation with percent body fat. But, when the subjects were separated by sex, the highest coefficients were for $W^{1.2}/H^{3.3}$ and percent body fat.

When the relative weight indices were individually incorporated into simple regressions to predict percent body fat, the SEE ranged from 5.47% to 6.18%. The $W^{1.2}/H^{3.3}$ index had the lowest error (female, SEE = 5.84%; male, SEE = 5.47%). When subjects were ranked by percent body fat and by each of the relative weight indices, the $W^{1.2}/H^{3.3}$ index had the highest correlation coefficients (females, rs = 0.604, p<0.01; males, rs = 0.566, p<0.01).

The correlation coefficients were higher, and the error less, when the analyses were made by sex rather than for the group as a whole. The error in predicting % body fat with relative weight indices is about the same as the error in anthropometer skinfold techniques.

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(70)   DETERMINATION OF RAT BODY COMPOSITION USING BIOELECTRICAL IMPEDANCE ANALYSIS

C.B. Hall[*1], H.C. Lukaski[1], and M.J. Marchello[2]
[1]USDA, ARS, Grand Forks Human Nutrition Research Center, Grand Forks, ND 58202
[2]Dept. Animal Range Sciences, North Dakota State University, Fargo, ND 58105

Assessment of body composition in humans and other mammalian species is important to the researcher evaluating physiological function and nutritional status. Unfortunately, traditional methods, either direct by chemical proximate analysis or indirect by isotopic dilution and densiotometry, are subject to physical constraints which are unworkable when dealing with small animals. Another limitation is the inability to do longitudinal studies with these methods. Recently, bioelectrical impedance analysis (BIA) was shown to be suitable for predicting body composition in humans (1). In theory, the conductance (e.g., 1/resistance) of an applied current should be related to the volume of water and electrolytes within the body. Because fat contains no water, conductance will be limited to the lean body component and therefore an estimate of lean mass can be made (2).

This study was done to establish the relationship of bioelectrical impedance to body components determined by chemical analysis. We studied 64 male Sprague-Dawley rats ranging in weight from 200 to 500 g. The rats were fed ad lib a rat chow (Purina #5001[a], St. Louis MO) and tap drinking water. The rats were housed in an environmentally controlled room with a 12 hr light/dark cycle. The rats were anesthetized with Nembutal and were prepared for BIA by shaving the electrode sites and placing the animal in a standard prone position by aligning the head and the tail with the body and positioning the front and rear legs at a 90 degree angle to the body. Impedance was measured using phase sensitive electronics capable of reading both resistance and reactance. Initial attempts to use aluminum foil tape and silver solder electrodes failed because of poor electrical contact which caused erratic and non-reproducible readings varying by as much as 90% between trials. The procedure was modified by using needle electrodes placed sub-dermally on the head and spine at anatomically identifiable landmarks. The length of the rat and the distance between electrodes was measured. After obtaining impedance readings, the animals were sacrificed and prepared for chemical analysis by closely shaving all hair and removing the lungs and contents of the gut. Chemical analysis was accomplished by standard methods (3). The results of the chemical analysis are presented in Table 1.

Table 1
Chemical Composition of Rats[*]

	TBW	Protein	Ash	Fat
Mean	66.6	18.7	3.8	9.8
Std Dev	3.5	1.2	0.4	3.2
Range	60.1-73.2	15.2-23.2	2.9-5.0	4.5-18.6

*expressed as % live weight

The regression coefficients for the relationship between proximate chemical analysis and resistance (R), electrode distance (ED/R), electrode distance squared (ED^2/R), length (L/R), and length squared (L^2/R), are presented in Table 2.

Table 2
Relationship Body Components and Impedance

	R	ED/R	ED^2/R	L/R	L^2/R
TBW	0.852**	0.968**	0.985**	0.968**	0.974**
Protein	0.840**	0.950**	0.970**	0.948**	0.955**
Fat	0.674*	0.826*	0.860**	0.849**	0.883*
Ash	0.811**	0.926**	0.947**	0.932**	0.945**
LBM	0.848**	0.967**	0.986**	0.967**	0.974**

*p <0.001   **p <0.0001

The strong correlation of ED^2/R and L^2/R with LBM and TBW is in agreement with data previously obtained with humans (4). The findings of this study comparing BIA with chemical determination suggests that this method may be of use in predicting body composition. Further work is needed to validate this technique by studying body composition changes associated with altered physical status.

[a]Mention of a trademark/proprietary product does not constitute a guarantee/warranty of the product by the USDA and does not imply its approval to the exclusion of other products that may be suitable.

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(75)   INTERRELATION OF DIET AND HERPES SIMPLEX VIRUS PATHOGENESIS IN MICE

Keith J. Fischer, Steve M. Wright* and James J. Kelleher
Department of Microbiology and Immunology, University of North Dakota, Grand Forks, ND 58202

A number of studies have been done relating microbial infection, diet and immunity (1,2). However few reports have concentrated on the effects of diet on viral infections and specifically, herpes simplex virus disease. We have observed that the pathogenesis of herpes simplex virus, type 1 (HSV-1) in mice is significantly different when mice are maintained on two different but presumably nutritionally adequate diets.

Studies on HSV-1, strain MacIntyre, were done on three strains of mice; Swiss Webster, B10/D2 (NSN); Swiss Webster, B10/D2 (OSN), and BALB/c mice. Male mice, 4-6 weeks old, were maintained on their respective diets for 5 weeks prior to infection with HSV-1. The diets used were a laboratory chow (No. 5001, Ralston Purina, St. Louis, MO) and a sprayed egg white diet (No. 170989, Teklad Test Diets, Madison, WI). The animals were routinely given tap water and no attempt was made to control the amount of food or water intake. Weight gain during the five week period was equivalent for mice fed either diet. Mice on the chow diet ate more in order to maintain weight equality with mice fed the egg white diet. Observations of movement and appearance, e.g. fur and musculature, indicated healthy animals for both diet groups.

Following an intraperitoneal injection of 10^5 plaque-forming units of HSV-1, mice fed the egg white diet were more resistant to the viral infection (p<0.005, ANOVA). The percent survival of BALB/c mice on the chow vs. the egg white diet was increased from 18 to 63% (Fig. 1,A). The Swiss Webster mice, which are genetically more resistant to HSV (3), exhibited similar results. Cumulative percent survival increased from 50 to 90 (NSN) and from 35 to 90 (OSN) for chow vs. egg white diets (Fig. 1,B). The difference in survival rates between strain NSN and OSN mice fed the egg white diet was not significant.
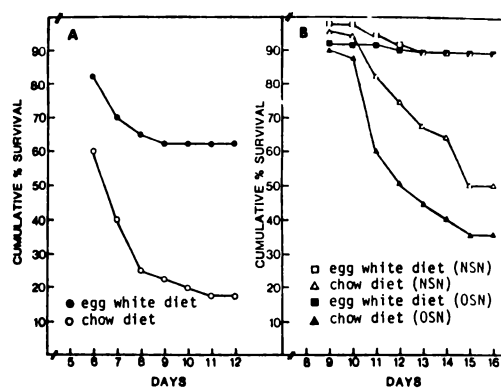

Fig. 1. Survival of BALB/c (A) and Swiss Webster mice (B)

Studies were done to determine the daily titers of HSV in various organs of BALB/c mice fed these two diets. Viral titers were comparable in the peritoneum, spleen and liver of mice in both diet groups during the first 4 days post-infection and were below detectable levels by day 4. Virus was found in the spinal cord of the chow-fed mice as early as day 4 and viral titers on day 5 were equivalent in both dietary groups. However, HSV was not detected beyond the 5th day in the egg white-fed mice, while HSV was continually detected in the spinal cord of mice on the chow diet through day 9 when the experiment was terminated. Virus was detected in brain tissue on day 5 and 6 at equivalent levels in mice on either diet. On day 6 to 8, viral concentrations dropped to non-detectable levels in brain tissue of mice on the egg white diet while HSV levels in the brain tissue of chow-fed mice continued to increase.

Counts of BALB/c peritoneal exudate cells and adherent cells showed an increase in the number of both total and adherent cells in the chow-fed (1.7 x 10^6 and 7.4 x 10^5) vs. egg white-fed animals (1.2 x 10^6 and 3.3 x 10^5). However, preliminary studies indicated that the adherent cells from chow-fed animals were able to handle HSV infection less efficiently than were cells from egg white-fed mice. Infectious center assays using adherent peritoneal cells showed a significant difference in the number of foci developed in adherent cells from chow-fed (1,120 ± 494) vs. egg white-fed mice (499 ± 440). These data were significant at p<0.01 (ANOVA). Finally, preliminary studies of serum interferon of BALB/c mice indicated that at 2-4 hours post-infection interferon levels in egg white-fed mice were considerably higher (1,000 to 800 units) than levels observed in the chow-fed animals (150 to 160 units).

We conclude that mice maintained on an egg white diet are significantly more resistant to HSV-1 infection as demonstrated by survival rates and viral distribution in murine organs. This resistance may relate, at least in part, to early immune responses involving both macrophages and interferon. At present, the factor(s) in these diets that account for the variance in resistance to HSV-1 infection is not known.

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(76) AN ENZYME - LINKED IMMUNOSORBENT ASSAY FOR THE DETECTION OF
ANTIBODIES TO TOXOPLASMA GONDII

M.B. Freeh*, S.M. Greenwald and D.A. Gabrielson
Department of Microbiology, North Dakota State University, Fargo
Biology Department, Valley City State University, Valley City

Toxoplasma gondii is an obligate intracellular protozoan
parasite of worldwide distribution. The disease has always been
a threat to immunocompromised hosts. Traditionally this group
included the very young and the very old, but with the increased
incidence of AIDS, there has also been an increase in reports of
toxoplasmosis. We have previously reported the development of a
preparation with vaccine potential, as well as a possible
differential diagnostic test to distinguish vaccinated from
infected animals. In this study, we report on the development of
an enzyme-linked immunosorbent assay (ELISA) test procedure that
can be correlated with previous data. Test parameters included
consideration of antigen integrity, antigen adherence, dispersal
of antigen, test reproducibility, antigen concentration to avoid
interference and correlation with previous data.
Immulon 2 flat bottomed microtiter plates (Dynatech) were
chosen as the reaction matrix based on reproducibility between
plates. The same reactions in 24 wells of 3 different plates
gave a mean variation of only 0.025 at an optical density of
405nm.
The antigen (Ag) used in this assay is the intact Toxoplasma
gondii tachyzoite, washed, formalin-fixed, suspended in carbonate
coating buffer and allowed to dry in the wells. Microscopic
examination showed that formalin fixed organisms kept their shape
better than those that were not. This treatment allows exposure
of more of the membrane surface and, theoretically, more of the
antigenic determinants for reaction with antibody (Ab). The
proper concentration of antigen was determined by serial dilution
and comparison with results obtained using an indirect
fluorescent antibody test (IFA).
The wells were washed with a phosphate buffered saline-tween
20 solution containing 4% bovine serum albumin (BSA). The BSA
prevents nonspecific adsorption of immunoglobulins in subsequent
steps and reduces background.
The test sera was then added to the wells, allowed to incubate
for 30 minutes at 37C, and washed. Commercially prepared Ab,
conjugated with alkaline phosphatase, was added and allowed to
incubate. After a final wash, p-nitrophenyl phosphate was added,
incubated in the dark, and the resulting color reaction was
measured in a plate reader at 405nm.
This protocol was used to measure the titer of 5 different
positive serum samples and 2 negative samples. Our standardized
IFA protocol was used to measure the titers of these same
samples. In all cases, ELISA and IFA titers were comparable. The
ELISA titers were one or two dilutions higher than the IFA titers
for all the positive samples. Generally, ELISA tests have
greater sensitivity than IFA. Though further refinements are
necessary, the reproducibility is such that we have adopted the
ELISA for routine laboratory use. Another advantage of this
test, is that by simply changing the Ab-conjugate, the test can
be adapted for use with many different animal species. Sheep and
mouse sera have been tested and the techniques for expanding the
procedure to other species are in development.

(77)   IDENTIFICATION OF A SEX-LIMITED ESTERASE GENE FROM
              DIABROTICA VIRGIFERA VIRGIFERA

P.P. Rosen* and D.A. Gabrielson
Department of Microbiology, North Dakota State University
and
I.C. McDonald
USDA, ARS, Metabolism and Radiation Research Laboratory
Fargo, North Dakota 58105

Corn rootworms (Diabrotica spp.) are recognized as the most serious insect pests of corn in the United States. Crop rotation and insecticides have been used to reduce the yearly economic damage done by the rootworm, but unfortunately these have shortcomings and the continued use of insecticides is environmentally unsafe. This research concerned with the potential for regulating the rootworm population by the manipulation of physiological or molecular processes that are involved during mating and reproduction.

Esterases are enzymatic proteins that are widespread in insect populations. The male-limited esterases of Drosophila melanogaster that are involved in reproduction have been studied extensively. They are produced in the male and transferred to the female during copulation. The presence of these enzymes in the ejaculate has been associated with effects on sperm utilization, female fertility, and the timing of female remating. The enzymes are glycoproteins that are classified as carboxylesterases and specifically serine hydrolases. A 1.8-Kb EcoRI fragment of the male-limited enzyme Est-6 gene of D. melanogaster DNA cloned in plasmid pGEM-1 was obtained from Dr. R.C. Richmond (1). This recombinant plasmid will be used in the DNA-DNA hybridization studies.

A sex-limited esterase enzyme, Est-m, which is produced in the male accessory glands of the western corn rootworm, Diabrotica virgifera virgifera LeConte, is currently being investigated. Previous studies indicated that Est-m may have the same role in reproduction as Est-6 (2).

In this study, the genomic DNA of D. v. virgifera was isolated and dot blotted to Hoefer nylon membranes. DNA-DNA hybridizations were performed using the biotin-labeled Est-6 fragment from D. melanogaster as the probe to detect potentially homologous Est-m sequences in D. v. virgifera. Because the level of nucleotide sequence similarity was not known, the inital hybridizations were performed at a low stringency to detect a 40% nucleotide sequence similarity and progressed to a high stringency, which detected a 70% nucleotide sequence similarity. The D. v. virgifera DNA was digested with the restriction endonucleases BamHI, EcoRI, HindIII, PstI, and SalI and the resulting DNA fragments were separated on a 0.7% agarose gel. Then the DNA was electroblotted to a Hoefer nylon membrane and probed with the biotinylated D. melanogaster Est-6 DNA fragment using hybridization conditions to detect a 70% nucleotide sequence similarity. One band in each restriction digest of the D. v. virgifera DNA was revealed. The results indicate there is a 70% nucleotide sequence similarity in the DNA for the esterase genes of the two insects.

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(99)   ON THE TRACK OF COMETS BRADFIELD, BORRELLY, AND MCNAUGHT

Franz H. Rathmann* and Larry Armfield
Department of Physics, North Dakota State University
Fargo, North Dakota 58105
Paul K. Bjornstad, Fargo; Tom Knutson, Horace, N.D.;
Iver Possehl, Barnesville, Minn.; and David Moritz, Devils Lake, N.D.

On August 11, 1987 William Bradfield, in Australia, discovered his 13th comet, 1987s. After a few observations Brian Marsden of the Smithsonian Institution and Harvard University calculated the orbital elements. From these were obtained the ephemeris data published in the Comet Digest[1]. From the numerical data for right ascension and declination we plotted the path on Tirion 2000 and other star charts.

For observation we used 8 x 40 and 11 x 80 binoculars, an 80 millimeter refractor, as well as a Celestron-8 telescope. Larry Armfield was also able to see Comet Bradfield as a naked-eye object. Comet Bradfield did develop a short tail. We plotted the position of the comet on a section of Tirion 2000 star chart.

From the various known star positions we could determine the right ascension and the declination of the comet for the date and time of that observation. Using the Celestron-8 properly mounted and oriented, with clock drive, we could also read the right ascension and declination on the setting circles. Our data agreed very well with the positions predicted as drawn on our charts, indicating that Bradfield's observations had been correct, and that the orbital elements given by Brian Marsden were also quite accurate.

In September Comet Bradfield passed through constellation Serpens Cauda, and on into Pegasus. During October and November it could be observed in the western-southwestern sky for some time after the end of evening twilight. In December and January it was far enough north, near the Tropic of Cancer, so that it was visible for many hours after sunset. It was then passing through Aries and heading toward the Pleiades and Hyades in Taurus. It is now well beyond perihelion on its way beyond our solar system and on its presumed 2500 year orbit.

Periodic Comet Borrelly P/1987p was for some time observable in the southern hemisphere in Eridanus, then came far enough north to be observed at our latitude. After mid-December it moved rapidly through the constellations Taurus and Triangula. On January 30 it passed variable Algol in Perseus. During the six day interval January 28 to February 3, while Algol went through two sixty-nine hour cycles from m = 2.2 to 3.4 and back, Borrelly moved from declination 40^0 to 45^0 while Algol blinked. Soon after Borrelly reached declination 45^0, it became a circumpolar object visible throughout the night.

Comet McNaught was first seen in the south, in Scorpius, came north through Ophiuchus and Serpens Cauda, then between Cygnus and Lyra, finally passing between Albireo and the interesting cluster M56 on January 30. Like Borrelly it became circumpolar about February 15, heading toward Cepheus.

We intend to follow these three comets as they fade from m = 8.9 to possibly m = 12 and as they slowly disappear from the night sky on their way to their aphelion points and return.

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(101)   VOICE--CONTROLLED VIDEO-DISPLAY SYSTEM

G. Kumar*, T. Hapy, and J. Maalouf
Department of Electrical Engineering
University of North Dakota
Grand Forks, ND 58202

This paper describes an innovative way of manipulating the motion of an object on a television set via vocal commands. This system, named as Voice-Controlled Video-Display System (VCVDS), will react to a person's spoken words by analyzing the speech and carrying out the required simplistic processing for the TV in accordance with the user's demands. This system (shown in Figure 1) is a blend of software and hardware and consists of the following four subsystems:

(1) Speech Recognition Subsystem (recognizing spoken words):
Voice commands enter the speech recognition circuitry through a microphone. The user's incoming speech patterns are compared to a stored voice pattern. When the circuit detects a reasonable match, a digital command is issued to the main microprocessor via an interrupt signal.

(2) Main Microprocessor Subsystem (controlling voice and video interactions):
The main processing unit is a general-purpose processor. Its function is to coordinate the input and output data from the two speech subsystems and the video subsystem. The programming for the microprocessor adopts a command response operation. That is, as vocal commands are received from the speech recognition subsystem, two different outputs (i.e., video and audio) are sent out to their respective subsystems.

(3) Voice Synthesis Subsystem (generating words):
The voice-synthesis circuitry receives the digital values from the main processor and sends appropriate analog signals to a speaker, where they are converted to sound. The words generated are synthesized from word phonetics. Since there is no limit to how the different sounds can be concatenated together, there is virtually no limit to what words can be produced.

(4) Video Display Subsystem (television processing):
The video display subsystem receives the data required to produce the appropriate TV signals from the main microprocessor. The figures on the screen, and their positions and colors, are maintained by the video coprocessor. The main processor defines initially the screen and figure characteristics to be moved on the screen. After the initial load of data, the video display circuit acts on the data as prescribed by the main microprocessor using mapping techniques. When voice command is interpreted to move an object on the display, the main processor is needed only to prescribe the action to the display subsystem, and then the video-display processor takes over, thus alleviating the burden of the main processor unit.

The design of the VCVDS is modular in nature and can lend itself to enhancement easily as more sophisticated technology becomes available. It is adaptable for a multitude of uses by software change. This system can be used for education, as an aid to the handicapped, and is limited only by the imagination of the users.
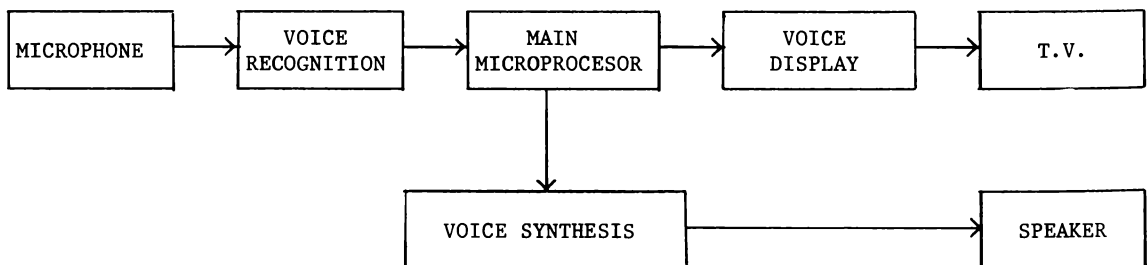

Figure 1 Voice-Controlled Video-Display System

(102)   LATERITIC VERSUS TEMPERATE ZONE SOILS
                PROPERTIES FOR ROADWAY MATERIALS

H. I. Inyang, R. O. Rogness* and G. Padmanabhan
North Dakota State University, Fargo, ND

Lateritic soils are found in abundance in the tropics. They are highly weathered reddish brown soils dominated by iron and aluminum oxides (sesquioxides) but poor in humus and combined silica (1). Generally, they are of higher strength and permeability than temperate zone soils. Their plasticity values, compressibility and shrink/swell potential are, in most cases, lower than those of their temperate zone equivalent (2). There is a need to modify present temperate zone maintenance and design procedures when being used with lateritic soils. This is also true for material specifications and stabilization techniques (3).

The lateritic soil particles are cemented into clusters by sesquioxides and mineral hydrants. This results in high strength, low compressibility, and sometimes high permeability versus temperate zone soil equivalents. Sesquioxides reduce the plasticity of lateritic soils by coat-binding clay particles and reducing their water absorption capacity. The lateritic soils also exhibit higher specific gravities because of the greater accumulation of iron in the coarser fractions. The shearing strength also is increased because of the presence of sesquioxides. Table 1 shows the overall comparison between lateritic and temperate zone soils.

Table 1. Comparison of Soil Properties

PARAMETER	TROPICAL	TEMPERATE
Strength	Greater	Lower
Permeability	Greater	Smaller
Density	Lower	Higher
Plasticity	Lower	Higher
Compressibility	Lower	Higher
Shrink/swell	Lower	Higher
Specific surface	Lower	Higher

Compaction and stabilization will increase the strength of a lateritic soil and reduce volume change. Lateritic soils are likely to exist insitu at a natural water content that excedes the optimum for compaction. For the same liquid limit and grain size, the compressibility of lateritic soils is less than that of temperate zone clays. About half the quantity of cement required to stabilize temperate soils is needed to stabilize lateritic soils. Adequate compaction and stabilization can reduce subsequent settlement and water content even in the event of subsequent saturation, resulting in improved soil properties. The stabilizing agent used is important. It is necessary to examine the minerology of the predominant clay mineral to determine the suitability of a specific stabilizizing agent. The predominant clay mineral in lateritic soils is kaolinite, which has a relatively low cation exchange capacity. Thus lateritic soils are of low activity and have less capacity for chemical activity than temperate zone clays, that are mainly montmorillonite. Montmorillonites have a large specific surface and hence higher cation exchange capacity than kaolinite.

Lime stabilization is usually highly successful in temperate zone clays because the surface change is relatively constant for high activity clays. Liming reduces the surface changes and also introduces a net gain in positive change to satisy the negative oxygen or hydroxyl charges on the surfaces. Liming does not work well for low activity, variable change and low silica clays that dominate lateritic soils. Cement is the dominant stabilizing agent employed on lateritic soils. However only about 50 percent of the cement required to stabilize a termperate zone soil is needed. This arises because of lateritic soils existing at a higher strength level due to higher sesquioxide content; kaolinte being of lower activity than montmorillonite resulting in fewer charges needing to be satisfied, and the sesquioxides themselves coating the clay particles reducing their cation exchange capacity.

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(103)   USE OF MULTIVARIATE STATISTICS IN
PAVEMENT PERFORMANCE DATA

John G. Rohlf
Federal Highway Administration, Washington, DC
Ramey O. Rogness*
G. Padmanabhan
North Dakota State University, Fargo, ND

Evaluation and management of pavements are of great concern for highway departments. In general, pavement evaluation data can be classified into: roughness, surface distress, structural capability and skid resistance (1). Structural capability is usually evaluated by measuring the deflection of the pavement under a standardized load. The pavement deflections are affected by: type and thickness of pavement layers, pavement temperatures, subgrade moisture content, and amount of traffic which has cumulatively passed over the roadway. The ojective of this study was to develop a relationship between deflection and pavement temperature, subgrade moisture and traffic loading for a number of different pavement structures. This relationship could then be used to standardize deflection measurements to a reference temperature, thus permitting pavement sections to be compared at various moisture and traffic combinations. The North Dakota State Highway Department had deflection readings over a ten-year period for a test road. The test road had seventy-six different pavement segments consisting of different layer materials and thicknesses to evaluate the pavement structure performance. Because of incomplete or missing data for moisture content, a surrogate measure was developed for moisture. This was a seasonality factor corresponding to wet or dry conditions and was introduced as a dummy variable (SEAS). Also, the five-day mean air temperature (T5), in addition to the surface temperature (T) was used to represent the overall pavement temperature.

The five deflection readings corresponding to the five sensors were found to be highly corre-lated as shown in Table 1. As a result, multivariate analysis techniques (2) were used to analyze the data. The multivariate analysis of variance (MANOVA) table and the test statistics (3) - Wilk's Lambda, Roy's GCR, Lawley-Hotelling, and Pillai's trace were used (4). Season (moisture), pavement surface and air temperature and traffic were found to significantly affect pavement deflection. The effects of temperature were significanlty different for the different seasons. The effect of traffic varied with the season during which the load was applied. A regression model was developed between deflections, pavement material properties, temperature, moisture (season), and traffic. This can be used to explain some of the variability in deflection data. It permits data collected over various conditions to be compared on a more equivalent basis. As an example, the regression model for the first sensor reading, W1, is given below.

$$W1 = .10165 + .02324(T) + .03329(T5) - .27352(SEAS) - .00036(T*T5) + .00696(T5*SEAS)$$

To verify the model results, the univariate coefficient of determination and residual plots were made for the deflection readings. These plots indicated that the model is adequate. None of the residual versus predicted plots showed any systematic trends. The model developed can be used to compare pavement deflections for a single roadway section over time. It can also be used to deter-mine season effects on pavement structure for load-limit decisions. The use of multivariage statis-tics permitted the development of interaction factors that influenced the pavement performance.

·Table 1

CORRELATION BETWEEN SENSOR READINGS

SENSOR	W1	W2	W3	W4	W5
W1	1.0000	0.8516	0.5899	0.4095	0.3600
W2	0.8516	1.0000	0.8540	0.6366	0.6196
W3	0.5899	0.8540	1.0000	0.8980	0.8368
W4	0.4095	0.6366	0.8980	1.0000	0.9337
W5	0.3600	0.6196	0.8368	0.9337	1.000

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(104)   THE IMPORTANCE OF THE FLOCCULATION ON THE
          PHYSICAL ASPECTS OF COLOR COAGULATION

Shahin Rezania*
Civil Engineering Department, University of North Dakota
Grand Forks, North Dakota 58202

As a water treatment process, flocculation was unknown a century ago. The object of coagulation and flocculation is to attain almost complete envelopment of suspended particles within the floc particles, and to condition the floc particles so they will readily be removable in the subsequent process of sedimentation, or filtration, or both.

Water treatment practitioners once used the word coagulation to refer to an entire process that included addition of chemicals, coagulants, dispersion, flocculation, and settling. Today, the chemist's definition of coagulation is used: it is the driving together of colloidal particles by chemical forces. The process is speedy and occurs within seconds of the application of the coagulating reagent to the water. Because of this, intense mixing is necessary at the point of chemical application in order to ensure uniform chemical distribution and exposure of the fine particles in the water to the coagulating agent before the coagulation reaction is completed. This is the work of the rapid mix. The term flocculation refers to the assembling of coagulated particles into floc particles. Flocculation may be partly a chemical bridging mechanism, enhanced by the use of substances like polyelectrolyts, but it is much slower, and more dependent on time and amount of agitation than is coagulation.

Coagulation and flocculation are greatly influenced by physical and chemical forces such as electrical charges on particles, exchange capacity, particle size and concentration, pH, water temperature, and electrolyte concentrations. It is important to secure information on the behavior of the water to be treated in a proposed plant.

After the coagulatant has been introduced and diffused, the minute coagulated particles are brought into contact with each other and with the other particles present, by prolonged agitation, during which the particles coalesce, increase in size, and are packed to greater density. The completeness of the process depends on the character of the water and the value of GT, (i.e., G is the velocity gradient and T is time).

The object of this study was to examine the importance of G and T on color removal during the flocculation process. Three values of G were considered in the flocculation tests: 90, 50, and 20. All physical parameters in the jar test procedure held constant, with the exception of the detention time and mixing intensity in the rapid mix phase, to eliminate any other factors in the interpretation of the data.

Figure 1 shows the settled color versus detention time in flocculations. The results from these experiments show that in the case of the flocculators, both G and T are important, but for different reasons. The detention time, T, is important for allowing enough time for the particles to be formed that will settle out of suspension in the sedimentation basin. At least 900 seconds is required to do this, after which no improvement in the final water quality will occur. After a detention time of at least 900 seconds the velocity gradient makes a significant difference in the final water quality where, of the three values of G tested in this experiment, a G of 20 sec^{-1} provides the best treatment. Based on this information the water treatment plant operator can determine the effectiveness of physical mixing conditions prior to the filtration by using the settled color curves. Because all these tests were conducted at 25°C, further research still needs to be performed at colder temperatures to see if the conclusions drawn from this investigation also apply to the colder temperatures.
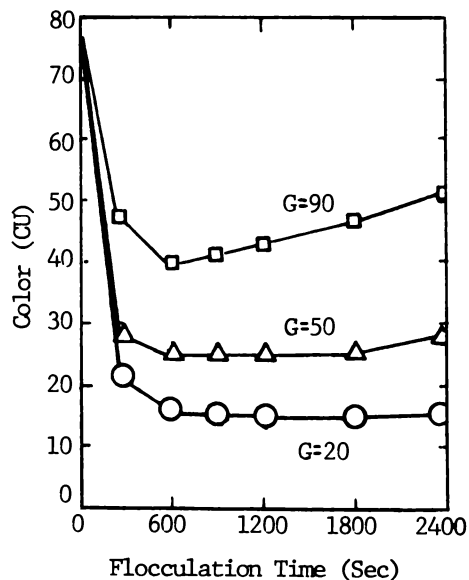

Flocculation Time (Sec)

Figure 1

(105)   ETHICAL CONCERNS OF FACULTY MEMBERS IN ENGINEERING AND APPLIED SCIENCE

David A. Rogers* and William A. Bares
Department of Electrical and Electronics Engineering
North Dakota State University
Fargo, North Dakota 58105

Intense technical and academic pressures on faculty members in engineering and the applied sciences can lead to ignoring some serious personal and professional issues that can be critical to one's personal life, career, and employing institution. Faculty must be concerned with ethical requirements in research, teaching, and advising. It is hoped that by presenting this material the authors can contribute to renewing interest in this area of common concern to faculty in various disciplines.

Rapid changes in science and technology as well as a fluid political scene have made it more difficult each passing year for faculty to follow their own ethical principles. Our own training has been to a large degree in strictly technical areas, and consideration of personal or ethical factors often can become little more than an embarrassment to some. For this reason we would like to point out some areas where faculty members need to be especially alert in the conduct of their profession.

The literature (1,2) on the subject deals with several areas of concern to faculty involved in research. Important points to consider are: 1) revenge--engaging in a pattern of conduct whereby a colleague or institution is habitually wronged in terms of low performance ratings, poor reviews, negative informal comments, and unwillingness to cooperate in intellectual activities; 2) abuse of confidentiality--appropriating ideas discovered during the formal or informal review process; 3) abuse of scholarly privileges--engaging in research to the neglect of basic responsibilities such as maintenance of scholarly breadth, practice of good teaching, and engaging in conscientious advising; 4) plagiarism--an attempt to receive credit for the work of someone else by not recognizing contributions to our work by colleagues and by deliberately neglecting to accurately list reference materials consulted; 5) conflict of interest--an outside involvement dictates that we withdraw from professional policy, employment, and financial decisions; 6) seemingly deliberate violations of regulations--professional pressure for personal achievement may lead us to find a way to get around an institutional regulation; and 7) inhumane use of science--engaging in research leading to results offering no positive outcome for humanity but only short-term gains for a chosen few (a vast literature exists on this topic--see Henry (3) as a starting point).

Teaching is another potential problem area for engineering and applied science faculty. One type of problem would be to attempt to avoid or abuse the teaching of values and ethics in our courses. The teacher might use the course to "propagandize" the student--that is, attempt to recruit the student to become a simple follower of the teacher's point of view. The AAUP advises that a student "should not be forced...to make...personal choices as to...his own part in society. Evaluation...must be based on academic performance...not on...personal beliefs." (2) Luegenbiehl and Dekker (4) and Peterson (5) suggest that faculty educate in a value-option context--the educator admits his biases to the student but tries to honestly present and discuss a variety of points of view. The AAUP has further advised that "it is improper for an instructor persistently to intrude material that has no relation to his subject, or to fail to present the subject matter of his course as announced to his students and as approved by the faculty in their collective responsibility for the curriculum." (2) This is an appropriate caution but should not be carried to the extreme of preventing innovation. If faculty are not concerned about ethics, there is an unspoken message to students: it's not important.

Allied to the area of teaching is academic advising. Students often claim that faculty don't give sufficient time to advising. If faculty allowed more time for this, students would use it for more extensive discussions in the areas of career and life planning. However, there are students who feel that the faculty give too much advice. Appropriate advising could lead to a better understanding of our goals in higher education and a better orientation to the curriculum for the student.

Concern for ethics in research, teaching, and advising is a must for faculty. In some disciplines this can be demonstrated by registration in a professional organization which subscribes to a code of ethics. It is hoped that the authors have contributed to renewed interest in some areas of ethical concern for faculty members in engineering and the applied sciences. This work was partially supported by the Bush Foundation through an NDSU Faculty Development Institute grant.

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THE METHOD OF MIXED MONOTONY FOR SOLVING DIFFERENTIAL EQUATION

(107)

Mohammad Khavanin[*]
Mathematics Department, University of North Dakota
Grand Forks, North Dakota 58202

Consider the integro-differential system

$$u' = f(t,u,Tu), \quad [tu](t) = \int_0^t K(t,s)u(s)ds, \quad u(o) = u_o \tag{1}$$

where $f \in [I \times R^N \times R^N, R^N]$, $I = [0,T]$ and $K(t,s) = (K_{ij}(t,s))$ in an $N \times N$ matrix kernel whose elements $K_{ij} \in C[I \times I, R_+]$. We construct monotone sequences that converge to the unique solution of first order integro-differential systems (1) when f does not possess any monotone properties. This method offers a flexible and effective mechanism for proving constructive existence results in a sector, the iterative schemes are also useful to investigate qualitative properties of solutions.

Theorem 1. Consider the system (1). Suppose that the following conditions are satisfied.

(I) $\alpha, \beta \in C'[I, R^N]$, $\alpha(t) \leq \beta(t)$ on $I = [0,T]$;

(II) $\alpha' \leq f(t,\alpha,T\alpha) - B[\overline{(\beta-\alpha)} + T(\beta-\alpha)]$;
        $\beta' \geq f(t,\beta,T\beta) + B[(\beta-\alpha) + T(\beta-\alpha)]$;

(III) $-B[\overline{(u-\overline{u})} + T(\phi-\overline{\phi})] \leq f(t,u,T\overline{\phi}) - f(t,\overline{u},T\overline{\phi}) \leq [B(u-\overline{u}) + T(\phi-\overline{\phi})]$;

whenever $\alpha \leq \overline{u} \leq u \leq \beta$ and $\alpha \leq \overline{\phi} \leq \phi \leq \beta$, B is an $N \times N$ matrix of nonnegative elements. Then there exist monotone sequences $\{\alpha_n(t)\}$, $\{\beta_n(t)\}$, that converge uniformly on I to the unique solution $u(t)$ of (1). Furthermore,

$$\alpha(t) \leq \alpha_1(t) \leq \ldots \leq \alpha_n(t) \leq u(t) \leq \beta_n(t) \leq \ldots \leq \beta_1(t) \leq \beta(t) \text{ on } I.$$

Proof. We define

$$F(t,y,Ty,z,Tz) = \tfrac{1}{2}[f(t,y,Ty) + f(t,z,Tz) + B(y-z) + T(y-z)]. \tag{2}$$

we can show that the following inequalities hold

$$-B[(z-\overline{z}) + T(\phi_1-\overline{\phi}_1)] \leq F(t,y,T\phi_2,z,T\phi_1) - F(t,\overline{y},T\overline{\phi}_2,\overline{z},T\overline{\phi}_1) \leq B[(y-\overline{y}) + T(\phi_2-\overline{\phi}_2)] \tag{3}$$

whenever $\alpha \leq \overline{y} \leq y \leq \beta$, $\alpha \leq \overline{z} \leq z \leq \beta$, $\alpha \leq \overline{\phi}_1 \leq \phi_1 \leq \beta$ and $\alpha \leq \overline{\phi}_2 \leq \overline{\phi}_2 \leq \beta$.

From (2) and (II) it is easy to see that F is mixed monotone and

$$\alpha' \leq F(t,\alpha,T\alpha,\beta,T\beta), \quad \beta' \geq F(t,\beta,T\beta,\alpha,T\alpha). \tag{4}$$

Finally $F(t,u,Tu,u,Tu) = f(t,u,Tu)$ follows from (2). For any $\eta,\mu \in [I,R^N]$ such that $\alpha \leq \eta \leq \beta$ and $\alpha \leq \mu \leq \beta$, consider linear differential equation for each i,

$$u'_i = F_i(t,\eta,T\eta,\mu,T\mu), \quad u(o) = u_o. \tag{5}$$

Given any η,μ clearly there exists a unique solution u of (5) on I. We define a mapping A by $A[\eta,\mu] = u$, for any $\eta,\mu \in [\alpha,\beta]$, where u is the unique solution of (5). Taking into account that F is mixed monotone together with inequalities in (4) we can show that

(i) $\alpha \leq A[\alpha,\beta]$, $\beta > A[\beta,\alpha]$

(ii) A is a mixed monotone operator in the sector $[\alpha,\beta]$.

we define the sequences $\{\alpha_n\}$, $\{\beta_n\}$ by $\alpha_{n+1} = A[\alpha_n,\beta_n]$, $\beta_{n+1} = A[\beta_n,\alpha_n]$, $n = 0,1,2,\ldots$, on I, where $\alpha_0 = \alpha$, $\beta_0 = \beta$. By properties (I) and (II), we concluded that

$$\alpha \leq \alpha_1 \leq \alpha_2 \leq \ldots \leq \alpha_n \leq u \leq \beta_n \leq \ldots \leq \beta_2 \leq \beta_1 \leq \beta \text{ on } I.$$

It then follows using standard argument, see [1] that $\lim_{n \to \infty} \alpha_n = \rho(t)$, $\lim_{n \to \infty} \beta_n = r(t)$ exist, uniformly on I. Also $P'(t) = B[P(t) + (TP)(t)]$, $P(0) = 0$, where $P(t) = r(t) - \rho(t)$ on I. This implies that $r(t) = \rho(t) = u(t)$ on I. The proof is complete.

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(121)   TRACE ELEMENT NUTRITURE OF FEMALE COMPETITIVE SWIMMERS

H.C. Lukaski[*1], B.S. Hoverson[2], and W.W. Bolonchuk[1,2]
[1]USDA, ARS, Grand Forks Human Nutrition Research Center and [2]University of North Dakota
Grand Forks, ND 58202

Information about nutritional status during physical training is limited. Studies of athletes during training describe changes in either nutrient intakes or blood biochemical indices; there are no reports integrating both types of information.

We studied 21 female members of the University of North Dakota swim team at the start and end of the 1985-86 competitive season. Nutritional status was assessed by determining body composition using hydrodensitometry, nutrient intake from 7 day diet records, and analysis of some blood constituents. Data were not included for 9 of the swimmers in this analysis because they reported use of oral contraceptive agents or regular consumption of nutritional supplements.

Body mass did not change, but fat free mass increased (48.7 ± 1.3 vs 51.1 ± 1.3 kg, mean ± SEM; $p < 0.001$) and fat mass decreased (13.4 ± 0.3 vs 11.5 ± 0.3 kg; $p < 0.001$).

Energy, protein, and fat intakes were similar, but carbohydrate intake increased during training ($p < 0.05$; see Table 1). Trace element intakes were unchanged. Daily iron, magnesium, and zinc intakes averaged 65-88% of the recommended dietary level, whereas copper intake was less than the suggested level of 2-3 mg/d.

Table 1

Macronutrient and Trace Element Intakes at Start and End of Season

	Energy kcal/d	Protein g/d	CHO g/d	Fat g/d	Copper mg/d	Iron mg/d	Magnesium mg/d	Zinc mg/d
Start	2338 ± 106[a]	70 ± 6	310 ± 25	90 ± 15	1.1 ± 0.1	13.2 ± 0.8	263 ± 19	10.2 ± 0.7
End	2569 ± 140	68 ± 5	380 ± 20[*]	87 ± 9	1.0 ± 0.1	12.0 ± 1.0	243 ± 22	9.7 ± 0.8

[a]Values are mean ± SEM; n = 12   [*]$p < 0.05$

Although all blood biochemical measures were within the range of normal values, some statistically significant ($p < 0.05$) changes were found (see Table 2). Hemoglobin (Hgb) decreased and total iron binding capacity (TIBC) increased, while hematocrit (Hct) and ferritin did not change. Plasma trace element concentrations also were unchanged.

TABLE 2

Changes in Blood Biochemical Indices of Nutritional Status

					Plasma			
	Hct %	Hgb g/dl	TIBC µg/dl	Ferritin ng/ml	Copper µg/dl	Iron µg/dl	Magnesium mg/dl	Zinc µg/dl
Start	40.8 ± 0.4[a]	13.9 ± 0.2	319 ± 19	18 ± 5	95.4 ± 11.2	102.1 ± 6.4	1.9 ± 0.03	80.6 ± 2.1
End	39.4 ± 0.7	13.2 ± 0.2[*]	349 ± 20[*]	25 ± 4	94.5 ± 10.5	93.1 ± 9.4	2.0 ± 0.04	76.8 ± 2.1

[a]Values are mean ± SEM; n = 12   [*]$p < 0.05$

Another blood constituent, superoxide dismutase, a copper-dependent enzyme in red blood cells, increased ($p < 0.01$) from 4083 ± 81 to 4987 ± 171 U/g Hgb during training.

These findings indicate that intensive swim training is associated with favorable changes in body composition and that the slight reduction in circulating trace element levels within the normal range is probably the result of plasma volume expansion and a redistribution of nutrients in body pools. The increase in superoxide dismutase activity may reflect a unique biochemical adaptation to aerobic training.

(122)   THE EFFECT OF BORON, MAGNESIUM, POTASSIUM AND THEIR INTERACTION
ON SOME MAJOR MINERAL ELEMENTS IN LIVER, KIDNEY AND BONE

Terrence R. Shuler[*] and Forrest H. Nielsen
USDA, ARS, Grand Forks Human Nutrition Research Center, Grand Forks, ND 58202

Recent experiments in our laboratory have shown that boron, and an interaction between boron and magnesium affects major mineral metabolism in chicks (1), rats (2) and post-menopausal women (3). The experimental findings suggested that boron has a role in some disorders that exhibit disturbed mineral metabolism, e.g., osteoporosis. The following study was done to obtain further data supporting such a role for boron.

Male weanling Sprague-Dawley rats were assigned to groups of six in a fully crossed, three-way 2x2x2 experimental design. The methionine-supplemented diets were supplemented with boron at 0 and 3 µg/g diet, with magnesium at 100 and 400 µg/g diet and potassium at 1.8 and 3.6 mg/g diet. Environmental conditions have been described (2). The rats were fed their respective diets for seven weeks, fasted overnight, weighed, then anesthetized for cardiac exsanguination and decapitation. The liver, one kidney, and one femur were removed and frozen for later analysis. The samples were prepared in our usual manner for mineral analysis using inductively coupled argon plasma atomic emission spectrometry.

Table 1
Effect of boron, magnesium, potassium and their interaction on major mineral elements in organs

Treatment, µg/g Diet			µg Ca/g Dry Tissue			µg Mg/g Dry Tissue			mg K/g Dry Tissue		
B	Mg	K	Liver	Kidney	Femur	Liver	Kidney	Femur	Liver	Kidney	Femur
0	100	1800	136	806	2.09×10^5	925	787	1130	10.4	10.6	4.34
3	100	1800	135	1147	2.15×10^5	913	799	1134	10.8	10.1	4.39
0	100	3600	116	2445	2.12×10^5	815	820	982	14.5	11.6	4.06
3	100	3600	112	3428	2.16×10^5	791	800	1030	14.3	12.0	4.09
0	400	1800	117	315	2.07×10^5	782	846	4233	11.0	11.4	4.32
3	400	1800	105	323	2.05×10^5	765	866	4253	11.0	11.6	3.90
0	400	3600	96	296	1.97×10^5	742	852	3921	11.0	11.5	4.18
3	400	3600	112	334	2.07×10^5	764	822	4083	11.1	11.2	4.21
			Analysis of Variance -P Value								
B			NS	NS	0.04	NS	NS	(0.08)	NS	NS	NS
Mg			0.0001	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.007	NS
B x Mg			NS	NS	NS	NS	NS	NS	NS	NS	NS
K			0.0001	0.0001	NS	0.0001	NS	0.0001	0.0001	0.0001	NS
B x K			0.004	NS	NS	NS	0.02	NS	NS	NS	NS
Mg x K			0.0008	0.0001	NS	0.0001	0.03	(0.09)	0.0001	0.0001	0.03
B x Mg x K			0.0003	NS	NS	NS	NS	NS	NS	0.005	NS

The distribution of calcium, magnesium and potassium in the organs examined was affected by the dietary variables. Boron deprivation slightly depressed femur calcium. The effect of dietary boron on liver calcium depended upon dietary potassium and magnesium. Boron did not affect liver calcium in magnesium-deprived rats. However, in the magnesium-adequate rats, boron deprivation elevated the liver calcium concentration when dietary potassium was low, but depressed the concentration when dietary potassium was adequate. Magnesium deprivation elevated the concentration of calcium in the liver; the elevation was most marked in the potassium-adequate rats. Boron deprivation tended to decrease calcium in the kidney; most likely the decrease did not reach significance because of the extreme variability of kidney calcium in the magnesium-deprived rats. Magnesium deprivation depressed the concentration of magnesium in kidney and bone, but, surprisingly, elevated the concentration in liver. The changes in liver and kidney were most marked when dietary potassium was low. Potassium deprivation did not affect the concentration of potassium in the organs from magnesium-adequate rats. In magnesium-deficient rats, potassium deprivation depressed the concentration of potassium in liver and kidney but elevated the concentration of potassium in bone. The findings demonstrate that boron, magnesium, potassium and their interaction affect the distribution of major mineral elements in the rat. The findings indicate that boron, in addition to magnesium and potassium, has a role in major mineral metabolism.

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(123)   BORON HOMEOSTASIS IN THE CHOLECALCIFEROL-DEFICIENT CHICK

Curtiss D. Hunt[*]
USDA, ARS, Grand Forks Human Nutrition Research Center
Grand Forks, N.D. 58202

Recent findings (1) indicate that dietary boron affects several physiological indices in the cholecalciferol (vit. D_3)-deficient chick. Those indices include growth, bone calcification rate, and femur molybdenum and boron concentrations. However, it was noted that the magnitude of the responses to dietary boron apparently fluctuated between experiments; this produced the hypothesis that variations in dietary boron caused those fluctuations and that boron metabolism therefore may be homeostatically controlled. Thus, an experiment was designed to elucidate possible boron homeostatic mechanisms in the chick. Because the effects of boron apparently are more marked in the vit. D_3-deficient chick fed amounts of magnesium normally considered adequate (1), that experimental model was employed in the present study.

Day-old cockerel chicks (16 per group) were weighed individually upon arrival and housed in all-plastic environmental chambers (2). The diet was based on ground corn-casein-corn oil and contained 0.200, 0.248, 0.334, 0.481, 1.231, 2.095, or 3.973 mg boron (as orthoboric acid)/kg, magnesium (as magnesium acetate) at 500 mg/kg, and vit. D_3 (400,000 units/g) at 125 (inadequate) IU/kg. The lowest level of dietary boron represents that permitted by available technology, whereas the highest level is similar to that found typically in human diets comprised mainly of fruits and vegetables. Chicks were provided 24 hours of light daily by using fluorescent lighting filtered through acrylic plastic and 1/4" plate glass. The chicks were fed their respective diets for 28 days, weighed, and decapitated subsequent to cardiac exsanguination. Elemental analyses were obtained by inductively coupled argon plasma spectroscopy following a wet ash procedure.

Table 1.   Effects in Vit. D_3-Deficient Chicks of Dietary Boron on Selected Indices

Treatment, µg B/g diet	Body Wt. at 28 days, g	Blood Plasma				
		B, ng/ml	Mo, ng/ml	Albumin, mg%	Chol., mg%	Glucose, mg%
0.200	604	58	85	193	156	496
0.248	662	60	44	201	176	452
0.334	613	58	60	205	166	349
0.481	695	82	39	208	187	327
1.231	710	95	39	218	178	352
2.095	725	131	39	205	187	330
3.973	509	218	49	193	162	400
2nd Order Regression Analysis – P Values	0.010		0.000	0.000	0.000	0.001
Critical Values, mg B/kg	0.86		1.18	0.88	0.92	1.04
Root M. Sq. Er.	164		0.03	0.15	22	143

At four weeks, all chicks exhibited the classic signs of vit. D_3 deficiency including depressed growth, elevated plasma glucose, and elongated tibial epiphysial growth plates. Gross observation indicated that the highest level of boron fed substantially increased the length of the growth plates. Plasma boron concentrations were similar in chicks fed 0.481 or less mg boron/kg diet, whereas higher dietary boron elevated plasma boron concentrations progressively; chicks fed the highest amounts of boron exhibited plasma boron levels four times those of chicks fed the lowest amount of boron. Second order regression analysis of several measured indices described parabolas whose critical values (slope equals 0) occur around the point where mg boron/kg diet = 1. For example, plasma glucose, abnormally elevated by vit. D_3 deficiency, decreased, then increased, as a function of dietary boron. On the other hand, plasma albumin, cholesterol, and body weight increased, then decreased. These findings indicate that boron may be homeostatically controlled; a 5-fold range of dietary boron has been identified that apparently is beneficial to the vit. D_3-deficient chick, as evidenced by improved body growth and plasma glucose concentrations. Further increases in dietary boron apparently overwhelm homeostatic controls. The effects of dietary boron on plasma glucose may be particularly significant in situations such as diabetes mellitus, where sugar metabolism is altered.

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(124)   DIETARY POTASSIUM AFFECTS THE SIGNS OF BORON AND MAGNESIUM DEFICIENCY IN THE RAT

Forrest H. Nielsen[*], Thomas J. Zimmerman, and Terrence R. Shuler
USDA, ARS, Grand Forks Human Nutrition Research Center, Grand Forks, ND 58202

Recent findings (1) have resulted in the hypothesis that boron has a function necessary for maintaining membrane structure and/or function. Magnesium has a functional role as an activator of Na,K-ATPase, or the Na,K pump, which actively transports sodium and potassium across the cell membrane (2). Possibly, some of the biological interaction between boron and magnesium (1) occurs at the cellular membrane level. Thus, changes in the amounts of another element in cellular membranes needed for their normal function may affect the signs of boron and magnesium deficiency in animals. This thought led us to ascertain whether potassium, an integral part of Na,K-ATPase, affects the response of rats to dietary boron and magnesium deprivation.

Male weanling Sprague-Dawley rats were assigned to groups of six in a fully-crossed, three way 2x2x2 design. The treatments were the supplementation of the methionine-supplemented basal diet (1) with boron at 0 and 3 µg/g, with magnesium at 100 and 400 µg/g, and with potassium at 1800 and 3600 µg/g. Environmental conditions have been described (1). The rats were fed their respective diets for seven weeks, fasted overnight, weighed, anesthetized for heart puncture and decapitated. Selected variables listed in the table were determined by our usual methods (1).

Table 1
Effects in Rats of Dietary Boron, Magnesium, Potassium and Their Interaction on Selected Variables

Treatment, µg/g diet			Wt. at 7 wks, g	Liver wt×100 / Body wt	Kidney wt×100 / Body wt	Plasma		µg Boron / g Dry femur
B	K	Mg				Trigl., mg%	Chol.,mg%	
0	1800	100	191	3.31	0.410	52	89	0.59
3	1800	100	225	3.11	0.378	62	98	0.83
0	3600	100	216	3.13	0.369	89	102	0.54
3	3600	100	229	3.04	0.363	72	93	0.88
0	1800	400	255	3.06	0.374	44	99	0.48
3	1800	400	273	2.95	0.346	55	95	0.59
0	3600	400	245	3.06	0.349	42	92	1.16
3	3600	400	293	2.97	0.348	52	94	1.18
Analysis of Variance - P Values								
Boron			0.0001	0.03	0.007	NS	NS	0.02
Magnesium			0.0001	0.01	0.0001	0.0001	NS	(0.06)
B x Mg			NS	NS	NS	NS	NS	NS
Potassium			NS	NS	0.002	0.03	NS	0.0001
B x K			NS	NS	0.03	NS	NS	NS
Mg x K			NS	NS	NS	0.007	NS	0.0001
B x Mg x K			0.04	NS	NS	NS	0.03	NS

The findings indicate that dietary potassium influences the response of rats to boron and magnesium deprivation. Deficiency either in dietary boron or magnesium depressed the growth of rats. However, the depression in growth caused by boron deprivation was most marked in magnesium-deficient rats when dietary potassium was low, but most marked in magnesium-adequate rats when dietary potassium was adequate. The effect of boron on kidney wt/body wt ratio (KW/BW) was influenced by potassium. KW/BW was elevated in boron-deprived rats when dietary potassium was low, but not when it was adequate. The effect of magnesium on plasma triglycerides was also influenced by potassium. The elevation in triglycerides caused by magnesium-deficiency was more marked in potassium-adequate than -deprived rats. There apparently was no effect of magnesium and potassium on plasma cholesterol in boron-supplemented rats. On the other hand, in boron-deprived rats magnesium deficiency elevated plasma cholesterol when dietary potassium was adequate, but depressed plasma cholesterol when it was not. Further evidence for a relationship among boron, magnesium and potassium is the bone boron findings. Magnesium deficiency depressed boron in the femur of potassium-adequate rats, but elevated boron in the femur of potassium-deprived rats. The findings demonstrate that dietary potassium affects the response of rats to dietary boron and magnesium deprivation. Possibly, some of the interaction among these three elements occurs at the cellular membrane level.

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(125)   POST-IMPLANTATION EMBRYONIC DEATH IN VITAMIN E DEFICIENCY

Donald L. Matthies[*] and Kap J. Lee
Department of Anatomy and Division of Comparative Medicine
University of North Dakota
Grand Forks, North Dakota

The six decades which have elapsed since the discovery of vitamin E have not produced an explanation for the infertility in rats which results from a dietary deficiency of this nutrient. Immediately following the first descriptions of the vitamin several histological studies were made which described many of the morphological events which accompanied this fertility loss (1,2). These studies continued into the 1930's and are now considered classics and are still frequently cited by investigators doing chemical and nutritional studies on vitamin E. Last year we presented at these meetings some recent morphological studies on E-deficient male rat infertility and now we wish to present our studies of some mechanisms which appear to produce infertility in the E-deficient female rat.

Unlike the gonad of the E-deficient male rat, the E-deficient ovary appears to remain structurally and functionally normal. In fact, all components of reproduction in the E-deficient female appear to function normally until mid-pregnancy. Pups are not born to the E-deficient female rat, however, because the embryos die at about day 12 to 13 of gestation. The conceptuses are then resorbed and the female resumes cycling. The mid-pregnancy death of the E-deficient embryo has been reported but only speculation has been recorded on the cause of death. As a preliminary to an electron microscope study we have examined by light microscopy some events surrounding this embryonic death and we wish to present the following observations:

Twenty-five female Long Evans rats were raised on a synthetic diet provided ad lib from the time of arrival as weanlings. The deficient diet contained less than 1 ppm alpha tocopherol ·(vitamin E). The control diet contained 128 ppm and 8 animals were raised on this diet. The accompanying table demonstrates the severity of the damage to reproduction imposed on the female by a deficiency of dietary vitamin E. None of the 77 pregnancies in the deficient animals produced living young. The deficient females had been mated to normal males; vaginal sperm having been the criterion of successful mating. Implantation was confirmed by following weight gain and by vaginal bleeding caused by resportion of the dead conceptuses. All of the females had lost at least one litter before being sacrificed at mid pregnancy for embryonic and placental tissue study. Embryonic death was confirmed at autopsy by the absence of heart beat which is readily seen in the normal embryo at mid pregnancy. It should be noted that in the rat, the heart becomes functional on day 11 of a 22 day gestation. Maternal and fetal blood do not become apposed across a placental membrane, however, until day 12.

Tissues from deficient and control animals were fixed in Carnoy's solution, sectioned at 7μ in paraffin and stained by the PAS-Hem method. Study of placental tissue indicated that the maternal component of this organ had formed normally and was being perfused by maternal blood at the time of autopsy. In the control animals, fetal blood had arrived at the newly forming placenta with the allantoic vessels but such vessels had only rarely arrived at the placenta in deficient animals. In some cases, a blind stump of the allantoic vessels could be found in the body stalk. Examination of embryonic hemopoietic organs revealed a deficiency in the number of erythoblasts in the yolk sac blood islands. Frequent multinucleate erythroblasts were present in such vessels, and also in the heart and blood vessels of the embryo. The livers of the normal embryos were large and contained many hepatic plates and sinusoids and were clearly producing erythryoblasts whereas the livers of the deficient embryos were small with few sinusoids and little evidence of hemopoiesis.

Gestation Failure in Vitamin E-deficient Female Rat

Diet	No. of Rats	Pregnancies	Normal Deliveries
E-deficient	25	77	0
E-replete	8	16	15

From the evidence obtained thus far in these studies, it appears that in the vitamin E deficient pregnant rat fetal erythroblast formation is impaired limiting the gas exchange capacity of the embryo which, in turn, prevents vascularization of the placenta, aggravating already deficient organogenesis including liver formation and its badly needed hematopoietic function, resulting in a downward spiral of gas exchange which starves the embryo for oxygen causing embryonic death.

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(126)   EFFECT OF DIETARY COPPER DEFICIENCY ON VAGAL INNERVATION OF THE HEART

J.T. Saari[*] and L.M. Klevay
USDA, ARS, Grand Forks Human Nutrition Research Center
Grand Forks, N.D. 58202

Copper deficiency causes an array of cardiovascular problems including structural deficits in the heart and blood vessels, anemia, hypercholesterolemia, cardiac enlargement, as well as depletion of cardiac stores of norepinephrine (1). Any of these deficits may alter, directly or indirectly, control of the heart and circulation by the nervous system. The object of this study was to determine whether autonomic innervation of the heart, in particular its effect on heart rate, is altered in copper deficiency. Such knowledge carries important implications regarding regulation of blood pressure (known to change in copper deficiency) and blood volume, as well as how the cardiovascular system responds to stress.

Male, weanling, Sprague-Dawley rats were fed, for 32-35 days, a diet (ad-libitum) based on 62% sucrose, 20% egg white and 10% corn oil (by weight) which contained all the nutrients known to be essential for rats but was deficient in copper and zinc (2). Their water (also fed ad libitum) contained 10 µg/ml zinc and either 2 µg/ml (supplemented) or no copper (deficient).

Prior to surgery and experimental protocol, each animal was anesthetized with Na pentobarbital (65 mg/kg, i.p.). A one cm, ventral, midline incision was made in the neck. After isolation of the right and left vagus nerves, stimulation electrodes were placed under each nerve. An electrocardiogram (EKG) was recorded from subcutaneous EKG leads placed on each limb. The stimulation protocol called for alternate stimulation of left and right nerves for periods of 10 sec, separated by rest periods of one minute or longer. Stimulations were repetitive square waves (60 pulses/sec, 2 msec/pulse), and varied from 2 to 10 volts at increments of 2 volts. Heart rate was taken from the EKG during any given 10 sec stimulation period, subtracted from and then divided by the heart rate immediately prior to stimulation in order to calculate per cent inhibition of heart rate. Atrial rate was estimated by counting P waves and ventricular rate by counting QRS complexes.

Copper deficiency was verified by anemia and growth retardation. Resting heart rates under anesthesia prior to nerve stimulation were significantly lower (p<.01, t test) for copper deficient (301 ± 29(SD)/min) than for control animals (348 ± 23(SD)/min). Data for inhibition of heart (ventricular) rate by vagal stimulation are given in Table 1. Copper deficiency was found to significantly reduce the inhibitory influence of the right vagus on heart rate over a large portion of the range of stimulation voltages. Copper deficiency did not affect the inhibition caused by left vagal stimulation. Qualitatively similar findings, though less marked, were seen when atrial rate rather than ventricular rate was examined.

Table 1. % Inhibition (± SD) of Ventricular Rate by Vagal Stimulation

Stimulation voltage	Right vagus		Left vagus	
	Supplemented (n=10)	Deficient (n=5)	Supplemented (n=10)	Deficient (n=5)
2	2 ± 3	3 ± 5	1 ± 2	3 ± 4
4	60 ± 34	10 ± 10[*]	30 ± 37	45 ± 37
6	79 ± 15	34 ± 30[*]	74 ± 27	89 ± 15
8	84 ± 17	64 ± 24	77 ± 23	94 ± 7
10	79 ± 20	86 ± 24	76 ± 28	89 ± 12

[*]Denotes significant difference from supplemented value (p<.01, t test)

The findings suggest that heart rate may be a poorly regulated cardiovascular component in copper deficiency, and thus may affect the animal's ability to regulate blood pressure and respond to stress. This deficit may be a reflection of the reduced norepinephrine content (i.e. sympathetic neurotransmitter) in the heart known to occur in copper deficiency (3). The asymmetry of the response in copper deficiency may be a function of the differential distribution of sympathetic fibers between right and left vagus nerves (4). Experiments are under way to investigate these possibilities.

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(127)   OPPOSING EFFECTS OF ZINC AND COPPER DEFICIENCIES ON MEAN PLATELET VOLUMES

N.V.C. Ralston[*] and D.B. Milne
USDA, ARS, Grand Forks Human Nutrition Research Center, Grand Forks, ND 58202

Reduced zinc concentrations in isolated white blood cells (WBCs) in zinc deficiency have been reported (1). However, improvement of WBC isolation techniques (2) that reduced platelet contamination showed that zinc deficiency did not affect the apparent zinc content of WBCs (3). It is demonstrated that errors occur if platelet contamination of WBCs is not eliminated. For instance, apparent WBC zinc measured without platelet elimination was 10.0 ng/10^6 cells, but was 5.0 ng/10^6 cells when platelets were eliminated. The possibility exists that the lower WBC zinc seen in zinc deficiency is due to a reduced platelet sedimentation rate resulting in less platelet contamination of the WBC. Because there is a metabolic relationshp between zinc and copper, we also decided to examine the effect of copper deficiency on platelets.

For the zinc deficiency portion of the study, six-week old male Wistar rats were fed a diet containing either <1.0 mg Zn/g or 50.0 µg Zn/g for four weeks. A pair-fed group was fed amounts of 50.0 µg Zn/g diet to match the amounts consumed by the zinc deficient rats. For the copper deficiency portion of the study, weanling male Sprague Dawley rats were fed a diet containing either <1.0 µg Cu/g or 5.0 µg Cu/g for six weeks.

Blood was anticoagulated by immediately adding 0.030 mL of isotonic 0.134 M disodium EDTA per mL of whole blood (WB). After gentle mixing for approximately 15 minutes at room temperature, platelet variables were measured on a blood analyzer. Platelet rich plasma (PRP) was isolated by centrifuging the whole blood for 15 minutes at 250 x g. The supernatant PRP was removed, mixed, and mean platelet volumes (MPV) were measured on a blood analyzer.

Table 1
Effects of Zinc and Copper Deficiencies on Platelet Size

Diet	WB MPV ± SD	PRP MPV ± SD	Diet	WB MPV ± SD	PRP MPV ± SD
Zn deficient	6.5 ± 0.3^a	5.5 ± 0.5^a	Cu deficient	7.3 ± 0.4^a	6.8 ± 0.7^a
n	(9)	(7)	n	(31)	(32)
Pair-fed	6.9 ± 0.5^a	$5.6 \pm 0.6^{a,b}$			
n	(9)	(11)			
Zn adequate	6.9 ± 0.5^a	6.1 ± 0.5^b	Cu adequate	6.9 ± 0.3^b	6.3 ± 0.5^b
n	(12)	(13)	n	(31)	(31)

Values significantly different (p <0.05) within columns are denoted by different superscripts.

Smaller platelets, observed in zinc deficiency, explain the apparent WBC zinc concentration reduction mentioned above. Small platelets settle much slower than large platelets (4), resulting in less contamination of WBCs and reduced PRP MPVs when compared to the WB MPVs. It has been suggested that the larger and more aggregable platelets represent the young platelet population (5). Thus, in zinc deficiency, fewer young aggregable platelets are present. This is consistent with the finding of depressed platelet aggregation ability in zinc deficiency (6).

Copper deficiency seemed to be characterized by predominantly large, young, and possibly more aggregable platelets. If enhanced aggregability accompanies this size distribution, a directly applicable connection between copper deficiency and atherosclerosis would exist. Abnormal platelet function in atherosclerosis contributes to plaque formation and increased clotting tendencies which can lead to heart attacks and strokes. The biochemical explanation for these observed changes in platelet size due to zinc and copper deficiency remains to be determined.

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(128)   EGG WHITE PROTEIN AND ZINC IN A MEAL INTERACT TO AFFECT ZINC RETENTION BY RATS

J.R. Hunt[*]
USDA, ARS Grand Forks Human Nutrition Research Center
Grand Forks, ND 58202

Zinc retention from a variety of foods has been correlated with the amount of protein in the meal (1, 2). The objective of the present investigation was to determine the effect of different amounts of zinc and of protein on zinc retention, using a single protein source. Egg white protein was used because egg protein was previously associated with enhanced zinc retention (1, 2), and because it contains negligible amounts of zinc, which allow convenient, independent manipulation of protein and zinc in a meal.

Male, Long-Evans rats, weighing approximately 100 g, were fed purified diets providing 35 mg zinc/kg of diet and adequate amounts of all known nutrients. After 21 days, the rats were fed a test meal containing fixed amounts of sucrose, corn starch and corn oil, varying amounts of dry egg white or zinc chloride, and 1 µCi 65-zinc. Retention of zinc from the meal was determined by whole body counting (3) during the subsequent 4 weeks, during which the rats consumed their usual diet.

A significant interaction occurred between the zinc and protein content of the meal, such that with greater amounts of zinc in the meal, greater amounts of protein were needed to enhance zinc retention (Table 1).

Table 1

The Effect of Zinc and Protein in a Meal on Percent Zinc Retention

Meal Zn, µmol	Meal Protein, g	Protein/Zn Ratio	Zn Retention, %[*]	Zn Retention, µmol
0.25	0	0	60 ± 6	0.15 ± 0.02
0.25	0.6	2.4	76 ± 6[+]	0.19 ± 0.01[+]
0.25	1.2	4.8	78 ± 4[+]	0.20 ± 0.01[+]
1.5	0	0	44 ± 5	0.55 ± 0.06
1.5	0.6	0.4	41 ± 3	0.51 ± 0.03
1.5	1.2	0.8	56 ± 3[+]	0.70 ± 0.04[+]

[*]Values are mean ± S.D. for 6 rats per group
[+]Percent zinc retention from this meal is significantly different ($p < 0.05$) than that from the protein-free meal having similar zinc content.

A similar interaction between meal protein and zinc content was observed when rats were accustomed to dietary zinc concentrations of 12 mg/kg, although values for zinc retention were generally higher when the usual zinc intake was lower. From these results, it was hypothesized that there may be a minimum ratio of protein:zinc (probably occurring between 0.4 and 0.8), necessary to enhance zinc absorption. This hypothesis was disproved in a subsequent experiment using either 0.25 or 1.5 µmol zinc in the meal and ratios of 0, 0.4, 0.6, 0.8, and 1.2 g protein/µmol zinc. Addition of protein to obtain a protein:zinc ratio of 1.2 resulted in enhanced zinc retention using 1.5 µmol zinc, but not using 0.25 µmol zinc.

The present data indicate that zinc and egg white protein interact, affecting the amount of zinc retained from a meal. This effect was independent of the usual dietary zinc intake, and was not explained by the ratio of protein:zinc in the meal. Further research may determine whether the relative amounts of protein and total (dietary and endogenous) zinc in the intestinal lumen explain this interaction.

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(129)   EFFECT OF ZN DEFICIENCY ON THE ACTIVITY OF ANGIOTENSIN CONVERTING
          ENZYME IN REPRODUCTIVE ORGANS OF TESTOSTERONE-TREATED MALE RATS

Philip G. Reeves[*]
USDA, ARS, Grand Forks Human Nutrition Research Center
Grand Forks, N.D. 58202

Zinc deficiency in animals causes a variety of abnormal physiological responses. One of major importance is an inhibition of sexual maturation in the male. Previous investigations showed that zinc deficiency in the male rat led to testicular damage, reduction in the number of spermatozoa, and underdevelopment of both primary and secondary sex characteristics (1). Treatment of zinc-deficient rats with gonadotrophic stimulating hormones showed that testosterone production in testes was depressed, suggesting that low testosterone might be partially the cause of depressed sexual maturation in zinc deficiency (2). The activity of the zinc-dependent, angiotensin converting enzyme (ACE) is closely associated with testicular maturation, and its activity is depressed in zinc-deficient rats (3). Testosterone treatment of gonadotrophin-depleted rats stimulated testicular development and increased ACE (4). The objective of the present experiment was to determine if testosterone treatment of rats during the developmental stages of zinc deficiency would have an effect on ACE activity in the testes and epididymides.

Thirty Wistar male rats, 5 weeks of age, were divided into 3 groups of 10 rats each. One group was fed a zinc-deficient diet (<1 mg zinc/kg of diet)(-ZnAL), while another group was fed a similar diet with adequate zinc (50 mg zinc/kg of diet)(+ZnAL). Because zinc deficiency depresses food intake, another group was fed the zinc-adequate diet in daily amounts equal to that eaten by rats in the zinc-deficient group (+ZnPF). One-half of the rats in each dietary group received a daily subcutaneous injection of 0.1 ml of safflower oil containing 1 mg of testosterone. The remaining rats received injections of oil only. After 2 weeks, a unilateral orchidectomy was performed and the activity of ACE was determined in the homogenates of the testis and epididymis of each rat. At this point, testosterone treatment was stopped and the experiment continued for another 2 weeks, after which the remaining testis and epididymis were removed and ACE activity determined.

Effect of Zinc Deficiency and Testosterone (TT) Treatment
on ACE Activity in Testes and Epididymides of Rats

Treatment		ACE Activity, mmoles/min/g protein			
Diet	TT	Testes	Epididymides	Testes	Epididymides
		(2nd Week)		(4th Week)	
-ZnAL	−	0.37 ± 0.02	0.23 ± 0.01	0.22 ± 0.02	0.63 ± 0.08
	+	0.11 ± 0.01	0.25 ± 0.02	0.32 ± 0.05	0.43 ± 0.03
+ZnPF	−	0.53 ± 0.04	0.24 ± 0.01	0.67 ± 0.11	0.93 ± 0.03
	+	0.15 ± 0.03	0.31 ± 0.03	0.48 ± 0.02	0.70 ± 0.09
+ZnAL	−	0.51 ± 0.03	0.31 ± 0.03	0.64 ± 0.06	0.83 ± 0.05
	+	0.43 ± 0.07	0.32 ± 0.02	0.85 ± 0.06	0.74 ± 0.04

Treatment Effects	P Values			
Diet	<.001	<.005	<.001	<.001
TT	<.001	<.050	NS	<.002
Diet x TT	<.003	NS	NS	NS

The data (means ± SEM) show that zinc deficiency alone resulted in lower ACE activity in testes when compared with either control group at both time periods. On the other hand, ACE activity was significantly lower in the tissue of both zinc-deficient and paired-fed controls treated with testosterone. Testosterone treatment did not affect the ad libitum-fed controls. When testosterone treatment was discontinued, ACE activity increased in those groups receiving prior hormone treatment. After 2 weeks on experiment, zinc deficiency did not significantly affect ACE activity in the epididymis compared to paired-fed controls. After 4 weeks, however, ACE activity was significantly lower in zinc-deficient rats than either of the control groups. After 2 weeks, ACE activity in the epididymis was slightly higher in testosterone-treated rats than controls. After 4 weeks, those rats with prior treatment had epididymal ACE activities that were significantly lower than in rats not receiving the hormone. These data indicate that low testosterone levels might not be a causative factor in depressed sexual maturation in zinc deficiency.

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(30)   LYSOSOMAL ENZYMES IN DIFFERENTIATED AND UNDIFFERENTIATED HL-60 CELLS
Julie J. Ackerman*
Department of Microbiology and Immunology, University of North Dakota
Grand Forks, ND 58202

The HL-60 cell line is a human promyelocytic leukemia cell line[1] which has been found to be capable of differentiating to a macrophage-like cell upon exposure to phorbol esters. Macrophage characteristics the cells acquire once exposed to the tumor promoting agent 12-0-tetradecanoyl-phorbol 13-acetate (TPA) include; attachment to a plastic or glass substrate with subsequent spreading of the cells, decreased nuclear to cytoplasmic ratio, the ability to phagocytize, and an increase in α-naphthylacetate esterase activity.[2] The α-naphthylacetate esterase test is a procedure which allows for the demonstration of non-specific esterases characteristically found in cells of the monocytic lineage. The presence of increased levels of these enzymes in TPA treated HL-60 cells indicates that the cells have differentiated to those of monocytic lineage. The purpose of this study was to isolate and quantitate the levels of specific esterases (ie. chymotrypsin and elastase) in differentiated and undifferentiated HL-60 cells.

HL-60 cells were grown in RPMI-1640 medium with 5% fetal bovine serum under atmospheric conditions of 5% CO_2 at 35°C. Cells were treated with TPA (100 nM). After incubation for 48 hours, they were harvested and suspended in 0.25 M Sucrose:1 mM $MgCl_2$. Differentiated and undifferentiated cells were lysed and cell organelles separated by centrifugation. These fractions were tested for the presence of the lysosomal enzymes, chymotrypsin and elastase. The activity of chymotrypsin in the TPA treated cells was increased significantly as compared to control cells (Figure 1). Levels of elastase were impossible to quantitate in this cell preparation; therefore, a different harvesting procedure was used. Whole cell lysates were tested for the presence of elastase. As was seen for chymotrypsin, the TPA treated cells had a significantly higher level of enzyme as compared to the control cells (Figure 2).

It is known that macrophages and monocytes contain increased levels of proteolytic enzymes including elastase.[3] The demonstration of increased levels of this enzyme and chymotrypsin in differentiated HL-60 cells is supporting evidence that TPA treatment does in fact induce the maturation of a cell that closely parallels a macrophage. The existance of the lytic enzymes and the phagocytic capacity of TPA treated HL-60 cells indicates that the HL-60 cell line could prove to be very useful as a tool for studying the susceptibility or resistance of certain microbes to phagocytosis by human macrophages.
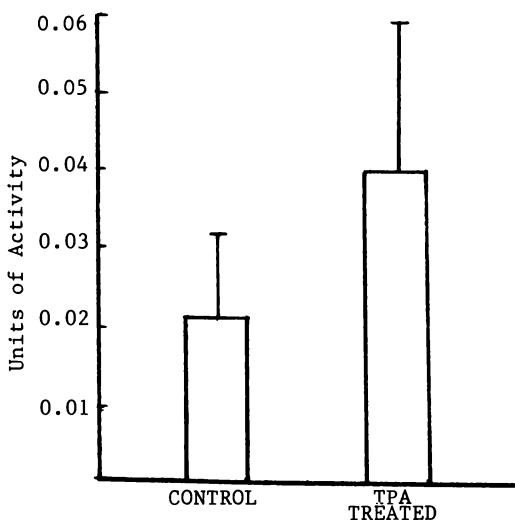

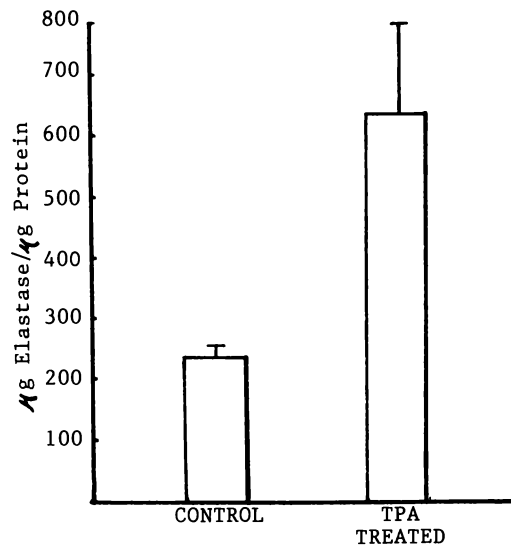Figure 1. Chymotrypsin activity in lysosomal fraction (mean values).

Figure 2. Levels of elastase in whole cell lysates (mean values).

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(31)   CHLOROPHYLL LOSS IN WHEAT INFECTED WITH <u>PUCCINIA</u> <u>RECONDITA</u>

G. L. Ketterling*, and G. D. Statler
Department of Plant Pathology, North Dakota State University
Fargo, ND 58105

Wheat leaf rust, caused by the fungus <u>Puccinia</u> <u>recondita</u> Rob. ex. Desm. f. sp. <u>tritici</u> is an important foliar disease affecting the potential yield of the world's wheat supply. Yield reduction has been found to be proportional to disease severity and resistance to the cultivar (4). Effective leaf rust resistance prevents yield loss by inhibiting reproduction and spread of the pathogen. Necrotic areas associated with resistance involves the destruction of a certain amount of leaf tissue around each infection. Chlorosis is one of the most visible symptoms in wheat infected with <u>P. recondita</u>. The cause of chlorosis has been attributed to inhibition, degradation, and destruction of the chloroplasts (2). Degeneration has been observed as early as 1-3 days after inoculation. These alterations result in loss of chlorophyll and reduced photosynthesis.

Previous studies on chlorophyll and carotenoid concentrations in wheat infected with <u>P. recondita</u> showed decreased amounts of total chlorophyll, chlorophyll a, and chlorophyll b with increased severity of infection (5). Light to moderate levels of infection on resistant line <u>Lr</u>19 stimulated chlorophyll synthesis.

The purpose of this research was to measure and evaluate chlorophyll and carotenoid concentrations in wheat heavily infected with <u>P. recondita</u> (culture 71-112), over a 14 day period. The isogenic line <u>Lr</u>19, was chosen for the resistant line and has a 0; (necrotic fleck) reaction. The isogenic line <u>Lr</u>16 was chosen for the moderately resistant line and has an infection type 2. Thatcher was used as the susceptible cultivar and has an infection type 4.

Seeds of the respective wheat lines were planted in 4 inch pots containing Sunshine mix and grown for 12 days in the greenhouse at 20 C $\pm$ 3° C under General Electric sodium vapor s52/bu lamps with an illuminance of 1400 lux. On day 13 the plants were transferred to growth chambers where they were grown under 16 hours of continuous light, and 8 hours of darkness at 21° C. Plants were inoculated on day 14 in a settling tower with 0.90 mg of spores giving an average density of 79.2 pustules/10cm^2. The primary leaves had been removed to allow better spore coverage on the secondary leaves. After inoculation the plants were placed in a moist closed chamber for 24 hours and then returned to the growth chamber.

Ten secondary leaf seedlings were cut from each cultivar on days 2, 4, 6, 8, 10, 12, and 14 after inoculation. Ten centimeter segments were cut from each leaf, weighed and ground in a mortar containing 80% acetone to break the pigment-protein bond and prevent chlorophyllase action. The pigment-acetone mixture was poured through Whatman #1 filter paper and brought to a 25 ml volume with 80% acetone. The absorbance of the solution was determined using the Beckman DU-7 Spectrophotometer at 475, 645, 652, and 663 nm using 80% acetone as a blank.

Arnon's (1) method was used to calculate the concentration of total chlorophyll, chlorophyll a, and chlorophyll b in the leaves. The total carotenoids were determined using the formulas based on Liaaen-Jensen (3).

Results showed that total chlorophylls, chlorophyll a, and chlorophyll b were significantly lower between healthy and infected plants on day 6 for Thatcher and day 10 for the line with <u>Lr</u>16. The line with <u>Lr</u>19 showed no significant difference in chlorophyll or carotenoid levels between healthy and diseased plants. Carotenoid levels in Thatcher were significantly lower on day 6 and day 10 while levels in the line with <u>Lr</u>16 were significantly different on days 10-14. The susceptible cultivar Thatcher and the moderatley resistant line with <u>Lr</u>16 had less chlorophyll and carotenoid concentrations than <u>Lr</u>19. Chlorophyll levels were not significantly different between <u>Lr</u>16 and Thatcher.

Since chlorophyll is located on the thylakoid membranes of the chloroplasts, notable losses of chlorophyll for Thatcher on days 6-14 is probably due to disruption and degradation of the chloroplasts. Day 6 and day 10 correspond to pustule formation and sporulation of the fungus in Thatcher and account for differences between healthy and infected plants. A comparison of Thatcher and line <u>Lr</u>16 shows a four day lag period before significance was found on day 10 of the moderately resistant line. Day 10 corresponds to a time of increased necrotic areas in <u>Lr</u>16. Pustule formation, sporulation and increased necrosis appear to be major chlorophyll reducing stages in the disease cycle.

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(32)   THE CELL CULTURE, MORPHOLOGICAL CHARACTERIZATION, AND ANALYSIS OF PROLIFERATIVE
        POTENTIAL OF VENTRICULAR MYOCYTES FROM THE ADULT NEWT, NOTOPHTHALMUS VIRIDESCENS

J.M. Tate * and J.O. Oberpriller
Department of Anatomy, University of North Dakota
Grand Forks, ND 58202

Previous work has demonstrated that adult newt ventricular myocytes proliferate in response to experimentally-induced injury, in vivo (1,2). However, similar injuries induced in adult mammals has been shown to result in scar formation with virtually no DNA synthesis or mitosis in ventricular myocytes (3). The work outlined in this study describes the development of an in vitro model to study the proliferative events in adult cardiac myocytes.

Ventricles were minced and then enzymatically dissociated in a Ca^{++}- and Mg^{++}-free amphibian wash medium which contained 0.5% trypsin and 625 U/ml of CLS II collagenase for 8 to 15 hours at 25°C. Enzyme digests were first preplated into plastic culture dishes for 48 hours and then inoculated into a second group of culture dishes which contained bovine corneal endothelial-derived basement membrane "carpets". Most of the non-myocytes attached to the bottom of the first group of culture dishes while the myocytes, which remained in suspension, were aspirated and inoculated into the second group of "carpeted" dishes. The myocytes were cultured in either serum-free or serum-supplemented modified Liebovitz's medium for up to 30 days.

Light and transmission electron microscopic characterization demonstrated that the myocytes underwent an initial period of disorganization which was characterized by a "rounding-up" of the cell and a loss of myofibrillar organization. Once the myocytes had attached to the culture substratum they began to spread out, underwent a reassembly of their contractile elements, resumed spontaneous contractions, and demonstrated ultrastructural evidence of protein synthesis.

DNA synthetic ability was assessed by incubating the myocytes with ^3H-thymidine and then processing them for light microscopic autoradiography. In the first study, myocytes cultured in serum-supplemented medium were incubated with ^3H-thymidine for 24 hours at 10, 15, 20, and 30 days following isolation. The labeling indices were 20.5±2.5, 26.5±2.8, 10.5±2.2, and 2.9±0.6, respectively. In the second study, myocytes in serum-supplemented medium were incubated with ^3H-thymidine continuously from 5 to 15 and from 5 to 30 days following isolation. The labeling indices were 26.4±4.9 and 34.5±6.8 at 15 and 30 days following isolation, respectively. In the third study, myocytes were cultured in serum-free medium and incubated with ^3H-thymidine continuously from 5 to 30 days. This study demonstrated that 8.3±1.6% of the nuclei were labeled.

Mitosis was observed in several of the myocytes between 10 and 15 days following isolation. A significant number of myocytes were observed to become binucleated or multinucleated at later stages of culture.

These results demonstrate that adult newt ventricular myocytes can be successfully placed into primary culture and are capable of resuming DNA synthesis and mitosis. This work can be considered as a foundation for future investigations which are intended to focus on the mechanisms which control adult cardiac myocyte proliferation.

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    Cell Biol., 49:560-563.
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(33)   RETINAL MICROVASCULAR PERICYTES IN VITRO DISPLAY SIMILAR
SDS-PAGE PROTEIN PROFILES THROUGH SUCCESSIVE PASSAGES

Jon A. Jackson[*]
Department of Anatomy, University of North Dakota
Grand Forks; North Dakota

Retinal microvascular pericytes (RMP) play an as yet unresolved part in the pathological process of diabetic retinopathy (1). In order to ascertain the role of RMP in this disease, a culture method must be devised which generates sufficient numbers of pericytes for detailed analysis of their secretory biochemistry. In addition, the method must avoid in vitro cell differentiation of the cultured cells, a problem common with continued passaging of other cell lines (2). This report describes a method for generating large numbers of pericytes and reports on the SDS-PAGE secretory protein profiles of these cells through four successive generations in vitro.

Bovine eyes were obtained locally and utilized within 48 hours of slaughter. The retinas were aseptically isolated, homogenized in a glass tube with a Teflon plunger and washed free of contaminating tissue debris in Dulbecco's modified Eagle's medium containing 3.7 g/L sodium bicarbonate, 50 μg/mL ascorbic acid, and 50 μg/mL gentamicin sulfate (DMEM). The vessels were collected over an 88 μm mesh screen and suspended in DMEM containing collagenase (1 mg/mL; Cooper CLS Lot No. 67047M) for 1.5 h at 37°C. After incubation in enzyme, the suspended vessel clump was removed, rinsed in two successive 10 mL aliquots of DMEM and discarded. The DMEM solutions were centrifuged 10 minutes at 83 x g; the resulting pellets, consisting primarily of pericytes, were plated onto plastic culture dishes in DMEM containing 20% fetal bovine serum (FBS). All cultures were incubated at 37°C in a humidified atmosphere of 5% CO_2 in air with medium changes at three to four day intervals. At confluence, the cultures were trypsinized and passaged (split ratio 1:3) into 20% FBS in DMEM. Purity of the cell cultures was monitored by absence of Factor VIII-related antigen immunofluorescence, lack of uptake of labeled low density lipoprotein, and by transmission electron microscopy.

Biosynthetic products of RMP were analyzed by sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE) using the method of Kramer et al. (3). Confluent pericyte cultures from first to fourth generations were incubated in serum-free DMEM and the medium collected after each of two successive 24 hour periods. The pooled samples were dialyzed against 0.5M acetic acid and lyopholyzed to dryness. Reduced aliquots of the samples were loaded into wells of a SDS-polyacrylamide slab gel (5% stacking - 7.5% separating gel) and separated electrophoretically. A typical SDS-PAGE protein profile was obtained for each generation of cultured pericytes and compared. The pattern of protein migration through the gel was virtually identical for all of the samples tested, indicating that the proteins produced by these cells through three successive passages in vitro remain qualitatively similar.

These data suggest that retinal microvascular pericytes do not secrete substantively different types of proteins with increasing age in culture. Thus, it may be inferred that the culture system described above represents an efficacious method for the generation of a finite cell line of retinal microvascular pericytes, which are morphologically homogeneous and biochemically stable. The ability to successfully culture large numbers of pericytes in vitro will substantially aid efforts to elucidate the role these cells play in retinal microvascular pathology.

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(34)   KINETICS AND MECHANISM OF 2,2'-DINAPHTHYL ETHER REDUCTIVE CLEAVAGE

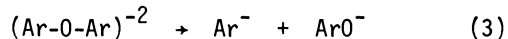J.O. Warwick[*] and D.E. Bartak

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

Ethers are a class of organic compounds that have demanded increased attention within the last few years. The reason for this attention can be attributed to the presence of this functional group within important molecules such as peat, lignin, and low grade coals (1).   Ordinary spectroscopic methods, which can be used to analyze these molecules, has proved to be ineffective due to the complexity of these materials. Other methods, therefore, have been developed to first "break down" the polymer into smaller molecules that can be analyzed with much greater ease. One of the possible methods involves the selective cleavage of the ether linkage by electrochemical reduction, i.e., the formation of reactive radical anions or dianions. The results of this reductive cleavage upon complex molecules, however, cannot be clearly understood until similar model compounds are studied and their results obtained.

One possible system that could be employed as model compounds is the dinaphthyl ether system. This system contains three different isomers, the 1,1'-, 2,2'-, and 1,2'-dinaphthyl ether. We, report herein on our results of the electrochemical reductive cleavage of 2,2'-dinaphthyl ether.

Electrochemical kinetic studies were carried out to determine the lifetimes of key intermediates in the reaction pathway. Voltammetry experiments were carried out in dry N,N-dimethylformamide (DMF) with 0.2 M tetra-n-butylammonium perchlorate (TBAP) as the supporting electrolyte. Cyclic voltammetry indicates two reversible one-electron waves corresponding to the formation of the radical anion at -2.45 V and the dianion at -2.68 V vs. SCE. The radical anion and the dianion both show high stability with half-lives greater than 20 seconds at room temperature. At elevated temperatures, the radical anion still retains its stability of a half-life greater than 20 seconds, while the dianion disappears at slow scan rates, indicating a half-life less than 20 seconds. Quantitative kinetic data on the disappearance of the dianion will be presented.

The electrochemical reductive cleavage of 2,2'-dinaphthyl ether occurs via a dianion intermediate according to the following mechanism (eqs. 1-5).

$$Ar-O-Ar + e^- \rightarrow (Ar-O-Ar)^- \qquad (1)$$

$$(Ar-O-Ar)^- + e^- \rightarrow (Ar-O-Ar)^{-2} \qquad (2)$$

$$(Ar-O-Ar)^{-2} \rightarrow Ar^- + ArO^- \qquad (3)$$

$$Ar^- + H^+ \rightarrow ArH \qquad (4)$$

$$ArH \rightarrow ArH^- \qquad (5)$$

Our data clearly indicates that the radical anion is further reduced to the dianion upon which cleavage occurs to yield the major products naphthalene and 2-naphthol (eqs 2 & 3). The naphthalene moiety abstracts a proton from the solvent and is readily reduced (eq. 4 & 5). This mechanism is in agreement with the products obtained in the reductive cleavage of dinaphthyl ethers with sodium in dimethoxyethane (2). The controlled-potential electrolysis of 2,2'-dinaphthyl ether yields cleavage products with the product yields dependent on the method by which charge was applied to the system. Table 1 lists the results of these electrolyses.

Table 1. Electrolysis Results for 2,2'-Dinaphthyl Ether[1]

Entry	Method[2]	Charge (F/mol)	Product Yields[3]				
			Naphthalene	2-Naphthol	Tetralin	2,2'Dinaphthyl	2,2'Dinaphthyl Ether
1	S	3	20%	29%	<1%	<1%	57%
2	C	3	18%	21%	<1%	<1%	66%
3	S	5	30%	41%	7%	1.2%	44%
4	S	7	36%	56%	5%	1.4%	34%
5	S	8	41%	58%	6%	1.4%	23%
6	C[4]	8	32%	46%	9%	1.4%	33%
7	S[4]	9	37%	83%	30%	<1%	1%

1) All of the electrolysis experiments were carried out at -2.68 V vs. SCE in 4.1 to 4.4 mM ether dissolved in DMF/0.2 M TBAP.
2) S = Stepwise addition of charge in the form of two faradays per mole, ceasing the electrolysis, monitoring the rest potential to -2.28 V vs. SCE before the addition of the next increment of charge. C = Continuous addition of charge.
3) Product yields were computed on the basis of recovered ether and determined by GC/MS and HPLC.
4) The rest potential was allowed to decay to -2.19 V vs. SCE before further addition of charge.

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(35)   Electrochemical Studies of the Reductive Cleavage of Alkyl Naphthyl Ethers

J.L. Schmit[*] and D.E. Bartak
Department of Chemistry, University of North Dakota, Grand Forks, ND 58202

A central goal in coal research involves the breaking down of complex coal structures into less complicated, tractable compounds. One of the focal points in this research centers on the study of the structure and reactivity of the ether linkage, a common functionality present in coal structures. The ease of degradation of coal structures would be facilitated by the determination of the mechanisms and products of reductive ether cleavage and also by determination of the effects of reaction conditions on ether cleavage, i.e., reduction potential, solvent, concentration, additives, etc. Studies of model ether compounds should lead to future applications on more complex structures.

Our group has reported detailed mechanistic studies using electrochemical techniques on several diaryl ethers.[1] There is less data available on the reductive cleavage of alkyl aryl ethers, that is, an ether in which the oxygen is bonded to both an aliphatic moiety and an aromatic moiety. Literature reports in this area include work by our group on the reaction pathways for the reductive cleavages of the cyanoanisoles.[2] We currently report herein the reductive cleavage reactions for 1-methyoxynaphthalene, 2-methoxynaphthalene, and 6-(1'-naphthoxy)hept-1-ene.

Controlled-potential experiments were conducted (via potentiostat with a function generator) on all ethers in N,N-dimethylformamide with 0.2M tetra-n-butylammonium perchlorate as supporting electrolyte. Reductions were carried out at a Pt electrode. Product analyses of the reductive cleavages were conducted by a combination of high performance liquid chromatography, capillary gas chromatography, and capillary gas chromatography/ mass spectroscopy.

Cyclic voltammetry (CV) scans of 1-methoxynaphthalene ($\underline{1}$) resulted in a reduction (cathodic) peak potential of -2.72 V $\underline{vs.}$ a saturated calomel electrode (SCE). The reverse cycle of the CV indicated some disappearance of the initially formed radical anion implying the presence of chemical decomposition of the radical anion. Bulk electrolysis of $\underline{1}$ at -2.58 V $\underline{vs.}$ SCE followed by protonation of the products resulted in cleavage of the ether forming 1-naphthol. The results of the bulk electrolysis are listed in Table 1. The kinetics of the cleavage were analyzed and a first-order rate constant of 0.2 sec^{-1} for the disappearance of the radical anion was obtained.

CV scans of 2-methoxynaphthalene ($\underline{2}$) showed the ether to have a reduction peak potential of -2.68 V $\underline{vs.}$ SCE. The CV scans were characterized by equal peak currents in the reduction and reverse oxidative waves indicating a thermodynamically reversible system. The difference in peak potentials (anodic and cathodic) was about 60 mV indicating rapid electrode kinetics, i.e., an electrochemically reversible system. Upon subjecting $\underline{2}$ to the rigorous bulk electrolysis conditions (-2.50 V $\underline{vs.}$ SCE), cleavage of ether resulted producing 2-naphthol and small quantities of unidentified products. The results of the bulk electrolysis are listed in Table 1.

Garst has reported on the intramolecular cyclization of both 1-methyl-5-hexenyl radicals and anions each of which yields different ratios of stereochemical products.[3] The reductive cleavage of 6-(1'-naphthoxy)hept-1-ene ($\underline{3}$) will produce the 1-methyl-5-hexenyl probe as well as 1-naphthol. This probe will yield information about the mechanistic pathway of 1-naphthyl ether cleavages, which will be discussed.

Table 1. Bulk Electrolysis Results

Ether	Conc.	F/mole[a]	Uncleaved Ether	Naphthol	% mass recovery[b]
$\underline{1}$	8.6mM	2.5	0.5mM	8.1mM	99.7
$\underline{2}$	12.1mM	2	8.1mM	2.0mM	83.5
$\underline{3}$	9.2mM	2.5	0.4mM	5.3mM	62.0

[a] Faraday/mole indicates moles of electrons transferred per mole of ether.
[b] Values do not include undetermined products. Naphthalene and reduced naphthalenes (i.e., dihydronaphthelene and tetralin) were not found, which indicated that only β-cleavage occurred.

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(36)   Friedel-Crafts Polymerization of 1- and 2-Chloromethylnaphthalene

Julie Bouley[*] and Martin Jones
Department of Chemistry, University of North Dakota, Grand Forks, ND 58202

In the past few years, we have been interested in the preparation of poly(arylene methylene)s [-ArCH$_2$-] via Friedel-Crafts reactions of aromatic nuclei. Our goal is to synthesize soluble, linear poly(arylene methylene)s. These characteristics permit ready analyses of molecular structure and facilitate the processing of the polymer. Herein we report the results of soluble, linear polymers derived from Friedel-Crafts self-condensation products of 1- or 2-chloromethylnaphthalene.

The polymerization of 1-chloromethylnaphthalene (1-CMN) has been previously reported.[1] We decided it would be of interest to compare the regiochemistry and the thermal stability of polymers prepared from Friedel-Crafts self-condensation of 1- or 2-chloromethylnaphthalene. The polymerization was carried out in a 25 ml, 3-necked flask equipped with a magnetic stirrer, drying tube, thermometer and streaming N$_2$. The 1-CMN or 2-CMN, 0.5g (0.0028 mol), was dissolved in excess EtNO$_2$ (10 ml) at 45°C. Upon addition of SnCl$_4$, 0.32 ml (0.0028 mol), to this clear solution a cloudy, light green solution appeared. After stirring for 10 minutes the reaction was terminated by addition of methanol (5 ml) and the color changed to white.[2] The reaction mixture was then allowed to cool to room temperature, filtered, and washed with methanol. The 1-CMN polymerization gave 0.40 grams of a soluble, off-white solid that did not melt, but did change slowly to a rubbery material at 230°C. (Note that this differs from the previous report in which the same behavior was observed at 140°C).[1] The 2-CMN polymerization gave 0.42 grams of a soluble, white solid that exhibited the same melting behavior but at 185°C. Both polymers consisted mainly of molecular weights >2000 g/mole as determined by gel permeation chromatography (GPC - polystyrene calibration curve).

Structures of the polymers were established through their IR and NMR spectra, and through analogy with appropriate model compounds. The 2-CMN polymer and Sato's, et. al.[3] 2,6-polynaphthalene IR spectra correspond well. The major bands in the fingerprint region are at 747 and 814 cm^{-1}, 750 and 810 cm^{-1}, respectively. The ^{13}C-NMR spectrum of our polymer also suggests β-linkages. On the basis of this data we propose that the polymer prepared from 2-CMN is predominantly 2,6-linked. The 1-CMN polymer's IR and ^{13}C-NMR spectra suggest α-linkages. The major bands in the fingerprint region are at 758 and 785 cm^{-1} in our polymer and in 1,4- and 1,5-dimethylnaphthalene the bands are at 820, 740 cm^{-1} and 785 cm^{-1} respectively. Also, all but one of the ^{13}C-NMR aromatic resonances seen in 1,4- and 1,5-dimethylnaphthalene are seen in the 1-CMN polymer spectrum. However, a distinct feature of the 1-CMN polymer is the three resonances seen in the methylene region. This suggests unequivalent methylene groups which is not explainable by 1,4- and 1,5-substitution. On the basis of this data we propose that the 1-chloromethylnaphthalene polymer is a mixture of 1,4- 1,5-, and β-linkages. It should be noted that the starting material, 1-CMN, appears to contain a little 2-CMN which could be one explanation for the β-linkages.

In Table 1, the TGA data is shown for the 1-CMN and 2-CMN polymers and the highest molecular weight fraction of both. Both polymers maintain 90% of their mass up to 485°C in air and N$_2$. Interestingly the different regiochemistry of the polymers appears to have no effect in their thermal and thermo-oxidative stabilities, in spite of their differing melting points.

Table 1. Thermal Analysis Results

Sample	T(°C) at 10% Mass Loss		% Residue at Final T (°C)	
	N$_2$	Air	N$_2$	Air
1-CMN	494	490	24.60(1000)[a]	3.18(805)[a]
2-CMN	492	495	22.68(1000)[a]	5.22(810)[a]
1-CMN (2000 g/mole)	494	520	21.70(1000)[a]	1.96(765)[a]
2-CMN (2000 g/mole)	485	505	21.87(725)[a]	2.49(765)[a]

[a] Numbers in parentheses represent the final temperature attained.

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(79)   EXPERIMENTALLY INDUCED MORPHOLOGICAL VARIABILITY IN <u>STIGEOCLONIUM TENUE</u>

Kerstin K. Leuther* and John F. Brauner
Department of Biology
Jamestown College
Jamestown, North Dakota 58401

Morphological variability is a phenomenon characteristic of nearly all organisms. Plants, especially aquatic nonvascular plants (algae), sometimes exhibit extremes in habit as a result of their local conditions of growth. Morphological variability within a taxon, expressed as the phenotype, is the function of two major factors: 1) the genetic variability of the organisms and 2) the environmental conditions interacting with the genotype(s). This latter interaction is expressed by the classic illustration:

$$\boxed{\text{GENOTYPE}} + \boxed{\text{ENVIRONMENT}} = \boxed{\text{PHENOTYPE}}$$

While morphological variation among purportedly different taxa of <u>Stigeoclonium</u> has been examined (1)(2), this study examines variation induced through a range of a single physical environmental condition, water motion. An examination of this subject has special relevance to the subdisciplines of ecology and of taxonomy. Because classification tools used for algae are often based on gross morphological features with limited correlation to environmental conditions, the accurate recognition of species is sometimes a problem. This study demonstrates how a single variable, water motion, changes the morphology of an alga, <u>Stigeoclonium tenue</u>.

To study the effect of water motion on morphology, two separate experimental apparatus were designed and constructed. One, a wave simulator, moved specimens through the water in a reciprocating motion for 12 hours per day. Specimens were positioned on the radii of a reciprocating disc thus were moved through various distances during the cycle of motion while control specimens were grown in the same environment without motion. The second device simulated a stream with water continuously moving over the stationary specimens at different velocities and with a protected control zone without water motion.

Plastic cover slips were inoculated with spores of the alga during a three day period after which they were introduced to the experimental conditions. They were allowed to grow for periods of six days (wave simulator) and of 14 days (stream simulator) at which time they were removed, fixed, stained, examined, and measured microscopically. Data was collected from random squares of uniform area and the specimens within were analyzed for filament length, for cell diameter, and for form of the prostrate attaching filaments.

There exists an inverse correlation of erect filament length to water velocity. Mean length ranged from 1.55 mm in high current to 18.0 mm in protected water; a 12-fold difference in mean length. A similar relationship is expressed by algae grown in the wave simulator. Mean length ranged from 0.32 mm in the high wave energy environment to 0.86 mm for the still water controls; a 3-fold difference in mean length.

Dimensions (length, diameter) of cells in the erect filaments varied uniformly from base to apex with the more basal cells having shorter lengths and larger diameters. This did not change with respect to degree of water motion.

The prostrate attachment filaments exhibit a difference in morphology relative to degree of water movement. Plants grown in still or slowly moving water have an open array of attachment filaments, whereas plants in more rapidly moving water are attached by a holdfast which approximates a pseudoparenchymatous disc.

The morphology of <u>Stigeoclonium tenue</u> is shown to vary relative to the degree of water motion. Cell size was not affected, but erect filament length was inversely proportional to water velocity and attachment filaments were more condensed when exposed to greater water motion.

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(80)   The Synthesis and Photochemical Study of N,N'-Diacetyl-p-phenylenediamine

S. Ross Norlin,[*] Michael G. Bouley, Virgil I. Stenberg
Department of Chemistry, The University of North Dakota, Grand Forks, ND 58202

Polyaramide fibers have been commercially available for more than a decade. These fibers are important in the development of high-strength light-weight composites. Although the fibers are resistant to chemical attack except for strong acids and bases at high concentrations, they have been shown to degrade under ultraviolet radiation (1).

The objective of this study is to understand the photochemistry of the degradation process. Consequently, the effects of ultraviolet light were studied on a model compound which represents repeating units in the fiber.

The synthesis of the model compound, N,N'-diacetyl-p-phenylenediamine, was accomplished by the acetylation of p-phenylenediamine (2). To effect the reaction, p-phenylenediamine, sodium acetate and acetic anhydride were dissolved and reacted in hydrochloric acid. After recrystallization in aqueous methanol, a product yield of 70% was obtained.

The appropriate analytical data on the product are mp 314-315 °C [lit. 304°](3); UVmax (CH_3OH) 264 nm (ϵ = 21,325 cm^{-1} M^{-1}); IR (KBr) 3450-3100 and 1560 (N-H), 1650 (C=O), 1510 and 1310 (C-N) cm^{-1}; NMR (CD_3OD) δ 7.45 (aromatic) and 2.10 (methyl).

N-N'-diacetyl-p-phenylenediamine, at a concentration of 30 micrograms/liter, was then subjected to irradiation with a 450-watt, medium-pressure Hanovia mercury arc lamp. The reaction was done under nitrogen atmosphere in a quartz immersion well. UV spectra obtained at time intervals during the reaction showed a decrease in the absorption at 264 nm and a new absorbance at 240 nm.

The absorption at 264 nm is the principal aromatic chromophore of the model compound. This chromophore is being converted into a non-aromatic chromophore during the course of the irradiation.

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(81)   A FOSSIL INSECT ASSEMBLAGE FROM A BURIED, POSTGLACIAL-AGE, BEAVER
          POND AND DAM SEDIMENTARY COMPLEX IN NORTHEASTERN IOWA

Kevin D. Krogstad* and Donald P. Schwert

Geology Department, North Dakota State University
Fargo, North Dakota 58105

Exposed along a cutbank within the upper basin of Roberts Creek (NW1/4, Sec. 1, T.94N, R.6W.,
Clayton Co., Iowa) is a nearly-complete, oblique section across a buried beaver dam. Spruce
(*Picea*) wood from the dam has a radiocarbon age of 10,700 $\pm$ 110 yr B.P. (Beta-6156) (1). The
construction of the dam is unusual in that it appears to be composed almost entirely of
coniferous wood, particularly spruce; emplacement of the logs and twigs appears to be identical
to that of modern beaver dams. The wood is uniformly beaver-chewed, and the surfaces of many
of the larger pieces have been extensively burrowed by bark beetles (Scolytidae).

Approximately 60 kg of sediment associated with the dam and pond have been collected and
processed for fossil content. Included in these sediments were the well-preserved remains of
snails, clams, ostracods, oribatid mites, and five orders of insects. Of the latter, beetles
(Coleoptera) are the most abundant. The insect assemblage can be divided into four ecological
groups:
1. Running water - The remains of elmid and dryopid beetles are particularly common
    within the sediments. Aside from being associated with flowing water, both groups
    are indicative of high water quality - conditions that no longer exist in Roberts
    Creek due to intensive agricultural development associated with European settlement.
2. Still-water - This is a minor component of the assemblage but includes taxa that
    probably inhabited the beaver pond itself. Members of this group include beetles of
    the hydrophilid genera *Tropisternus* and *Hydrochus* and the dytiscid genera *Rhantus* and
    Dytiscus.
3. Water-marginal - Insects of this group dominate the assemblage. Water-marginal
    ground beetles include species of *Elaphrus*, *Chlaenius*, and several species of
    Bembidion. Donaciine chrysomelids, a subfamily common to water-marginal plants, are
    also well-represented. Among the other orders of insects are saldid bugs and
    cicadellid leafhoppers.
4. Upland - That spruce forest surrounded the beaver pond is indicated not only by the
    abundant presence of spruce wood, cones, and needles but of bark beetles associated
    with spruce. Bark beetle taxa include *Polygraphus* sp. and *Pityophthorus* sp., as well
    as *Carphoborus andersoni* Sw., a species which is today apparently restricted to
    extreme northwestern Canada and eastern Alaska (2). Other upland taxa represented
    include ants, scarabs, and litter-dwelling beetles (e.g. the rove beetle *Micropeplus
    cribratus* LeC.).

Together, the assemblage is analogous to insect communities that currently exist in and
proximal to beaver ponds of the central and southern boreal forest of Canada. While most of
the fauna is indicative of a cool, boreal
climate, some elements suggest that a
transition into somewhat warmer conditions is
occurring.

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Roberts Creek •
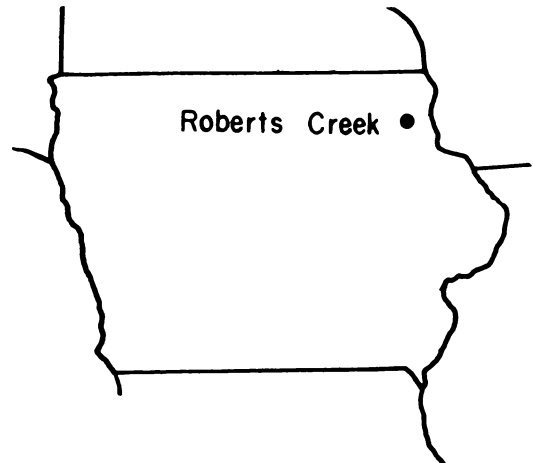
(82)   THE EFFECT OF BYPRODUCT FORMATION ON RESIDUE ANALYSIS OF SULFAMETHAZINE

Anders L. Lund,* V. J. Feil and G. D. Paulson
USDA, ARS, Metabolism and Radiation Research Laboratory, Fargo, ND, 58102

Sulfamethazine [4-amino-N-(4,6-dimethyl-2-pyrimidinyl)benzenesulfonamide] is an antibiotic used in commercial swine production to control or prevent respiratory infections and to increase animal growth rate. Sulfamethazine residues in animal tissues have been analyzed by solvent extraction, diazomethane derivatization and gas chromatographic (GC) analysis of the N^1-methyl derivative.[1-4] However, when we reacted sulfamethazine with an excess of diazomethane, two major products (A and B) were formed that were separated by high performance liquid chromatography (HPLC) (C-18, 20 to 50% linear gradient of acetonitrile-water, uv detector at 254 nm). Both products yielded ions at m/z 293 (M + 1) when analyzed by fast atom bombardment mass spectrometry. The ^{1}H NMR spectrum of A (Fig. 1) showed a singlet for the pyrimidinyl methyl groups; in contrast the ^{1}H NMR of B showed two peaks for the pyrimidinyl methyl groups indicating the loss of symmetry in the pyrimidine ring. A nuclear Overhauser enhancement (NOE) study showed 15% and 9% increases in responses of the two pyrimidine methyl groups on irradiation at the frequency corresponding to the N-methyl protons of B. Compound A gave no NOE response. Thus we assigned the structures in Fig. 1.
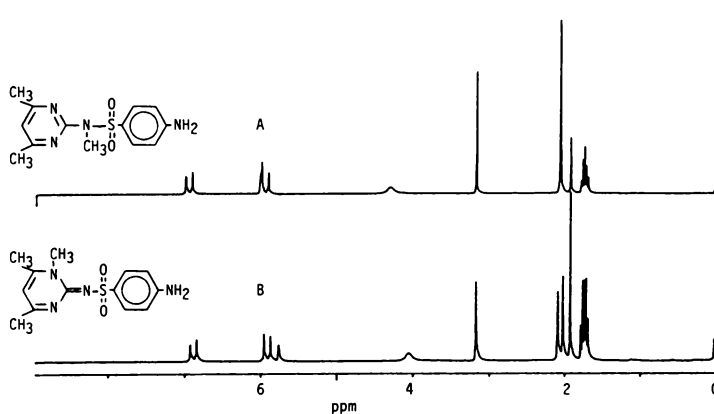

Figure 1.

We investigated different solvents, reverse addition, temperature, ratio of reactants, size of reactions and concentrations to determine variables affecting yields of A and B. Although great variability was observed, the size of the reaction was the only parameter that altered the A/B ratio. Decreased amounts of sulfamethazine gave reduced yields of B, suggesting the involvement of surface phenomena. When porous glass adsorbant (120-140 mesh) was added to increase the surface area for a given size reaction, the yield of B decreased. Schwartz et. al[5] reported that sulfamethazine could be methylated by adsorbing it onto Chromasorb 102, and passing diazomethane vapors over the support. We repeated the experiment, isolated both A and B by HPLC and identified them by mass and ^{1}H NMR spectral comparison with authentic samples. Di- and tri- methyl products were also isolated in some of the reactions. These were purified by HPLC and analyzed by mass spectrometry; however, limited sample prevented rigorous identification.

Two products were also isolated when desaminosulfamethazine, (4-dimethyaminophenyl)[4-(N-4,6-dimethyl-2-pyrimidinyl)-sulfamidophenyl]diazene and sulfisoxazole were reacted with diazomethane. Other investigators also reported the formation of two products when sulfathiazole was reacted with diazomethane.[6,7] Thus, this appears to be a general phenomenon with sulfonamide drugs that can tautomerize.

Compound A when analyzed by GC (methyl silicone or 5% phenyl methyl silicone capillary columns, 80-300° at 10°/min, on-column injector, flame ionization detector) gave single peaks at 245° on both columns. When B was analyzed under the same conditions no response was observed. Therefore the determination of some sulfonamide related residues by diazomethane derivatization and GC analysis may give erroneous results.

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(83)   AGGLOMERATION OF SELECTED BED MATERIALS IN THE PRESENCE OF
          TRONA OR K_2CO_3 DURING CATALYTIC COAL GASIFICATION.

THOMAS R. MOHS[*], R. C. TIMPE AND R. E. SEARS
UNIVERSITY of NORTH DAKOTA ENERGY and MINERAL RESEARCH CENTER
GRAND FORKS, ND 58202

Pilot-scale catalytic steam gasification of coal to produce hydrogen at the University of North Dakota Energy and Mineral Research Center (UNDEMRC) is carried out utilizing a 20 lb. feedstock/hr. fluidized bed reactor at a temperature range of $700^{\circ}C$-$800^{\circ}C$. The reaction is catalyzed by adding alkali metal carbonates such as Trona (naturally occuring Na_2CO_3) and K_2CO_3. During pilot-scale catalytic coal gasification, agglomeration was identified as a significant problem in the operation of the fluidized bed.

The purpose of our research was to study the agglomeration on a laboratory-scale using selected bed materials of silica sand, olivine sand, aluminum oxide and mulgrains #47. Each of the four bed materials was placed in a calibrated muffle furnace with either Trona or K_2CO_3 and heated under oxidizing conditions as rapidly as possible to the target temperatures of $650^{\circ}C$, $700^{\circ}C$, $750^{\circ}C$ and $800^{\circ}C$. Samples without coal contained 75% bed material and 25% catalyst. Samples containing coal had mixtures of 75% bed materials and 25% coal/catalyst. The coal/catalyst used in the test was prepared in a ratio of 90% coal to 10% catalyst. Each sample remained in the oven at temperature for 15 minutes, followed by 10 minutes of cooling in the oven before being removed.

Agglomeration is characterized by the formation of cemented conglomerates of bed materials as shown in Figure 1. In studying the reaction residues, optical microscopy revealed particles cemented together in groups of a few to several hundred. Agglomeration was present in all samples tested. The agglomerates in some instances changed in particle color and/or shape, particularly the silica and olivine sands. Table 1 illustrates such changes for all the tested materials at $800^{\circ}C$. The coal containing samples followed the same changes as the samples without coal.

Table 1

sample	Agglomerate?	Color	Particle Shape
silica sand	yes	sandy -> pink	various -> round
olivine sand	yes	grey -> orange	various -> degraded
Al_2O_3	yes	white -> white	round -> pitted
mulgrains #47	yes	grey -> grey	various -> various

After heating, agglomerates for each sample were tested for static adhesion by casting rays from a piezoelectric anti-static gun onto the sample. Much of the agglomeration involving fly ash particles was static induced, but those involving large bed material particles was induced chemically rather than by static charge. Scanning electron microscopy photomicrographs showed crystallization on the surface of the olivine and silica sands.

When the research was initiated, it was hoped that the catalyst would interact with the coal and not the bed material. However, this was not the case. The resolution lies in finding a catalyst or bed material that will eliminate agglomeration and maintain high hydrogen production rates.
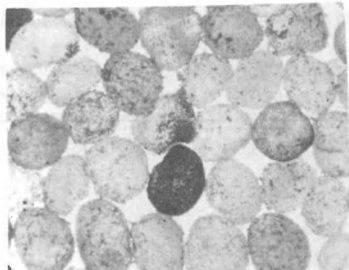
Figure 1.

75% silica sand and 25% coal/K_2CO_3
after heating to $800^{\circ}C$.
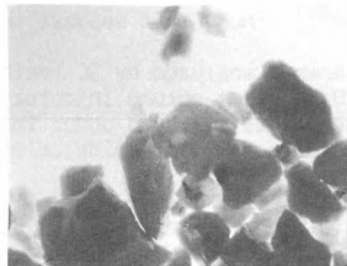
75% mulgrains #47 and 25% trona
after heating to $800^{\circ}C$.

(84)   PLASMIDS OF THE EPIPHYTIC PLANT BACTERIUM ERWINIA HERBICOLA

Matthew L. Hilles* and Robert B. Sparks, Jr.
Department of Biochemistry, North Dakota State University
Fargo, ND 58105

Several strains of Erwinia herbicola give rise to spontaneous double mutations that result in a stable phenotypic variant when incubated at supra-optimal temperatures; incubation in the presence of SDS or growth in the presence of nalidixic acid may also induce this change (1,2). This change in phenotype results in the loss of pigmentation and the loss of thiamine prototrophy in these strains. The loss of pigmentation has been correlated with the loss of a plasmid in two species of Erwinia (3).

Plasmids of various sizes have been reported in E. herbicola (2) although no genes have been associated with any of these plasmids. This paper demonstrates the existence of a plasmid of 56.4 2.5 Kb in E. herbicola strains L-321 and L-321W, which is a spontaneously occurring pigmentless thiamine requiring mutant of L-321, along with dimers and other multimers of this plasmid. This paper also gives preliminary evidence that the 56.4-Kb plasmids in strains L-321 and L-321W are identical and do not play a role in the loss of pigmentation and the loss of thiamine prototrophy.

Analysis of plasmid DNA (isolated from E. herbicola strains L-321 and L-321W by a rapid-boiling cleared lysate procedure) by transmission electron microscopy (TEM) showed a plasmid of 56.4 Kb (pEH56) as the predominant plasmid in both strains, as well as larger plasmids of 110- and 192-Kb. Agarose gel electrophoresis confirmed the presence of pEH56 by showing a single plasmid of 55.3 4.2 Kb exists in both E. herbicola strains L-321 and L-321W along with larger plasmids that are dimers and other multimers of pEH56; the dimers correspond to the 110 Kb plasmid found by TEM. Autoradiograms of Southern-blotted plasmid and chromosomal DNA from strains L-321 and L-321W showed that all plasmid DNA derived from the two strains exhibits homology to pEH56. The autoradiograms also showed that pEH56 is not integrated into the bacterial chromosome.

The loss of pigmentation and the loss of thiamine prototrophy could not be correlated with the loss of a plasmid in these strains since the plasmid composition of both strains is identical. The concomitant loss of pigmentation and the loss of thiamine prototrophy may be due to a polar mutation and/or a transposable element.

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(85)   Coal Conversion in Low Pressure Oxygen Atmospheres

Curtis A. Meske,* Jan Nowok, and Virgil I. Stenberg
Department of Chemistry, University of North Dakota, Grand Forks, ND 58202

The demand for petroleum products is continually increasing, while the supply of petroleum resources is diminishing. For this reason, new methods for synthetically producing petroleum-like products are being studied. One method, which has been successful, is the hydrogenation of coal. Although this process reached the goal, it is noncompetitively expensive due to the cost of the reducing gas, i.e., hydrogen or carbon monoxide.

This research has been designed to find another mehtod for producing petroleum-like products from coal by using a low pressure oxygen atmosphere (3.5 to 6.9 MPa). For the basis of this research, reactions 1,2 and 3 were expected to occur with coal in the presence of oxygen, water and heat. Reactions 1 and 2 are competitive with that of 3. Reaction 3, which represents combustion, is detrimental to accomplishing the objective.

$$2C(coal) + O_2 \rightarrow 2CO \qquad (1)$$
$$CO + H_2O \rightarrow CO_2 + H_2 \qquad (2)$$
$$C(coal) + O_2 \rightarrow CO_2 \qquad (3)$$
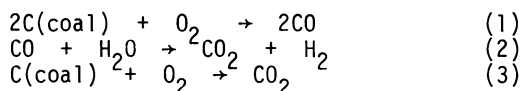
Experimental conditions were developed with the use of a rocking autoclave chamber containing one gram of Indian Head lignite (Zap, ND), 1 ml of water, and a glass bead for stirring. The vessel was placed in an oven and shaken while the temperature of the reaction was programmed to rise 300-400°C during the one hour reaction time. Separate reactions were performed at 0, 3.5, 4.8, 6.2, and 6.9 MPa of oxygen. THF and cyclohexane solubilities were used to determine the amount of unconverted coal.

The THF yield data illustrated in Table 1 allowed for the initial assumption that the desired liquefaction was taking place in an oxygen atmosphere. The steady decrease in the percent of unconverted coal with increasing pressures of oxygen provided the basis for this conclusion.

To double check this data, a cyclohexane yield determination was performed. If combustion were occurring, the THF and cyclohexane yields would have approximately the same value. The approximately equivalent (Table 1) cyclohexane yields are consistent with the view that combustion of the coal was taking place.

Table 1
Extraction Yield Data as a Function of Oxygen Pressure.

Oxygen, MPa	THF yield, %	Cyclohexane yield, %
0	43%	--
3.5	44%	53
4.8	49%	--
6.2	53%	--
6.9	69%	67

As a reference for the THF and cyclohexane extractions, the reaction was performed using 6.9 MPa of CO rather than O_2. The reactions using CO defines a practical limit of liquefaction yields assuming only reaction 1 were occurring. The THF and cyclohexane yields were 92% and 46%, respectively. Therefore this evidence augments the conclusion that combustion of the coal was taking place before the desired liquefaction.

To aid in the evaluation of the possible operation of reactions 1 and 2 in the reactor, gas analyses was performed at the end of the experiment using 6.9 MPa oxygen. Both carbon monoxide (2.2%) and hydrogen (3.5%) were present together with carbon dioxide (70.5%). Therefore, reactions 1 and 2 are indeed occurring in the reactor, but not to the extent of being productive for coal liquefaction.

GABRIEL W. COMITA
(July 27, 1915 - July 16, 1987)

Gabe Comita was born in Minneapolis, Minnesota where he grew up and attended school. He received the B.S. degree from the College of St. Thomas in 1937, the M.A. degree from the University of Minnesota in 1949, and the Ph.D. degree with a major in zoology from the University of Washington in 1953.

After receipt of his Ph.D. he joined the NDSU faculty where he rose to Professor of Zoology. He was awarded the Robert Odney Award, the Faculty Lectureship, and the Chamber of Commerce Distinguished Professorship. He was well known for his limnological research, having focused his study on the biology, energetics, and transformations of copepods. Much of his research was done at Lake Brewer near Fargo.

Comita retired from NDSU in 1981. He was a member of the North Dakota Academy from 1954 until his death.

HELGE EDERSTROM
(February 28, 1908 - October 2, 1987)

Helge Ederstrom was born in Torsas, Sweden, but moved to the United States at age four, growing up in Rockford, Illinois. He received a B.S. degree from Beloit College in 1937, and the M.S. and Ph.D. degrees from Northwestern University in 1939 and 1941, respectively, with a major in zoology.

Ederstrom taught at St. Louis University Medical School for ten years before coming to UND in 1952 where be became Professor of Physiology. He conducted research in cardiovascular physiology and temperature regulation.

He was especially well known regionally as a watercolorist who captured the North Dakota landscape, prairie scenes, farmsteads, and elevators. He actually preferred to sketch and paint in winter. His paintings are widely distributed.

Ederstrom retired from UND in 1977. He was a member of the Academy from 1953 until his death.

WASYL HNOJEWYJ
(February 12, 1909 - June 30, 1986)

Wasyl Hnojewyj was born in the Ukraine. He received both his school and college education in the U.S.S.R., culminating with the "Diploma Agricultural Chemist." After World War II he studied at the Ludwig Maximilian University in Munich from which he received the Dr. Natl. Sci. in physical chemistry in 1955.

Hnojewyj held post-doctoral appointments at Michigan and Minnesota after which he joined NDSU in 1963 as Assistant Professor of Physics. His research focused on the adsorptive nature of surfaces, especially natural macromolecules such as hemoglobin, using H/D and H_2O/D_2O exchange reactions.

Hnojewyj retired from NDSU in 1979. He was an Academy member from 1964 until his death.

JOHN MOLBERG
(April 10, 1917 - November 22, 1986)

John Molberg was born at Souris, North Dakota, and received an Associate degree from the North Dakota School of Forestry and his B.S. in Forestry from the University of Idaho. After graduation he worked for the U.S. Forest Service in the Nez Perce National Forest in Idaho. Following military service during World War II, Molberg became forestry instructor at NDSU-Bottineau until his retirement in 1972. During portions of that time he also served as Deputy State Forester and manager of the Towner and Bottineau tree nurseries.

Molberg's dedication to tree production, native North Dakota woodlands, and his classroom demeanor earned him the nickname "Tiger John." In 1984 the North Dakota Board of Higher Education honored him for his unselfish dedication and professional service by dedicating in his name the Molberg Center for Forestry and Horticulture, an education and research facility on the campus of NDSU-Bottineau.

Molberg published Common Trees and Shrubs of North Dakota in 1950, a guide used by both students and professionals. He was a member of the North Dakota Academy of Science from 1961 to 1974.

ITHEL A. SCHIPPER
(June 17, 1917 - April 18, 1987)

Ithel Schipper was born in Pelican Rapids, Minnesota where he grew up and went to school. He attended the University of Minnesota for all his degrees, receiving the B.S. in 1946, the M.S. in 1947, and the D.V.M. in 1951.

After a three year post-doctoral appointment at the University of Minnesota he joined NDSU where be became Professor of Veterinary Science. His specialty was veterinary virology. While at NDSU be received the Chamber of Commerce Distinguished Professorship, the Blue Key Doctor of Service Award, and the Faculty Lectureship.

Schipper retired from NDSU in 1984. He was a member of the Academy from 1962 to 1976.

CONSTITUTION
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 purposes 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 rotation 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.

NORTH DAKOTA ACADEMY OF SCIENCE
BY-LAWS

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

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 Rev.)

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 list by paying the current year dues and a membership renewal charge of $5.00. (1975 Rev.)

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

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

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 Rev.)

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 Rev.)

    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 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 Committee shall bring in two nominations for each office. Other nominations
may be made from the floor. The officers shall be elected by ballot at the Annual Meeting.
(1965 Rev.)

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 Rev.) 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 Sponsor 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 Rev.)
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 Rev.)

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 Rev.)

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 Rev.)

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 Rev.)

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

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

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

16. The Executive Committee of the North Dakota Academy of Science be 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 Rev.)

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 Rev.)

Revised May 1985

OFFICERS AND STANDING COMMITTEES FOR 1987-88

EXECUTIVE COMMITTEE
William Barker, Past-President
  North Dakota State University

Bonnie Heidel, President
  ND Game and Fish Department

Forrest Nielson, President-Elect
  Human Nutrition Research Center

A. William Johnson, Sec.-Treasurer (1986-89)
  University of North Dakota

Pamela Dryer, Member-at-large (1985-88)
  ND Parks and Recreation

Clark Markell, Member-at-large (1986-89)
  Minot State University

William Dando, Member-at-large (1987-90)
  University of North Dakota

EDITORIAL ADVISORY COMMITTEE
Paul B. Kannowski (1985-88), Chairperson
  University of North Dakota

Douglas Johnson (1987-90)
  NPWRC, Jamestown

Duane Erickson (1986-89)
  North Dakota State University

RESOLUTIONS COMMITTEE
William Dando (1985-88), Chairperson
  University of North Dakota

Allen Kihm (1986-89)
  Minot State University

Lee Manske (1987-90)
  North Dakota State University

DENISON AWARD COMMITTEE
Ken Wortham (1984-89), Chairperson
  Mayville State University

Rose Morgan (1986-89)
  Minot State University

Louis Rigley(1987-90)
  Dickinson State University

Jim Richardson (1987-90)
  North Dakota State University

David Lambeth (1985-88)
  University of North Dakota

Michael Stoy (1986-88)
  Bismarck State College

ND SCIENCE RESEARCH FOUNDATION BOARD
Harry Holloway (1986-90), Grand Forks, Chairperson

William Barker (1983-88), Fargo

Virgil Carmichael (1987-91), Bismarck

Virgil Stenberg(1987-92), Grand Forks

Randolph Rodewald (1984-89), Minot

NOMINATING COMMITTEE
Gary Clambey (1984-89), Chairperson
  North Dakota State University

Michael Thompson (1985-90)
  Minot State University

Elliot Shubert (1986-91)
  University of North Dakota

William Barker (1987-92)
  North Dakota State University

Virgil Stenberg (1983-88)
  University of North Dakota

SCIENCE EDUCATION COMMITTEE
Clark Markell (1987-92)
  Minot State University
    (Executive Liason, Chairperson)

Mike Burton (1984-89), Agassiz Junior
  High School, Fargo (Newsletter)

Jerome Knoblich (1986-90), Jamestown
  College (Science Fair Liason)

Donald Scoby (1983-88), North Dakota
  State University (Science Olympiad,
  Newletter)

Michael Stoy (1986-91), Bismarck State
  College (Junior Academy)

Richard Swanson (1983-88), West Fargo
  High School

Om Madhok (1987-92), Minot State University
  (Minigrants Coordinator)

Allen Khim (1987-92), Minot State University
  (National Science Week)

MEMBERSHIP COMMITTEE
Myron Freeman, Dickinson State University

Michael Thompson, Minot State University

Judy Kemp, Valley City State University

Gary Clambey, North Dakota State University

Eugene Doering, Northern Great Plains
  Research Center, USDA, Mandan

Vernon Feil, Metabolism and Radiation
  Research Lab, Fargo

F.D. Holland Jr., University of North Dakota

Carolyn Godfread, Bismarck

Charles Lura, NDSU-Bottineau

NECROLOGY COMMITTEE
Harold Klosterman (1985-88), Chairperson
  North Dakota State University

Charles Lura (1987-90)
  NDSU-Bottineau

William Wrenn (1986-89)
  University of North Dakota

NORTH DAKOTA ACADEMY OF SCIENCE
MEMBERSHIP LIST
MARCH 14, 1988

ABRAHAMSON, HARMON B.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202
ALBRECHT, STEVEN	JAMESTOWN COLLEGE	JAMESTOWN	ND	58401
ALESSI, JOSEPH	1210 11TH STREET SOUTH	FARGO	ND	58103
ALTENBURG, LOIS IVERS	1146 FIFTH STREET NORTH	FARGO	ND	58102
ANDERSON, EDWIN M.	1151 12TH AVENUE WEST	DICKINSON	ND	58601
ANDERSON, ORDEAN S.	RURAL ROUTE 1, BOX 269	NEW PRAGUE	MN	56071
ANNEXSTAD, JOHN O.	BEMIDJI STATE COLLEGE	BEMIDJI	MN	56601
ARMFIELD, LARRY	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105
ARNDT, JAMES	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105
ASBECK, ANN L.	3312 WALNUT STREET	GRAND FORKS	ND	58201
ASCHBACHER, PETER W.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105
ASHWORTH, ALLAN C.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105
AUYONG, THEODORE	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202
BABU, GURRAM R.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202
BALSBAUGH, EDWARD, JR.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105
BALTISBERGER, RICHARD	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202
BARKER, WILLIAM T.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105
BARNEY, WILLIAM G.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202
BARTAK, DUANE E.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202
BASSINGTHWAITE, DAVID	615 NORTH 39TH STREET, 307C	GRAND FORKS	ND	58201
BEHM, MARLA	PURDUE UNIVERSITY	WEST LAFAYETTE	IN	47907
BEHRINGER, MARJORIE	1613 CRIPPLE DRIVE	AUSTIN	TX	78758
BELINSKEY, CAROL R.	MINOT STATE UNIVERSITY	MINOT	ND	58701
BERGSTROM, DONALD E.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202
BERKEY, GORDON B.	MINOT STATE UNIVERSITY	MINOT	ND	58701
BERRYHILL, DAVID L.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105
BITZAN, EDWARD F.	2200 UNIVERSITY AVENUE	GRAND FORKS	ND	58201
BLEIER, WILLIAM J.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105
BLISS, HARALD N.	P.O. BOX 522	MAYVILLE	ND	58257
BLOCK, JEFFREY A.	3605 MANITOBA AVENUE #215	GRAND FORKS	ND	58201
BLUEMLE, JOHN P.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202
BOLIN, F. M.	1505 SIXTH STREET SOUTH	FARGO	ND	58102
BOLONCHUK, WILLIAM W.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202
BORHO, ALAN	4812 SIXTH AVENUE NORTH #1	GRAND FORKS	ND	58201
BOSSERT, CRYSTAL	BOX 562	TIOGA	ND	58856
BRAUNER, JOHN F.	JAMESTOWN COLLEGE	JAMESTOWN	ND	58401
BREKKE, DAVID	NORTH DAKOTA GEOLOGICAL SURVEY	GRAND FORKS	ND	58202
BRISKE-ANDERSON, MARY	1504 COTTONWOOD	GRAND FORKS	ND	58201
BROPHY, JOHN A.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105
BROSCHAT, MYRON D.	203 EAST CHANNING AVENUE	FERGUS FALLS	MN	56537
BROWN, RALPH C.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202
BRUMLEVE, STANLEY	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202
BURKE, CAROLE L.	110-1 SHAWNEE ROAD	MINOT	ND	58704
BURTON, MIKE	81 PRAIRIEWOOD DRIVE	FARGO	ND	58103
BUTLER, MALCOLM G.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105
BUTTZ, HARRIS	1023 4TH STREET	DEVILS LAKE	ND	58301
CALLENBACH, JOHN A.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105
CAMPBELL, LARRY G.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105
CARLSON, EDWARD C.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202
CARLSON, KENNETH T.	320 SECOND AVENUE NORTHWEST	MAYVILLE	ND	58257
CARMICHAEL, VIRGIL W.	1013 NORTH ANDERSON STREET	BISMARCK	ND	58501
CARTER, JACK F.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105
CASSEL, J. FRANK	U.S. AIR FORCE ACADEMY	COLORADO SPRINGS	CO	80840
CHALLEY, JOHN R.	1349 SECOND STREET NORTH	FARGO	ND	58102
CLAMBEY, GARY K.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105
CLAUSEN, ERIC N.	MINOT STATE COLLEGE	MINOT	ND	58701
COLLINS, CHARLES C.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105
CONNELL, MARVIN D.	2606 FIFTH AVENUE NORTH	GRAND FORKS	ND	58201
CORNATZER, WILLIAM E.	307 PARK AVENUE	GRAND FORKS	ND	58201
COWARDIN, LEWIS M.	310 16TH AVENUE NORTHEAST	JAMESTOWN	ND	58401
CRACKEL, ROBERT L.	2600 NW 4TH STREET, APT. 4	MINOT	ND	58701
CRAWFORD, RICHARD D.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202

Name	Address	City	State/Zip
CRENSHAW, JOE	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
CUNNINGHAM, RICHARD	RURAL ROUTE 2	BISMARCK	ND 58501
CVANCARA, ALAN M.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
D'APPOLONIA, BERT L.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
DAFOE, ARTHUR W.	551 THIRD STREET NORTHEAST	VALLEY CITY	ND 58072
DAGEL, KENNETH	2201 11TH AVENUE NORTH	GRAND FORKS	ND 58201
DANDO, WILLIAM A.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
DAVIS, DAVID G.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
DE LLANO, MANUEL	3101 MAPLE STREET	FARGO	ND 58102
DEBOER, BENJAMIN	312 ALPHA	GRAND FORKS	ND 58201
DEREMER, CHARLES	1526 POCATELLO DRIVE	BISMARCK	ND 58501
DINGA, GUSTAV P.	CONCORDIA COLLEGE	MOORHEAD	MN 56560
DISRUD, DENNIS T.	413 HILLCREST DRIVE	MINOT	ND 58701
DOERING, EUGENE J.	2206 LAFOREST AVENUE	BISMARCK	ND 58501
DOGGER, JAMES R.	BUILDING 476, BARC E	BELTSVILLE	MD 20705
DOUBLY, JOHN A.	306 23RD AVENUE NORTH	FARGO	ND 58102
DRAPER, MARTIN A.	STATE UNIVERSITY STATION	FARGO	ND 58105
DRYER, PAMELA	ND PARKS AND RECREATION	BISMARCK	ND 58501
DUERRE, JOHN A.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
DUXBURY, ALEXIS	GAME AND FISH DEPARTMENT	BISMARCK	ND 58501
EBERTZ, MICHAEL	205 STATE STREET, #203	GRAND FORKS	ND 58201
EDGERLY, CHARLES G.M.	1317 EIGHTH AVENUE SOUTH	FARGO	ND 58103
EGINTON, CHARLES T.	VETERANS ADMINISTRATION CENTER	FARGO	ND 58102
EIDE, JOHN D.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
ERICKSON, DUANE	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
ERICKSON, J. MARK	ST. LAWRENCE UNIVERSITY	CANTON	NY 13617
ESSLINGER, MONICA	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
FARNUM, BRUCE	543 QUIXOTE AVENUE NORTH	LAKELAND	MN 55043
FAWLEY, MARVIN W.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
FEIL, VERNON J.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
FIELDS, RENEE K.	508 PARKWAY DRIVE	BURLINGTON	ND 58722
FILLIPI, GORDON M.	1005 SOUTH 20TH STREET	GRAND FORKS	ND 58201
FISH, HAROLD F.	BOX 338	WATFORD CITY	ND 58854
FISK, ALLEN L.	1122 AVENUE B WEST	BISMARCK	ND 58501
FIVIZZANI, ALBERT J.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
FLEETWOOD, CHARLES W.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
FOSSUM, GUILFORD O.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
FRANCKOWIAK, JEROME	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
FRANK, RICHARD E.	1020 BOYD DRIVE	GRAND FORKS	ND 58201
FREEMAN, MYRON L.	DICKINSON STATE UNIVERSITY	DICKINSON	ND 58601
FRIEDERICHS, MARIE	313 DAKOTA HALL	MINOT	ND 58701
FUNKE, B. R.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
GABRIELSON, DAVID	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
GALLAHER, DANIEL D.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
GANO, DAVID R.	SUND-MINOT	MINOT	ND 58701
GARVEY, ROY	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
GLASS, THOMAS L.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
GODFREAD, CAROLYN	409 ASPEN AVENUE	BISMARCK	ND 58501
GOETTLER, HANS J.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
GRAU, BRENDA	1710 - 5 1/2 AVENUE NE	JAMESTOWN	ND 58401
GRAU, GERALD A.	1710 - 5 1/2 AVENUE NE	JAMESTWON	ND 58401
GREENWALD, STEPHEN	1729 NORTH 4TH STREET	FARGO	ND 58102
GROENEWOLD, GERALD	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
HALL, CLINT	3633 KIMBERLY COURT	GRAND FORKS	ND 58201
HALVORSON, GARY A.	BOX 459	MANDAN	ND 58554
HAMILTON, ROBERT G.	CROSS RANCH	HENSLER	ND 58547
HANSON, DAVID D.	RURAL ROUTE 1, BOX 48	TURTLE LAKE	ND 58575
HARMONING, ARLEN	1708 NORTH 4TH STREET	BISMARCK	ND 58501
HARRISON, STEPHEN	12424 NE 142ND LANE, D-104	KIRKLAND	WA 98034
HARTMAN, JOSEPH H.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
HASSETT, DAVID J.	20 FENTON AVENUE	GRAND FORKS	ND 58201
HASSETT, DEBRA	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
HASTINGS, MICHAEL	DICKINSON STATE UNIVERSITY	DICKINSON	ND 58601
HEIDEL, BONNIE	GAME AND FISH DEPARTMENT	BISMARCK	ND 58501
HEINTZ, MARK	1021 JAMES AVE. NE	JAMESTOWN	ND 58401
HELENBOLT, KENNETH S.	3563 LONGFELLOW ROAD	FARGO	ND 58102
HEMMASI, MOHAMMAD	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202

HENDERSON, WILLIAM	3014 NORTH ELM STREET	FARGO	ND	58102
HERATH, JOHN F.	625 THIRD STREET SW, #5	ROCHESTER	MN	55901
HERBEL, JOLAYNE	1109 SOUTH FRONTIER	MANDAN	ND	58554
HERTSGAARD, DORIS	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105
HESSE, LISA JOY	P. O. BOX 44	GRAND FORKS	ND	58206
HICKOK, FLOYD	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202
HILL, ALISON	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105
HINTZ, DENNIS D.	BOX 235	GLEN ULLIN	ND	58631
HIRSCH, KATHIE J.	817 NORTH THIRD STREET	BISMARCK	ND	58501
HOBBS, JOHN T.	BOX 264	FORDVILLE	ND	58231
HOEPPNER, JEROME J.	2518 NINTH AVENUE NORTH	GRAND FORKS	ND	58201
HOFF, DONALD L.	402 EAST FIRST STREET	VELVA	ND	58790
HOFFMAN, CHARLES A.	MINOT STATE UNIVERSITY	MINOT	ND	58701
HOFMANN, LENAT	317 SATURN DRIVE	BISMARCK	ND	58501
HOGANSON, JOHN W.	NORTH DAKOTA GEOLOGICAL SURVEY	GRAND FORKS	ND	58202
HOGANSON, SHELLY	722 BELMONT ROAD	GRAND FORKS	ND	58203
HOLLAND, F.D., JR.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202
HOLLAND, JEAN H.	4686 BELMONT ROAD	GRAND FORKS	ND	58201
HOLLOWAY, HARRY, JR.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202
HOUGHTON, ROBERT L.	12201 SUNRISE VALEY DRIVE	RESTON	VA	22092
HOWELL, FRANCIS L.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202
HUESERS, LLOYD B.	1900 HIGHLAND DRIVE	MINOT	ND	58701
HUNG, YUNG-TSE	CLEVELAND STATE UNIVERSITY	CLEVELAND	OH	44115
HUNT, CURTISS D.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202
HUNT, JANET	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202
HUSAIN, SYED	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202
JACKSON, JON A.	UND SCHOOL OF MEDICINE	GRAND FORKS	ND	58202
JACOBS, FRANCIS A.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202
JALAL, SYED M.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202
JENSEN, A. D.	613 PRINCETON COURT	GRAND FORKS	ND	58201
JOHANSEN, DOROTHY	MAYVILLE STATE UNIVERSITY	MAYVILLE	ND	58257
JOHANSEN, ROBERT H.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105
JOHNSON, A. WILLIAM	629 HIGH PLAINS COURT	GRAND FORKS	ND	58201
JOHNSON, ARNOLD R.	449 EAST BRONDON DRIVE	BISMARCK	ND	58501
JOHNSON, DOUGLAS H.	BOX 2096	JAMESTOWN	ND	58402
JOHNSON, LESTER E.	RURAL ROUTE 2, BOX 92	BOTTINEAU	ND	58318
JOHNSON, LYNDON L.	RURAL ROUTE	ALAMO	ND	58830
JOHNSON, PHYLLIS E.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202
JONES, MARTIN B.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202
JORDAN, DAN R.	1325 THIRD AVENUE EAST, #13	HIBBING	MN	55746
JORDE, DENNIS	U.S. FISH AND WILDLIFE SERVICE	LAUREL	MD	20708
JORDHEIM, FRANK H.	1409 SOUTH 9TH STREET	FARGO	ND	58103
JUHL, NYLA H.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202
JYRING, RONALD	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202
KALUZNIAK, MIKE	3904 UNIVERSITY AVENUE, #117	GRAND FORKS	ND	58201
KANNOWSKI, PAUL B.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202
KANTRUD, HAROLD A.	ROUTE 7	JAMESTOWN	ND	58401
KARNER, FRANK R.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202
KELLEHER, JAMES J.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202
KETTERLING, GERALD L.	3540 SECOND STREET N, #209	FARGO	ND	58102
KEYS, ROSS D.	2215 FIFTH AVENUE NORTH	GRAND FORKS	ND	58201
KHAVANIN, MOHAMMAD	1115 24TH AVENUE SOUTH	GRAND FORKS	ND	58201
KIESLING, RICHARD	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105
KIHM, ALLEN J.	MINOT STATE UNIVERSITY	MINOT	ND	58701
KIRBY, DON	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105
KLOSTERMAN, HAROLD J.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105
KLUK, EDWARD	162 9TH AVENUE EAST, #9	DICKINSON	ND	58601
KNOBLICH, JEROME	233 14TH AVENUE NORTHEAST	JAMESTOWN	ND	58401
KNUDSON, CURTIS L.	711 NORTH 25TH STREET	GRAND FORKS	ND	58201
KOENKER, WILLIAM E.	WHIPPOORWILL LANE	CHAPEL HILL	NC	27514
KOLSTOE, RALPH H.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202
KOST, KENT	615 NORTH 39TH, #308A	GRAND FORKS	ND	58201
KOTCH, ALEX	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202
KRAFT, DONALD J.	BEMIDJI STATE UNIVERSITY	BEMIDJI	MN	56601
KRALJIC, KATHLEEN M.	1821 SEVENTH STREET SW	MINOT	ND	58701
KRAUSE, DANIEL	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105

KROGSTAD, KEVIN D.	163 LANCASTER DRIVE	MOORHEAD	MN 56560
KRUPINSKY, JOSEPH M.	BOX 459, USDA-ARS	MANDAN	ND 58554
KRUSCHWITZ, EARL H.	431 SIXTH STREET SOUTHWEST	VALLEY CITY	ND 58072
KUCERA, HENRY L.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
KUIPERS, GILBERT	VALLEY CITY STATE UNIVERSITY	VALLEY CITY	ND 58072
KUMAR, GIRISH	UNIVERITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
LABORDE, JOYCE M.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
LADENDORF, THOMAS R.	622 FIFTH AVENUE NORTHWEST	MINOT	ND 58701
LAIRD, WILSON M.	101 SPANISH OAK LANE	KERRVILLE	TX 78028
LAMBETH, DAVID	1909 20TH AVENUE SOUTH	GRAND FORKS	ND 58201
LARSEN, KIM	509 11TH AVENUE NE, APT. B	MINOT	ND 58701
LARSON, LINDA	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
LARSON, OMER R.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
LEADBETTER, LARRY	UND SCHOOL OF MEDICINE	GRAND FORKS	ND 58202
LEAGUE, LARRY	DICKINSON STATE COLLEGE	DICKINSON	ND 58601
LEHR, EUGENE R.	BOX 724	LINTON	ND 58552
LENO, GREGORY H.	215 TANGLEWOOD AVENUE	CHARLESTON	SC 29407
LEUTHER, KERSTIN	JAMESTOWN COLLEGE	JAMESTOWN	ND 58401
LINDLEY, JAMES A.	1421 NORTH UNIVERSITY DRIVE	FARGO	ND 58102
LIPP, WILLIAM V.	3024 NORTH 10TH STREET, #19	FARGO	ND 58102
LOBDELL, FREDERICK	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
LOCKWOOD, KARL L.	MAYVILLE STATE UNIVERSITY	MAYVILLE	ND 58257
LOENDORF, LAWRENCE L.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
LORENZ, RUSSELL J.	1924 NORTH GRANDVIEW LANE	BISMARCK	ND 58501
LOW, FRANK N.	2511 ST. CHARLES AVENUE	NEW ORLEANS	LA 70130
LOWE, STEPHEN L.	MINOT STATE UNIVERSITY	MINOT	ND 58701
LUKASKI, HENRY C.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
LURA, CHARLES L.	NDSU-BOTTINEAU BRANCH	BOTTINEAU	ND 58318
LYKKEN, GLENN I.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
MACCARTHY, RONALD F.	5211 CHESTNUT STREET	GRAND FORKS	ND 58201
MADHOK, OM P.	MINOT STATE UNIVERSITY	MINOT	ND 58701
MAGILL, THOMAS R.	3510 7TH AVENUE NORTH	GRAND FORKS	ND 58201
MAGNUSON, JUDY K.	2515 CHESTNUT STREET	GRAND FORKS	ND 58201
MAGNUSSON, ADELYNN M.	1703 SOUTH 20TH STREET	GRAND FORKS	ND 58201
MAIANU, ALEXANDRU	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
MALTERER, THOMAS	2616 4TH AVENUE NORTH	GRAND FORKS	ND 58201
MANSKE, LLEWELLYN	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
MARKELL, CLARK	MINOT STATE UNIVERSITY	MINOT	ND 58701
MARTIN, DEWAYNE C.H.	2104 SEVENTH AVENUE NORTHWEST	MINOT	ND 58701
MARTIN, JAMES E.	SD SCHOOL OF MINES/TECHNOLOGY	RAPID CITY	SD 57701
MARWIN, RICHARD M.	1519 CHESTNUT STREET	GRAND FORKS	ND 58201
MASON, HARRY	P.O. BOX 1116	JAMESTOWN	ND 58401
MASTEL, JEROME A.	51 CORTHELL ROAD	LARAMIE	WY 82070
MATHSEN, DON	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
MATTHIES, DONALD L.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
MCCARTHY, G. J.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
MCCLEARY, SHARON	2670 6TH AVE WEST #6	DICKINSON	ND 58601
MCCOLLOR, DONALD P.	UND ENERGY RESEARCH CENTER	GRAND FORKS	ND 58202
MCDONALD, CLARENCE E.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
MCMAHON, KENNETH J.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
MEARTZ, PAUL D.	MAYVILLE STATE UNIVERSITY	MAYVILLE	ND 58257
MELDRUM, ALAN	512 COLUMBIA ROAD	GRAND FORKS	ND 58201
MESSENGER, THEODORE	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
MEYER, DWAIN W.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
MILLER, BRUCE G.	UND ENERGY RESEARCH CENTER	GRAND FORKS	ND 58202
MILLER, JAMES E.	3807 MICHAEL LANE	GLENVIEW	IL 60025
MINGS, THOMAS S.	P. O. BOX 5123	FARGO	ND 58105
MIRON, DOUGLAS	SOUTH DAKOTA STATE UNIVERSITY	BROOKINGS	SD 57007
MITCHELL, E.N.	220 GLENHILL LANE	CHAPEL HILL	NC 27514
MOLLAND, GIBBS	1205 NORTH 22ND STREET	BISMARCK	ND 58501
MORGAN, ROSE M.	823 SIXTH STREET SOUTHWEST	MINOT	ND 58701
MORLEY, JAMES	3712 BERKELEY DRIVE, APT. 6	GRAND FORKS	ND 58201
MOWER, ROLAND D.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
MUDDERMAN, DENIS	3435 SOUTH 10TH STREET, APT. 2	GRAND FORKS	ND 58201
MUNSKI, DOUGLAS	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
NALEWAJA, JOHN D.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
NEEL, JOE K.	2221 CHESTNUT STREET	GRAND FORKS	ND 58201

NELSON, BERLIN D.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
NELSON, C.N.	NORTH DAKOTA STATE UNIVERSITY	BOTTINEAU	ND 58318
NELSON, DENNIS R.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
NELSON, HARVEY K.	10515 KELL AVENUE SOUTH	BLOOMINGTON	MN 55437
NELSON, NADINE S.	312 PIONEER HALL - MSU	MINOT	ND 58701
NELSON, RICK	UNIVERSITY OF MARY	BISMARCK	ND 58501
NELSON, ROBERT	130C COURT UNIVERSITY VILLAGE	FARGO	ND 58102
NELSON, WALLACE T.	ROUTE 1, BOX 214	PARSHALL	ND 58770
NICHOLAS, JOSEPH W.	UNIVERSITY OF GEORGIA	ATHENS	GA 30602
NIELSEN, FORREST H.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
NIX, DAVID	7500 UNIVERSITY DRIVE	BISMARCK	ND 58501
NORDLIE, ROBERT C.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
NOWOK, JAN W.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
NYREN, PAUL E.	BOX 21	STREETER	ND 58483
O'BRIEN, RICK	2417 UNIVERSITY AVENUE	GRAND FORKS	ND 58201
O'CONNELL, JAMES W.	535 EIGHTH AVENUE SOUTHWEST	VALLEY CITY	ND 58072
OECHSLE, LOIS H.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
OLSON, CHERYL R.	1212 13TH AVENUE WEST	WILLISTON	ND 58801
OLSON, LINDA S.	RURAL ROUTE 1, BOX 408	COOPERSTOWN	ND 58425
ORING, LEWIS W.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
ORR, PAUL H.	1010 RIVER DRIVE SOUTHEAST	EAST GRAND FORKS	MN 56721
OWEN, ALICE K.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
OWEN, JOHN B.	1118 REEVES DRIVE	GRAND FORKS	ND 58201
OWEN, SHUBEL D.	210 SOUTH 12TH STREET	GUTHRIE CENTER	IA 50115
OWENS, THOMAS C.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
PADMANABHAN, G.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
PAN, GEORGE G.	SOUTH DAKOTA STATE UNIVERSITY	BROOKINGS	SD 57007
PARK, CHUNG S.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
PARMAR, SURENDRA	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
PATTERSON, DONALD D.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
PECKHAM, RICHARD A.	1016 2ND AVENUE SW	MINOT	ND 58701
PEDERSON, A. ROBERT	414 20TH AVENUE NORTH	FARGO	ND 58102
PEDERSON, VERNYL D.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
PETERKA, JOHN J.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
PFISTER, PHILIP C.	30 MEADOWLARK LANE	FARGO	ND 58102
POLITI, EILEEN E.	109 CHEVY CHASE	MINOT AFB	ND 58704
POLK, GLENDA C.	7301 BROMPTON, APT. 103B	HUSTON	TX 77030
POON, CHI-SANG	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
POWERS, BRIAN	P.O. BOX 1727	FARGO	ND 58107
PRATT, GEORGE L.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
PRUNTY, LYLE	318 23RD AVENUE NORTH	FARGO	ND 58102
RABINDRAN, EVELYN A.	RURAL ROUTE 1, BOX 285	JAMESTOWN	ND 58401
RALSTON, NICK V.C.	4859 FIFTH AVENUE NORTH	GRAND FORKS	ND 58201
RALSTON, ROBERT	MAYVILLE STATE UNIVERSITY	MAYVILLE	ND 58257
RAND, ROGER W.	542 FIFTH AVENUE SOUTHWEST	VALLEY CITY	ND 58072
RATHMANN, FRANZ H.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
RAWAT, BANMALI	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
RAWAT, SHANTI	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
RAY, PAUL D.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
REDLIN, SCOTT C.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
REEVES, PHILIP G.	812 NORTH 25TH STREET	GRAND FORKS	ND 58201
REICHMAN, GEORGE A.	306 SIXTH AVENUE NORTHWEST	MANDAN	ND 58554
REID, JOHN R.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
REINKE, ROBERT	BOX 391	RAY	ND 58849
REZANIA, SHAHIN	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
RICHARDSON, J.L.	1245 NORTH 9TH STREET	FARGO	ND 58102
RIES, RONALD E.	908 SECOND AVENUE NORTHWEST	MANDAN	ND 58554
RIGLEY, LOUIS	DICKINSON STATE UNIVERSITY	DICKINSON	ND 58601
RINDT, DIANE	UND ENERGY RESEARCH CENTER	GRAND FORKS	ND 58202
ROBERTS, KRIS	200 THIRD AVENUE SW, #1	MANDAN	ND 58554
RODEWALD, RANDOLPH F.	MINOT STATE UNIVERSITY	MINOT	ND 58701
ROGERS, DAVID A.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
ROGLER, GEORGE A.	BOX 459	MANDAN	ND 58554
ROTT, STEPHEN J.	ROUTE 2, HWY. 281 SOUTH	JAMESTOWN	ND 58401
ROWELL, JIM	#9 SIXTH STREET SW	MINOT	ND 58701
ROYER, RON	BOX 88	BURLINGTON	ND 58722
RUDESILL, JAMES T.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105

RUDIE, ERIC	210 THIRD AVENUE NE	WASECA	MN 56093
RYCKMAN, LAWRENCE	140 NORTHWEST DRIVE	BISMARCK	ND 58501
SAARI, JACK	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
SARGEANT, ALAN B.	N PRAIRIE WILDLIFE RES. CENTER	JAMESTOWN	ND 58401
SAUER, MICHAEL T.	1802 NORTH BELL STREET	BISMARCK	ND 58501
SCHEIBE, PAUL	3 STILL CREEK ROAD	WOODSIDE	CA 94062
SCHELKOPH, GWEN M.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
SCHIMMER, JAMES R.	114 1/2 NORTH THIRD, #16	GRAND FORKS	ND 58201
SCHLICHTING, JAMES D.	2222 BIRCHMONT DRIVE	BEMIDJI	MN 56601
SCHLOSSER, ISAAC	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
SCHMIDT, AUDREY E.	ROUTE 1, BOX 183AA	HORACE	ND 58047
SCHMIDT, CHERYL K.	815 DUKE DRIVE, #102	GRAND FORKS	ND 58201
SCHMIDT, CLAUDE H.	STATE UNIVERSITY STATION	FARGO	ND 58105
SCHMIDT, JOHN	ROUTE 1, BOX 183AA	HORACE	ND 58047
SCHNEIDER, FREDERICK	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
SCHULZ, JOHN	420 SW SECOND STREET	RUGBY	ND 58368
SCHULZ, JOHN T.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
SCHUMACHER, SUSANN	2101 SECOND AVENUE NW	MINOT	ND 58701
SCHWERT, DONALD P.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
SCOBY, DONALD R.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
SEABLOOM, ROBERT W.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
SEDIVEC, KEVIN	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
SEIDEL, JIMMY LEE	UNIVERSITY OF UTAH	SALT LAKE CITY	UT 84112
SEVERSON, D. E.	APT. 5-201	BROOMFIELD	CO 80020
SEVERSON, ROLAND G.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
SHELTON, DAVID R.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
SHUBERT, L. ELLIOT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
SHULER, TERRENCE R.	2974 COLUMBINE COURT	GRAND FORKS	ND 58201
SIDERS, WILLIAM A.	1105 SOUTH 22ND STREET	GRAND FORKS	ND 58201
SILVERMAN, LOUIS B.	2524 OLSON DRIVE	GRAND FORKS	ND 58201
SIMONS, PAUL B.	ANG COAL GASIFICATION	BEULAH	ND 58523
SIMS, RODGER L.	718 25TH STREET NORTH	GRAND FORKS	ND 58201
SKARSGARD, JACOLYN R.	BOX 870	STANLEY	ND 58784
SLEEPER, BAYARD P.	P.O. BOX 2236	PAULSBO	WA 98370
SLOTNICK, HENRY B.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
SMITH, DONALD	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
SMITH, GLENN S.	1115 NORTH 14TH STREET	FARGO	ND 58102
SNOOK, THEODORE	343 SHERIDAN ROAD	RACINE	WI 53403
SNOW, SKIP	STAR ROUTE 2, BOX 35	WATFORD CITY	ND 58854
SOUBY, ARMAND M.	103 NICHOLS	SAN MARCOS	TX 78666
SPARKS, ROBERT	UNIVERSITY OF NORTH DAKOTA	FARGO	ND 58105
STAAEL, GAYLAN	128 HAYCREEK COURT	BISMARCK	ND 58501
STACK, ROBERT W.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
STARCHER, GEORGE W.	700 JOHN RINGLING BOULEVARD	SARASOTA	FL 33577
STATLER, GLEN D.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
STENBERG, VIRGIL I.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
STENDELL, REY C.	1806 FIFTH STREET NORTHEAST	JAMESTOWN	ND 58401
STEWART, DANIEL D.	1200 MISSOURI AVENUE	BISMARCK	ND 58501
STEWART, JAMES A.	PEMBROKE ONTARIO	CANADA	K8A6X6
STICKLER, JOSEPH C.	547 NE SIXTH STREET	VALLEY CITY	ND 58072
STINNETT, HENRY O.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
STOAKS, RALPH D.	8047 EL CAPITAN DRIVE	LE MESA	CA 92041
STOY, W. MICHAEL	1826 NORTH BELL STREET	BISMARCK	ND 58501
STREEPER, JOSEPH B.	BOX 253	SAWYER	ND 58781
SUGIHARA, JAMES M.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
SUKALSKI, KATHERINE A.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
SUMMERS, LAWRENCE	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND 58202
SWANSON, GEORGE A.	1727 FOURTH AVENUE NORTHEAST	JAMESTOWN	ND 58401
SWANSON, RICHARD J.	507 THIRD STREET COURT	WEST FARGO	ND 58078
TATE, JOHN M.	412 ALPHA AVENUE, #108	GRAND FORKS	ND 58201
TAYLOR, RAYMOND	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
THOMPSON, MICHAEL B.	2208 CRESCENT DRIVE	MINOT	ND 58701
THRASHER, LAWRENCE C.	104 KUCHENSKI DRIVE	DICKINSON	ND 58601
TILTON, JAMES E.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
TIMIAN, ROLAND G.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND 58105
TIMPE, RONALD C.	604 STANFORD ROAD	GRAND FORKS	ND 58201

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TIMPSON, MICHAEL E.      NORTH DAKOTA STATE UNIVERSITY  FARGO          ND 58105
TOBER, DWIGHT A.         USDA-SCS, P.O. BOX 1458        BISMARCK       ND 58502
TODD, ROBERT G.          221 SEVENTH AVENUE WEST        DICKINSON      ND 58601
TORKELSON, DAVID R.      1903 NORTH 4TH                 BISMARCK       ND 58501
TRIEBOLD, BEVERLY        1729 NORTH 4TH STREET          FARGO          ND 58102
UTHUS, ERIC              UNIVERSITY OF NORTH DAKOTA     GRAND FORKS    ND 58202
VANALSTINE, JAMES B.     UNIVERSITY OF MINNESOTA        MORRIS         MN 56257
VENETTE, JAMES R.        NORTH DAKOTA STATE UNIVERSITY  FARGO          ND 58105
VINCENT, MURIEL C.       NORTH DAKOTA STATE UNIVERSITY  FARGO          ND 58105
VOLESKY, JERRY D.        FT KEOGH LIVESTOCK & RANGE LAB MILES CITY     MT 59301
WAHTOLA, CHARLES H.      121 MISTLETOE ROAD             GOLDEN         CO 80401
WAKEFIELD-FISHER, MARY   UNIVERSITY OF NORTH DAKOTA     GRAND FORKS    ND 58202
WALI, MOHAN K.           STATE UNIVERSITY OF NEW YORK   SYRACUSE       NY 13210
WALLA, JAMES             NORTH DAKOTA STATE UNIVERSITY  FARGO          ND 58105
WALLER, JAMES R.         UNIVERSITY OF NORTH DAKOTA     GRAND FORKS    ND 58202
WALSH, ROBERT G.         R.R. 6, BOX 124, CC ACRES      MINOT          ND 58701
WANEK, WALLACE J.        ROUTE 1, BOX 307               BEMIDJI        MN 56601
WASSON, RUD              NORTH DAKOTA STATE UNIVERSITY  FARGO          ND 58105
WATREL, ALBERT A.        1071 WEST FIFTH STREET         DICKINSON      ND 58601
WEBER, GREGORY F.        UND ENERGY RESEARCH CENTER     GRAND FORKS    ND 58202
WEISSER, WILBUR O.       UNIVERSITY OF NORTH DAKOTA     GRAND FORKS    ND 58202
WETSCH, JOHN R.          113 W CAPITOL AVENUE #112      BISMARCK       ND 58501
WHEELER, GEORGE C.       3358 NE 58TH AVENUE            SILVER SPRINGS FL 32688
WHITE, GLYNDON           902 THIRD AVENUE NW, BOX 1394  JAMESTOWN      ND 58401
WHITMAN, WARREN C.       NORTH DAKOTA STATE UNIVERSITY  FARGO          ND 58105
WILLIAMS, JOHN A.        UNIVERSITY OF NORTH DAKOTA     GRAND FORKS    ND 58202
WILLIAMS, JOHN D.        UNIVERSITY OF NORTH DAKOTA     GRAND FORKS    ND 58202
WILLIAMS, RICHARD L.     IOWA STATE UNIVERSITY          AMES           IA 50011
WILLMAN, CLYDE A.        620 TENTH STREET SOUTH         FARGO          ND 58103
WINCZEWSKI, LARAMIE      12614 VINDON DRIVE             HOUSTON        TX 77024
WINGER, MILTON           UNIVERSITY OF NORTH DAKOTA     GRAND FORKS    ND 58202
WORMAN, JAMES J.         UND ENERGY RESEARCH CENTER     GRAND FORKS    ND 58202
WORMAN, JOSEPH           UNIVERSITY OF NORTH DAKOTA     GRAND FORKS    ND 58202
WORTHAM, KENNETH E.      MAYVILLE STATE UNIVERSITY      MAYVILLE       ND 58257
WRENN, WILLIAM J.        UNIVERSITY OF NORTH DAKOTA     GRAND FORKS    ND 58202
WYCKOFF, ANN M.          UNIVERSITY OF NORTH DAKOTA     GRAND FORKS    ND 58202
WYCKOFF, JOHN W.         UNIVERSITY OF NORTH DAKOTA     GRAND FORKS    ND 58202
WYMORE, ROBERT W.        350 FIRST STREET NORTHWEST     MAYVILLE       ND 58257
YOUNG, KEVIN             UNIVERSITY OF NORTH DAKOTA     GRAND FORKS    ND 58202
ZIEMAN, DALE M.          BOX 643                        NEW TOWN       ND 58763
ZOELLNER, ROBERT         NORTHERN ARIZONA UNIVERSITY    FLAGSTAFF      AZ 86011
ZOGG, CARL               UNIVERSITY OF NORTH DAKOTA     GRAND FORKS    ND 58202
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