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75th Anniversary Meeting

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NORTH DAKOTA ACADEMY OF SCIENCE
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75th ANNUAL MEETING

April 28-30, 1983

Grand Forks, North Dakota

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 first section of this volume of the Proceedings contains the 48 papers presented in the nine symposia at the 1983 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 the 43 communications presented in the Professional section of the 1983 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 the 17 collegiate communications representing 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 students also were required to prepare a full manuscript for submission to the Denison Awards Committee which judged the oral presentation, the communication, and the manuscript in arriving at their decision for the first and second place awards in both the graduate and undergraduate competition. The collegiate communications are numbered in the sequence in which they appear in the meeting program.

This is a special issue of the Proceedings because it presents the activities of the Diamond Anniversary meeting of the Academy. It includes, as a special feature, a history of the last twenty-five years of the Academy which was presented as the Invited Paper for the 75th annual meeting. Dr. George A. Abbott wrote "The First Fifty Years," a history of the first fifty years of the Academy (1908-1958), upon the occasion of its Golden Anniversary, and it was published as a separate booklet in 1958. At the request of the Executive Committee, Dr. Richard Frank has written "Fifty Plus Twenty Five Equals Seventy Five," a history of the third quarter century of the Academy (1958-1983), for this Diamond Anniversary celebration, and it is published in full in this issue of the Proceedings (pages 121-136).

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.

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, 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 Phl, J.E.F. (1973) *Brit. Med. J.* 3, 474-475. (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.
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.

SYMPOSIUM

on

TRACE ELEMENTS IN HUMAN NUTRITION

Presiding: Phyllis E. Johnson
Human Nutrition Research Center-ARS-USDA
Grand Forks, ND

1. Trace Elements and Vitamins as Anticarcinogens
Forrest H. Nielsen*
Human Nutrition Research Center-ARS-USDA
Grand Forks, ND

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J. R. Mahalko*, B. Ervin, and L. K. Johnson
Human Nutrition Research Center-ARS-USDA
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Eric O. Uthus*
Human Nutrition Research Center-ARS-USDA and
Department of Biochemistry, University of North Dakota
Grand Forks, ND

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Grand Forks, ND

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Curtiss D. Hunt*
Human Nutrition Research Center-ARS-USDA
Grand Forks, ND

1. TRACE ELEMENTS AND VITAMINS AS ANTICARCINOGENS

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In recent years, a plethora of stories with extravagant claims regarding cancer preventative and curative properties of various trace elements and vitamins have become available to the public through sources such as newspapers, magazines, books and television. These stories often have concepts presented in an exaggerated and overly simplified manner with tentative evidence given as though it were complete and conclusive. Unfortunately, because of broad acceptance by those without a scientific understanding of nutrition, such stories misguide and misinform many cancer patients, as well as healthy people, to practice non-medical cancer treatments or possibly harmful nutritional regimens. Some of the trace elements and vitamins suggested to affect carcinogenesis are selenium, iron, zinc, copper, manganese, arsenic, iodine, vitamin A, vitamin C, vitamin E, riboflavin and pyridoxine. At present there is no conclusive evidence that the supplementation of any trace element or vitamin at levels greater than that normally consumed in a balanced diet has any practical value in the prevention of cancer. However, epidemiologic and animal findings suggest that selenium and the retinoids (vitamin A derivatives) may be chemopreventive or chemotherapeutic for some forms of cancer.

The most substantive evidence that selenium has anticarcinogenic properties has come from studies that show selenium supplementation, usually at levels in excess of ten times that required to prevent deficiency signs, of laboratory animals protects against carcinogen-induced neoplastic growth in various organ sites (1), reduces the incidence of "spontaneous" mammary tumors (2), and suppresses the growth of transplanted tumor cells (3). To date, no well-controlled clinical study has been done to ascertain whether selenium inhibits carcinogenesis in humans. Such studies are needed before conclusive statements about selenium as an anticarcinogen can be made because findings from animals cannot be extrapolated with assurance to humans. Different species may respond in unique ways to the same dietary treatment. Furthermore, before advocating selenium supplementation, the consequences of long term intake of selenium in excess of that required to prevent selenium deficiency must be determined.

The type and extent of the evidence that suggests vitamin A is effective in inhibiting or preventing the development of epithelial cancer is similar to that of selenium. However, naturally occurring forms of vitamin A are too ineffective and too toxic to be used practically for the prevention of cancer in humans (4). Thus, synthetic analogs of vitamin A (retinoids) are being tested for properties which are anticarcinogenetic and low toxicity (4). Apparently no suitable analog has been found yet.

Only tenuous evidence exists for the concept that reduced or excess amounts of a trace nutrient other than selenium or the retinoids have a beneficial role in the treatment or prevention of cancer in humans. For example, the evidence that vitamin C or vitamin E may be useful in preventing or treating malignant diseases is theoretical. Cameron and Pauling (5) postulated that high dietary ascorbic acid might prevent cancer by inhibiting, or by stimulating the synthesis of an inhibitor of, the enzyme hyaluronidase thought by some to control cell proliferation. Vitamin E is believed to protect against oxidant damage to membranes by eliminating free radicals. Because free radicals might be important in tumor development, it may be postulated that vitamin E, through its antioxidant properties, can modify the genesis of some forms of cancer. To date, unlike selenium or the retinoids, no conclusive findings from animal experiments that support the vitamin C and vitamin E hypotheses have appeared. Thus, recommendations for megadose intakes of vitamin C, or vitamin E, as a means of preventing human cancers are inappropriate, nonbeneficial and, possibly, harmful.

Although there are some intriguing leads, further research is needed to establish whether there is a non-toxic nutritionally-related trace substance that will effectively prevent some forms of cancer.

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2. NUTRIENT INTAKES OF ELDERLY PERSONS

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Research has been insufficient to adequately define the nutrient requirements of the elderly. With the exception of a decreased energy requirement, the requirements of the elderly generally are assumed to be the same as for younger adults. The nutrient intakes of the elderly may be of more concern than those of younger adults, however, because of lower incomes, limited mobility, and depression associated with bereavement or social isolation. In addition, a decreased energy requirement without corresponding decreases in protein, vitamin and mineral requirements suggest that foods consumed by the elderly should be relatively more concentrated in nutrients. Preliminary results are available from a dietary assessment of a group of fifty-four apparently healthy elderly persons age 55 to 95 (mean 71.0 ± 9.4 SD) years, who were recruited mainly by invitations to senior citizens groups in Grand Forks, N.D. A detailed dietary history to determine usual eating patterns was obtained in the home of each subject. Nutrient intakes were then calculated by computer, using USDA and additional privately published data. Of 18 males and 36 females, 46 were free-living and 8 lived in a minimal care retirement home providing cafeteria meals. Eighteen took some form of vitamin or mineral supplement regularly. Reported energy intakes varied widely, ranging from 900 to 2850 kilocalories per day, with a mean that was 85 percent of the Recommended Dietary Allowances (RDA) for this age group. Mean nutrient intakes from diet alone were 94 percent of the RDA for calcium, and were greater than 100 percent of the RDA for protein, vitamin A, ascorbic acid, niacin equivalents, riboflavin, thiamin, phosphorus, and iron. For each nutrient, the percent of persons consuming < 2/3 RDA from diet alone were: energy, 19%; protein, 0%; vitamin A, 9%; ascorbate, 7%; thiamin, 9%; riboflavin, 9%; niacin equivalents, 0%; calcium, 35%; phosphorus, 2%; iron, 2%. As a percent of the RDA, dietary intakes of protein and niacin, but not of other nutrients, decreased significantly ($p < 0.02$) with increasing age. Other factors affecting nutrient intake in this group will be discussed. In comparison with persons 60 and older in the 1968-70 Ten State Nutrition Survey, mean intakes for the Grand Forks group were similar (within 10%) for energy, protein, and riboflavin, but were higher for calcium (15%), iron (20%), vitamin A (17%), thiamin (22%), preformed niacin (13%), and ascorbate (40%). Since the recruiting methods used probably resulted in participants who were relatively healthy and socially out-going, dietary intakes of the Grand Forks group may have been different (and probably better) than would be found in a more representative sampling of the elderly population.

3. ARSENIC - A BENEVOLENT NUTRIENT WITH A MALEVOLENT IMAGE

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Since ancient times, arsenicals have been characterized by actions both benevolent and malevolent. Medicinal virtues of arsenic have been acclaimed for nearly 2500 years. Hippocrates is said to have used arsenic sulfide as a remedy for ulcers and similar disorders. Other ancients familiar with medicinal virtues of arsenic include Aristotle, Theophrastus and Pliny the Elder. In 1905, Ehrlich first synthesized organic arsenicals and demonstrated their chemotherapeutic action against trypanosomes. Arsenicals were considered at various times to be specific remedies in the treatment of anorexia, other nutritional disturbances, neuralgia, rheumatism, asthma, chorea, malaria, tuberculosis, diabetes, skin diseases, numerous hematologic abnormalities and syphilis. The use of arsenic for these disorders has fallen into disrepute or has been replaced by more effective alternatives. Organic arsenicals are still used, however, in the treatment of sleeping sickness due to Trypanosoma rhodesiense and T. gambiense, in amebiasis, and in veterinary medicine for the treatment of dogs infested with heart worms. In addition to medicinal use, arsenicals were, and in some cases, still are used as insecticides, herbicides and fungicides. Arsenic is also important in animal production. Feeding derivatives of phenylarsenic acid results in growth stimulation in chickens, turkeys, swine and calves. On the other hand, very early in the history of arsenic, it was found that some arsenic compounds were convenient, scentless and tasteless instruments for homicidal purposes. For about 1100 years, up to the last century, arsenicals reigned as the king of poisons. Around 1820 arsenic became equated with carcinogenicity. Even today arsenic is often thought of as being synonymous with "poison" and "cancer". Interestingly, arsenic is probably the oldest known chemotherapeutic agent for cancer. Arsenicals still may be used occasionally in the treatment of leukemia. Most likely, arsenic is neither a carcinogen or anticarcinogen, but indirectly influences other metabolic systems (e.g., immune system) or nutrients (e.g., zinc) which have a more direct role in the carcinogenic process. This indirect action means that depending upon the form, method of administration, and dosage, arsenic may have antagonistic, synergistic or no action in carcinogenesis.

In 1975 the first evidence that arsenic is physiologically essential came from studies on rats done by Nielsen et al. (1). The offspring of dams fed a diet containing approximately 30 ng As/g exhibited a rough hair coat and a significantly lower growth rate than controls fed supplemental arsenic. In 1976 Anke et al. (2) reported that arsenic was essential for goats and minipigs. Growing, pregnant and lactating goats and minipigs were fed a semisynthetic diet containing less than 50 ng As/g. Controls were fed supplemental arsenic (350 ng/g). Body weights of the arsenic-deprived newborn kids and piglets were depressed and the mortality rate was elevated. During the nursing period, growth of the arsenic-deprived kids was depressed. The mortality rate of adult deficient goats was elevated.

Recent findings have shown that arsenic, zinc and arginine interact in the chick to affect arginine and/or zinc metabolism (3). The mechanism through which arsenic affects arginine and/or zinc metabolism is unknown but arsenic possibly has a role in amino acid or protein metabolism. Findings which indicate this include: a) Arsenic deprivation affected plasma uric acid which indicates amino acid metabolism is altered because excess amino acid nitrogen is usually eliminated from the chick as uric acid. b) Preliminary findings have shown that arsenic deprivation depressed the level of arginine, and elevated the levels of cystine, glutamine, glycine and histidine, in plasma of chicks. c) Arsenic deprivation depressed the raw protein level in minipigs and goats (4). Perhaps arsenic affects protein and/or amino acid metabolism just by altering arginine metabolism. Support for this suggestion are the findings that zinc, arsenic and arginine individually, or by interacting with each other affect chick kidney arginase activity. Most likely, it is not a direct affect because arsenic deprivation elevated or depressed the activity with the direction determined by the zinc and arginine status of the chick.

Thus, substantial evidence exists that arsenic is necessary for health. Arsenic - synonymous with "poison" to many - is actually a benevolent nutrient.

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2. Anke, M., Grun, M. and Partschefeld, M. (1976) in Trace Substances in Environmental Health, Vol. 10 (Hemphill, D.D., ed.), pp. 403-409. University of Missouri, Columbia.
3. Uthus, E.O. (1982) Ph.D. Thesis, University of North Dakota.
4. Anke, M., et. al. (1978) in Trace Element Metabolism in Man and Animals-3 (Kirchgessner, M., ed.), pp. 248-252. Tech. Univ. Munchen, Freising-Weihenstephan, BRD.

4. EFFECT OF ZINC NUTRITURE ON THE ASSAY OF FOLIC ACID BY MICROBIOLOGICAL OR RADIOIMMUNOASSAY METHODS

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Several investigators have compared microbiological and radioimmunoassay (RIA) methods for folate analysis(1, 2). In most instances, the two methods were comparable. However, unexplained discrepancies have been noted (1, 2).

In a study of mild zinc deficiency in man, zinc effects on folic acid metabolism, as reflected by assay method, were observed. Three men were fed diets containing 150 µg of folate (by analysis) per day. One man was supplemented with 200 µg of folic acid daily. The other two men received no folate supplement. All of the men were fed diets containing 3.5 mg zinc/day which was supplemented to a total of 8.0 mg/day for 4 weeks, then unsupplemented for 16 weeks, then supplemented to 33.5 mg zinc/day for 4 weeks. Their body weights were kept constant by adjustments of energy intakes and expenditures.

Two folic acid assay methods were compared. Serum and RBC folate activities were determined by a microbiological procedure described by Scott et. al., (3) using a chloramphenicol resistant strain of L. Casei. Serum and RBC folates were also done by a radioimmunoassay procedure (Bectin-Dickinson Folate Radioassay Kit). Red cell folate was then calculated using whole blood, serum and hematocrit values.

As seen in Table 1, dietary zinc influenced the comparative results of the two procedures.

Table 1

Effect of Dietary Zinc and Folic Acid on
RBC Folic Acid as Determined by Two Different Methods

Dietary Zinc	RBC Folate			
	Folate Unsupplemented(2)*		Folate Supplemented(1)	
	Microbiological	RIA	Microbiological	RIA
8.0 mg Zn/day	312 ± 36(2)**	335 ± 30(3)	403 ± 46(3)	347 ± 98(3)
3.5 mg Zn/day	353 ± 44(17)	188 ± 44(19)	534 ± 159(8)	307 ± 60(10)
33.5 mg Zn/day	367 ± 67(4)	268 ± 79(4)	703 ± 5(2)	315 ± 49(2)

*Number of volunteers
**Number of observations

No difference on RBC folate activity as measured microbiologically was seen in men who did not receive folate supplement, regardless of the zinc content of the diet. There was a significant drop in apparent folate activity measured by the RIA procedure when the men were receiving 3.5 mg of zinc/day. When the diet was adequate in zinc and when supplemented to a level of 33.5 mg zinc the apparent RBC folate increases slightly. With folate supplementation, the microbiological RBC folate level increased with time throughout the study, whereas RBC folate, measured by RIA did not change. No significant changes in plasma zinc were observed. No difference in the apparent folate content was observed when exogenous zinc was added to a pool sample.

During zinc depletion there may be a form of folate that is initially measured by RIA which is converted to a metabolite not detected by RIA, but still measured microbiologically. Thus, zinc nutriture may need to be considered, in addition to the method, when assessing folate nutriture.

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2. Baril, L. and Carmel, R. (1978) Clin. Chem. 24, 2192-2196.
3. Scott, R.M., Ghanta, V., Herbert, V. (1974) Am. J. Med. Tech. 40, 125-134.

5. USE OF STABLE METAL ISOTOPES AS TRACERS IN HUMANS

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The determination of human requirements for trace elements necessarily includes knowledge of the factors that affect trace element availability for absorption. Quantitative studies in humans have been limited in number. The chemical balance technique is imprecise and laborious. More seriously, it fails to differentiate between endogenous intestinal metal and unabsorbed dietary metal. True absorption and apparent absorption, or balance, may differ markedly.

Radioisotopic studies are more precise, but dose is limited by ethical problems, particularly in the case of children and fertile women. An additional difficulty occurs for certain metals such as copper, which has only very short-lived radioisotopes that are not practical tracers for most metabolic studies.

The use of stable metal isotopes does not involve the ethical problems associated with radioisotopes, and eliminates the problem of radioactive decay during an experiment. Stable isotopes of iron, copper, zinc, magnesium, lead, selenium, and chromium have been used in human metabolic studies.

Stable isotope enrichment of samples from such studies can be measured by neutron activation analysis (NAA), by thermal ionization mass spectrometry (TI-MS), and by conventional electron impact ionization mass spectrometry (EI-MS). Each of these methods has its own drawbacks.

Thermal ionization mass spectrometry determines isotope ratios directly, by measuring the abundance of each nuclide of the metal in question. It is the most precise method of the three mentioned, with isotope ratios commonly determined to within 0.1%. Unfortunately, TI-MS instrumentation is extremely expensive and sample throughput is approximately one sample/hour. TI-MS also has the lowest limit of detection, and is the method of choice for kinetic studies when isotopic enrichment in plasma must be measured.

The precision of NAA varies from 10% to 1%, depending on the metal being analyzed. NAA facilities are very limited in number, but much of the work on stable isotope use in humans has been done using NAA in Janghorbani's laboratory at MIT (1). He has reported methods for measuring absorption of Zn, Fe, and Se in humans. One of the drawbacks of NAA is that not all isotopes of a given metal can necessarily be determined using this method, since only certain isotopes can be activated.

The method used in our laboratory is electron impact ionization mass spectrometry. In order to use EI-MS instrumentation, it is necessary to chelate the metal to be analyzed with a ligand which will form a volatile organometallic complex. In a few cases, such as for chromium (2), it is possible to introduce the metal complex into the mass spectrometer via the gas chromatograph. However it is usually necessary to use the direct itroduction probe. Ligands used are the acetylacetonates (3,4) and tetraphenylporphyrin (5). Precision of this method is 2-4%.

Volunteer subjects are given 2-4 mg of an enriched stable isotope such as ^{54}Fe, ^{65}Cu, or ^{67}Zn. Feces are collected for 21 days and analyzed for the presence of unabsorbed isotope. Absorption is calculated from (intake-excretion)/intake.

This method has been used to measure absorption of zinc, copper, and iron in both adult subjects and in infants.

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4. Miller, D.D. and Van Campen, D. (1979) Am. J. Clin. Nutr. 32, 2354, 2361.

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6. THE INFLUENCE OF CERTAIN TRACE ELEMENTS ON CARTILAGE AND BONE METABOLISM

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Cartilage and bone are living tissues which grow, remodel and repair themselves. They represent two types of connective tissue and as such consist of cells (chondrocytes or osteocytes) and extracellular fibers embedded in an amorphous ground substance (1). Bone matrix typically becomes heavily mineralized whereas cartilage matrix undergoes mineralization only in areas of endochondral ossification. The role of various essential trace elements in cartilage and bone metabolism is not fully understood at the present time. However, improper nutriture of various essential trace elements impairs normal cartilage or bone matrix synthesis and mineralization. Those trace elements apparently affect metabolism directly through involvement in a specific cellular metabolic process and/or indirectly through metabolic interaction with other essential nutrients. Some effects of four trace elements on cartilage and bone metabolism are discussed below.

Zinc is known to be an essential trace element and has an important influence on cartilage and bone formation (2). Zinc deficient animals exhibit prominent skeletal abnormalities such as shortened, thickened and bowed long bones. Chick embryos from the eggs of hens given severely zinc deficient diets show impaired skeletal development including agenesis of the limbs, dorsal curvature of the spine and fused vertebrae. Histological sections show that zinc deficiency apparently inhibits chondrogenesis and osteoblastic populations and activities. In addition, the width of the metaphysis is reduced and Haversian canals are increased in diameter. The primary effect of zinc on cartilage and bone may be its influence on cell division. Zinc deficiency decreases the activity of the zinc-dependent enzyme thymidine kinase. That enzyme is involved in thymidine triphosphate formation which is necessary for DNA synthesis.

Manganese is essential for many metabolic processes and several skeletal abnormalities occur in the leg bones of manganese deficient animals (2). Those abnormalities include retarded bone growth with twisting and weakening of the long bones and malformations of the hock joint. Manganese deficiency causes a dysplasia of epiphyseal cartilage but only a slight impairment of the mineralization process. Thus, manganese is thought to be involved in cartilage matrix synthesis. Biochemical data indicates that manganese deficiency impairs synthesis of glycosaminoglycans. Those substances are vital components of cartilage matrix.

Silicon is a recent addition to the list of essential trace elements (3). Gross examination of tibiae from silicon deficient chicks reveals a reduction in diameter and an increased opaqueness of the articular cartilage. The bone shaft is significantly shorter, thinner, and less flexible. Histological sections of the proximal tibial epiphyseal plate show that silicon deficiency results in a drastic reduction in the width of the proliferative zone, irregular penetration of the perforating cartilage canals, and loss of the characteristic columnar arrangement of the cartilage cells. These morphological changes in epiphyseal cartilage structure subsequently delay osteogenesis within the metaphysis. The effects of silicon deficiency on bone mineralization appear to be secondary to those on matrix synthesis however. Tibiae from silicon deficient chicks show only a minimal decrease in bone mineral content but substantial decreases in the amount of water content, total glycosaminoglycans and collagen.

Boron is recognized as essential for higher plants but conclusive evidence showing a physiological role for boron in animals has not been described. Recent findings by Hunt and Nielsen (4) suggest that boron influences bone formation through interaction with other nutrients essential to bone metabolism. Chicks fed a cholecalciferol deficient diet show a characteristic widening of the hypertrophic zone of epiphyseal plate cartilage. That zone is reduced in chicks supplemented with physiological levels of boron. Other preliminary data indicates that boron deficiency elevates plasma calcium, phosphorus, and magnesium.

It is apparent that proper nutriture of the essential trace elements is vital to the morphological integrity and normal metabolism of cartilage and bone tissues. Further study of those elements may reveal the etiology of various diseases peculiar to cartilage and bone tissue.

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2. Underwood, E.J. (1977) Trace Elements in Human and Animal Nutrition, pp. 170-242. Academic Press, New York.
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SYMPOSIUM

on

TOPICS IN REGRESSION ANALYSIS

Presiding: LuAnn Johnson
Human Nutrition Research Center-ARS-USDA
Grand Forks, ND

7. Regression and Correlation
Tom Petros*
Psychology Department, University of North Dakota
Grand Forks, ND

8. Variable Selection in Regression
Dave Smith*
Mathematical Sciences, North Dakota State University
Fargo, ND

9. Trouble Shooting Data
Leigh W. Murray*
Mathematical Sciences, North Dakota State University
Fargo, ND

10. Robust Regression
Doris M. F. Hertsgaard*
Mathematical Sciences, North Dakota State University
Fargo, ND

11. Regression Analysis using Statistical Software Packages
LuAnn K. Johnson*, Barry A. Shull, Alvin K. H. Foo
Human Nutrition Research Center-ARS-USDA
Grand Forks, ND

7. REGRESSION AND CORRELATION

Tom Petros
Department of Psychology, University of North Dakota
Grand Forks, North Dakota 58202

The goal of the scientist is to explain variability observed when measuring a phenomena or a variable. One common approach to this endeavor is to study whether the variable of interest covaries with other variables. One powerful approach to this task is an experiment in which the effect of some independent variable, x, on a dependent variable, y, is being studied. The basic question is how, and to what extent does variability in the dependent variable depend upon manipulations or variations in the independent variable. The purpose of this presentation is to illustrate one approach toward analyzing the degree of covariation present among dependent and independent variables, that is, multiple regression analysis. First, I will discuss a simple regression that attempts to explain variability of a dependent variable using one independent variable. Second, I will discuss the case when several independent variables are used to explain the variability observed in a dependent variable.

When discussing the simple linear regression case, a numerical example will be used to illustrate the components of the regression line and procedures used to estimate them. The relationship between the strength of prediction and each of these components will then be discussed. A brief discussion of how to partition the variability of the dependent variable into predictable variance and error variance will be offered. This will directly lead into a discussion of significance testing with simple linear regression. Finally, a discussion of factors that may influence the accuracy of the prediction will be discussed.

Since the aim of the researcher is to optimize their predictive ability, more than one independent variable is often used to account for the variability observed in the dependent variable. Therefore, procedures for computing the regression line from more than one independent variable will also be presented. Significance tests of the squared multiple correlation coefficient (R^2) and the partial regression coefficients will be presented along with the inferences permissable from such tests. Finally, procedures will be discussed that test whether adding more independent variables increases the amount of variance explained in the dependent variable.

8. VARIABLE SELECTION IN REGRESSION

Dave Smith
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Fargo, North Dakota 58105

The power provided by modern computers has enabled researchers to do rather extensive investigations of regression equations having substantial numbers of predictor variables. In collecting these variables it is not surprising that often a great deal of multicollinearity creeps into the data set. The desire for a more parsimonious model leads the researchers to try to reduce the set of predictor variables without losing a substantial amount of predictive ability.

Over the years many methods have been advocated for reducing the predictor set. These include the older methods such as step-up, step-down, and stepwise as well as more recent methods such as the "SELECT" algorithm due originally to Hocking and Leslie and the "Leaps and Bounds" algorithm of Furnival. There is also the notion of adequate subsets which has been explored by McKay for application in multivariate multiple regression.

A review of the above methods will be given. Characteristics of the methods mentioned above will also be reviewed.

9. TROUBLE SHOOTING DATA

Leigh W. Murray
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The technique of Least Squares estimation is used in multiple regression to give estimates for the model parameters $\beta_0, \beta_1, \ldots, \beta_k$ (where k = number of independent variables). Unfortunately, Least Squares estimates are known to be highly sensitive to problems with the data. Two problems in particular which will be discussed in this paper are (i) influential observations (including "outliers") and (ii) multicollinearity among the independent variables.

The presence of influential observations in a data set can completely change the values of the Least Squares estimates of the model parameters. Many diagnostic statistics have been developed in the past fifteen years to aid in the detection of influential observations. Some of these diagnostics will be examined here and include (i) residuals, (ii) the diagonal elements of the "Hat" matrix, X(X'X) X, (iii) studentized residuals, and (iv) Cook's D statistic. All of these statistics may be obtained through the REG procedure of the Statistical Analysis System (SAS).

The presence of multicollinearity (i.e., high dependencies among the independent variables) can cause inflated parameter estimates and inflated R-squares for the model under consideration. Examination of the simple correlation coefficient, r, can reveal linear dependencies among pairs of independent variables, but can shed no light on relations involving more than two variables. One diagnostic for examining multicollinearity is the variance inflation factor (VIF). In addition, the eigenvalues and eigenvectors of the X'X matrix can be examined. If there is multicollinearity, then one or more of the eigenvalues will be close to zero. Examination of the eigenvector(s) associated with near-zero eigenvalue(s) can give valuable information about dependencies among the independent variables. These two techniques may also be performed through the REG procedure of SAS. Some examples of the use of these diagnostics will be given.

10. ROBUST REGRESSION

Doris M.F. Hertsgaard
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The word "robust" has many - often inconsistent - connotations. In this paper "robustness" signifies insensitivity against small deviations from the assumptions. In many sets of data, there are fairly large percentages of "outliers" due to sampling from populations with heavy tails. These "influential" observations can have a large influence on ordinary "least squares" estimators. Robust methods have been developed to modify least squares so that outliers have less influence.

M-estimators are modifications of least squares estimators which have been shown to be more robust than classical methods. Let $X_1, X_2, \ldots X_n$ be a random sample from a continuous population represented by $f(x-\theta)$, where θ is a location parameter. Maximum likelihood maximizes

$$\ln L(\theta) = \sum_{r=1}^{n} \ln f(x_i-\theta) = \sum_{i=1}^{n} \rho(x_i-\theta),$$

This is equivalent to finding θ such that

$$\sum_{r=1}^{n} \psi(x_i-\theta) = 0$$

where $\psi(x) = \rho'(x) = \frac{d}{dx} \ln f(x) = \frac{f'(x)}{f(x)}$.

Robust M-estimation determines a ψ-function so that the resulting estimator will protect against a small percentage of outliers and at the same time work well if the data are normally distributed. Given the usual linear model

$$y_i = \sum_{j=1}^{p} x_{ij}\theta_j + e_i \ ,$$

The M-estimators of θ_i minimize

$$\sum_{r=1}^{N} \rho(y_i - \sum_{j} x_{ij}\theta_j).$$

This leads to solving the p equations

$$\sum_{r=1}^{n} \psi\left(\frac{y_i - x_i\beta}{s}\right) x_{ij} = 0, \quad j = 1, 2, \ \ldots, p$$

where s is a robust estimate of dispersion, often the median absolute deviation.

Several ψ-functions have been proposed for regression. These robust regression methods are iterative and iteration is continued until a reasonable degree of convergence is reached. The solution $\hat{\beta}$ is found and the final weight given to each observation will indicate outliers.

Hogg (1) and Tukey (2) advise using both a robust and a classical analysis. If they agree, report the classical. If they disagree, take a close look at data and report both.

1. Hogg, R.V. (1979) in Robustness in Statistics (Launer and Wilkinson, eds) pp. 1-18. Academic Press, New York.

2. Tukey, J.W. (1979) in Robustness in Statistics (Launer and Wilkinson, eds) pp. 103-106. Academic Press, New York.

11. REGRESSION ANALYSIS USING STATISTICAL SOFTWARE PACKAGES

LuAnn K. Johnson*, Barry A. Shull, Alvin K.H. Foo
Grand Forks Human Nutrition Research Center
Grand Forks, North Dakota 58202

Regression analysis is a powerful research tool, but without the aid of computers the numerous calculations involved would limit its usage by the average scientist. Writing one's own statistical routines requires the knowledge of both the computational algorithms and a suitable programming language. There are currently several statistical software packages which include routines for regression analysis that are commercially available. Four packages frequently used include the Statistical Analysis System (SAS); the Statistical Package for the Social Sciences (SPSS); the Biomedical Computer Programs (BMDP); and Datatext.

SAS, SPSS, BMDP, and Datatext are independent systems which provide methods for inputting data, performing numeric calculations, and invoking statistical routines. All of these systems will operate in a batch environment on larger computer systems. SAS and SPSS may be run interactively under certain operating systems. BMDP is currently available for microcomputers.

The gasoline mileage data of Hocking (1) will be used to demonstrate the capabilities of the four packages. A multiple regression, stepwise regressions, and various regression diagnostics such as residuals and eigenvalues will be computed using each package. The methods used for inputting data, the ease of usage of the system, the flexibility of the programs, and the clarity with which results are presented will be emphasized. The results of the analyses will be displayed in poster session format so that attendees may study those systems in which they are most interested. A person familiar with each package will be available for questions.

1. Hocking, R.R. (1976) Biometrics. 32, 1-50.

SYMPOSIUM

on

HISTORY OF SCIENCE IN NORTH DAKOTA

Presiding: Franz H. Rathmann
Chemistry Department, North Dakota State University
Fargo, ND

39. History of the North Dakota Academy of Science
Franz H. Rathmann
Chemistry Department, North Dakota State University
Fargo, ND

40. Science and Technology in the Development of Agriculture in North Dakota
H. Roald Lund
College of Agriculture, North Dakota State University, and
North Dakota Agricultural Experiment Station
Fargo, ND

41. Historical Development of Scientific Rangeland Research in North Dakota
Warren C. Whitman
Botany Department, North Dakota State University
Fargo, ND

42. Science and Conservation of Natural Resources
Harvey K. Nelson
U. S. Fish and Wildlife Service
Minneapolis, MN

43. A History of Applied Geology in North Dakota
Don L. Halvorson
North Dakota Geological Survey and
Geology Department, University of North Dakota
Grand Forks, ND

Panel Discussion

39. HISTORY OF THE NORTH DAKOTA ACADEMY OF SCIENCE

Franz H. Rathmann, Professor Emeritus, Chemistry
North Dakota State University, Fargo, ND 58105

The North Dakota Academy of Science was founded by eight persons in Valley City in 1908, celebrated its Silver Anniversary in 1933, its Golden Anniversary in 1958, and is now celebrating its Diamond Jubilee in 1983. For its first fifty years it was strictly a private organization. For its Golden Anniversary, the Legislature of the State declared it to be the Official North Dakota State Academy of Science. Annual meetings were held regularly each year, alternately in Grand Forks and Fargo until 1955. In 1956, the meeting was held at Jamestown College. Since then, about one meeting in three has been held elsewhere; in Minot, Valley City, Dickinson, Bismarck, one in Aberdeen, South Dakota, and one jointly in Fargo and Moorhead. It has been customary to have an outside after-dinner speaker at the annual banquets, a leader in the field well-known beyond the scientific community.

Presidents and Vice-Presidents have been elected annually, the Vice President succeeding to the Presidency. The Secretary-Treasurer and the Delegate to the American Association for the Advancement of Science served longer terms, George Abbott in the former office for forty years, in the latter for sixteen. Membership gradually rose to several hundred, attendance at the annual meetings up to 200. The majority of members of the Academy have always been men, but women were never excluded, and as early as 1916, a woman served as President. The names of officers, terms of service, numbers of members, and of papers presented at the annual meetings will be shown in several tables of data. Papers on research of the members,in the physical and the biological sciences, and the related applied sciences of Agriculture, Pharmacy, Medicine and Engineering were presented. For the first forty years the records of these are to be found only in the minutes in the archives of the Academy. Publication of the Proceedings of the N.D.A.S. began in 1948. Over the next thirty-five years the forms of publication, abstracts, communications prior to, and full papers after, as well as the format, have changed several times. Numerical data on these are shown in several tables of data. The reasons for such changes are discussed by Dr. Richard E. Frank in his Invited Lecture.

Much of the work done by members of the Academy may appear to the layman as abstract and high-brow; most of it lays the foundations for the applied fields, Agriculture, Pharmacy, Medicine, Engineering, Home Economics, Material and Energy Resources, especially as these apply to North Dakota,-rich in natural resources and in agricultural products, but much less developed in industrial production. Many activities of the Academy devoted to special matters of direct practical interest,-National Defense in World Wars I and II, Energy Symposia, coal, oil, Environmental Symposia, etc., are presented in the form of tables of data on slides and as posters. On occasion the Academy has expressed itself on matters pertaining to the integrity of the academic and scientific professions, and on ultimate public interests or against private political or economic exploitation (see Tables). The N.D.A.S. has joined with neighboring Academies of Science, Minnesota in 1976, South Dakota in 1979, in joint programs. It is like some academies limited to the natural sciences; unlike others that include the social sciences and even the liberal arts. It is one of the older state academies, but far younger than the venerable Academies of Science and Arts of Massachusetts and of Connecticut. These relationships are illustrated by several tables and graphs.

Our Academy is a member of the American Association for the Advancement of Science founded in 1848, and of the Association of State and City Academies of Science. It had its own Delegate to the some 500-member Council of the A.A.A.S., but since the latter Council was reduced to some 75 members, our Academy has been represented only through the delegates sent by the Association of State Academies. Our Academy maintains collegial relations, including joint meetings, with various other organizations,-Chemists, Statisticians, Science Teachers, Geographers, Sigma Xi, etc.

Preparation of the next generations is an important function in any social-economic-political structure. Dr. Frank discussed in great philosophic detail the problems of our interest in the next generation; a few tables of numerical data will suffice here. These include our Junior Academy, Science Fair, Talent Search, Denison awards, etc. Financing is vital for any organization. Our Academy and its publications are supported by membership dues, grants from our universities and colleges, special grants such as Denison etc. Several tables of data are given as appendices,-brief sketches of leaders in the Academy, North Dakota scientists on both the local and the national scene, indices of authors of papers and of subject matter of papers for the past fifteen years.

REFERENCES. SOURCES OF INFORMATION: 1) Proceedings of the North Dakota Academy of Science, Volumes I to XXXV. 2) Programs of Meetings 3) a. Minutes of Meetings of the Academy, b. Minutes of the Executive Committee 4) Correspondence of the Secretary. 5) The First Fifty Years, 1958, by George Alonzo Abbott, Proceedings, Vol XII 6) The Next Twenty Five Years, 1983, by Richard E. Frank. 7) History of the Association of State and City Academies of Science, 1976, by Franz H. Rathmann.

40. SCIENCE AND TECHNOLOGY IN THE DEVELOPMENT OF AGRICULTURE IN NORTH DAKOTA

H. Roald Lund
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Fargo, North Dakota 58105

Agriculture is often described as the science and art of producing food and fiber useful to man and animals. In this presentation, the term "agriculture" will refer to the supply and service, production, processing, distribution and marketing sectors which comprise the entire system responsible for food on our table, and fuel and fiber important to our total needs which are dependent upon a renewable resource.

It was not always this easy to identify agriculture and what it means to this state, region, and nation. Prior to 1862, higher education was found in large, essentially private institutions, directed towards study in the basic sciences, fine arts, law, and medicine. The common man, so to speak, did not have easy access to an education or to other institutions needed to develop the technology for the production of food and fiber. This situation was recognized by the Congress of the United States in the mid-1800's. The timing seems strange since we were embroiled in the Civil War. However, the overwhelming needs of the people in this period of our development caused several significant pieces of legislation to be presented to Congress and, ultimately, to President Abraham Lincoln for his signature. Morrill Act of 1862 and Hatch Act of 1887.

The State Constitution of North Dakota, adopted in 1889, established in Article XIX the "Agricultural College at the city of Fargo, in the County of Cass." The first Legislative Assembly of 1890, in Chapter 160 of the Session Laws, established an Agricultural Experiment Station in connection with the Agricultural College.

Collectively, the nine branch stations and the Main Station at Fargo comprise the physical holdings of the Agricultural Experiment Station which total approximately 17,136 acres.

This paper will present examples of how scientists in the basic disciplines integrated their knowledge to bring solutions to the biologically-oriented problems in agriculture; e.g., the genetic involvement of the host and its parasite. Also, the economic and social needs of the complex infrastructure of moving the products from the land to their ultimate use; e.g., transportation and marketing, both domestic and international.

The story of agricultural research at North Dakota State University would not be complete without mention of the significant contribution of the USDA-ARS federal scientists located at the several federal installations in North Dakota; i.e., the Metabolism and Radiation Research Laboratory at Fargo, the Human Nutrition Facility at Grand Forks, and the Northern Great Plains Research Laboratory, Mandan. In addition, there are 18 federally funded USDA-ARS research workers housed in buildings at NDSU, some of which were partially built with federal dollars. I need to repeat again that the federal-state partnership in agricultural research is the envy (and wonder) of the world.

The returns on investment (ROI) in agricultural research are enormous! It is safe to say that the annual increase in income due to the breeding and release of new wheat varieties in North Dakota would pay all the research bills at the Agricultural Experiment Station many times over. That North Dakota leads the nation in the production of hard red spring wheat, durum wheat, barley, oats, rye, sunflower, flax, honey, and sugarbeets (in the Red River Valley) is no accident! Some recent dry seasons have been equated to the dirty 30's in intensity, but improved farming techniques and crop varieties helped to weather these periods without the hardships seen 40 years ago.

We look ahead to exciting new breakthroughs in tillage, animal reproduction, power use on the farms, transportation of farm commodities, and an urban way of life in a rural setting. Rural electrification, telephone, water, mail service, trash collection, and paved roads are common in the country today. Tomorrow could bring even higher yielding crops with fewer inputs of fertilizer, insecticides, and fungicides, if they could be made to produce their own nitrogen, be distasteful to birds and insects, be completely resistant to disease, and suppress weeds that try to grow around them naturally. Sheep that have "litters" of lambs are possible. The recent developments in molecular biology, gene-splicing, etc., indicate that potential exists for the dairy farmer to have only female calves born in his production herd, or predominately males born in a beef or dairy herd to be sold for seedstock. I am personnally very optimistic about the success of the research program in North Dakota in the years ahead.

41. HISTORICAL DEVELOPMENT OF SCIENTIFIC RANGELAND RESEARCH IN NORTH DAKOTA 1/

Warren C. Whitman, Botany Dept., North Dakota State University, Fargo, ND 58105

The first significant scientific study of native range in North Dakota was started in 1915 at the Northern Great Plains Field Station, near Mandan. This project was set up to determine the "carrying capacity of a native range pasture of wild grass...". The individuals most directly involved were Dr. J.H. Shepperd of the N. Dak. Agr. Exp. Stn. and John T. Sarvis, Agronomist at the Mandan Station. The actual grazing trial was carried on under the direction of J. T. Sarvis from 1916 to 1940 and became the classic native range grazing study in the Northern Great Plains. The study contrasted the effects of light, moderate, and heavy grazing on both livestock performance and the native range vegetation. The Mandan Station, now known as the Northern Great Plains Research Center, has been a major center for experimental studies of the native range resource and the development, introduction, and testing of improved grass varieties since its establishment.

The disastrous drought of the 1930's brought greatly increased attention to the value of native and introduced grasses in Great Plains agriculture. The need for more information on grass performance under varying climatic and grazing influences was made dramatically apparent by the huge dust clouds that rolled off cultivated fields in the Northern Great Plains. An important project of the newly formed Soil Conservation Service of the U.S. Dept. of Agric. at this time was the introduction and field trial of numerous grass and legume species at various locations in N. Dak. Many of these small plot seedings were made at the branch stations of the N. Dak. Agric. Exp. Stn.

Crested wheatgrass was one introduced grass, which by the time of the great drought, had been proven unusually well-adapted in the Northern Great Plains. Both J. T. Sarvis at Mandan and Leroy Moomaw, Superintendent of the Dickinson Station, had already made tests of this grass. Following the drought, this grass was extensively used in the revegetation of eroded fields throughout the Northern Plains.

George A. Rogler became part of the professional staff at the Mandan Station in 1935. He was later joined by Russell J. Lorenz. Dr. Rogler and Dr. Lorenz have been exceptionally active and productive research workers carrying on studies mainly centered around the use of fertilizers in increasing range and pasture production. In the earlier phase of his work at Mandan, Dr. Rogler was also responsible for the grass breeding program. Currently, Dr. Reed Barker is in charge of this program and is engaged in an extensive study of ecotypes of blue grama grass and western wheatgrass. In the last few years, studies on the use of native and introduced grasses in the revegetation of mined lands and the grazing utilization of these grasses have been carried out by Drs. R.E. Ries and L. Hofmann of the Mandan Station.

Studies of range vegetation in western North Dakota by the N. Dak. Agric. Exp't. Stn. began in 1932, under the direction of Dr. Herbert C. Hanson. These studies were ecologically oriented. Grazing studies on range vegetation pastures did not begin at the Dickinson Station until 1946, when a cooperative study of the nutritive value of native range forage with special reference to carotene and vitamin A in beef cattle was begun. Grazing trials of combinations of native range and seeded pastures, with and without fertilization were added after 1950. At the same time, numerous other studies relating primarily to range plant growth and production were made at, and in the vicinity of the Dickinson Station by cooperating botanists from the Main Station, especially Dr. W. C. Whitman and Dr. Harold Goetz. Many of these studies were carried on in the Little Missouri National Grasslands under cooperative agreement with the U.S. Forest Service.

Significant studies of tall grass range vegetation have been under way in the Sheyenne National Grasslands in southeastern North Dakota since 1970. Here Dr. W. T. Barker and associates, working cooperatively with the U.S. Forest Service and the Sheyenne Grazing Association, have studied the usefulness of pasture rotation systems and controlled burning in relation to production, grazing utilization and forage quality of the native vegetation.

The lack of adequate areas of range vegetation for grazing trials has long placed serious restrictions on the scope of the trials which could be carried out by the Agric. Exp. Stn. The recent acquisition of two new experimental ranches, one in Kidder County south of Crystal Springs and one in Dunn County near Manning, will do much to make possible the expanded testing of grazing management systems. Drs. W. T. Barker, H. Goetz, Don Kirby, and Lee Manske will cooperate with the Station Superintendents in developing this work.

1/ A list of pertinent literature will be provided by the author.

42. SCIENCE IN CONSERVATION OF NATURAL RESOURCES

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It is difficult to select a specific time in history when the scientific approach was first applied to management of this Nation's natural resources. In the latter part of the Eighteenth Century, Statesmen like Thomas Jefferson, George Washington and Benjamin Franklin, who were also philosophers and scientists, began to express concerns about their environment. They could see the relationship between intensive tobacco farming and soil erosion, for example. Jefferson initiated one of the first scientific investigations of proper timber cutting patterns to maintain soil and water balances. Franklin, in 1753, cautioned against eliminating all blackbirds from corn fields, lest even more damaging insects devour the crops.

The Nineteenth Century brought new interest in natural resource conservation and management, as evidenced by the writings of Audubon, Wilson, Cooper, Catlin and Thoreau. They were generally concerned over the devastation of forests, pollution of streams and eradication of several fish and wildlife species, such as the bison, the passenger pigeon and stream trout.

Early scientific methodology was most evident in forestry and agricultural programs, largely because of the economic incentives involved. Fisheries came into the limelight in the 1860's via the fish culturist route, which led to the establishment of the national fisheries organizations and agencies that exist today. Scientific applications in wildlife management were slower in coming for a variety of reasons which are discussed.

Science in fish and wildlife management evolved through the understanding and application of zoological principles such as the theory of evolution, classification systems, genetics and molecular biology. The increasing relationships between the field of human medical sciences and subsequent application to lower life forms helped bridge the gap. Some of the earliest advances were in the fields of entomology and botany, the forerunners of present day understanding of ecological principles. While aquaculture opened the way to applied science in fisheries research and management, game breeding opened the doors to present day wildlife management philosophy.

One could cast the Twentieth Century in a series of progressive steps. The scientific cornerstones for fish and wildlife management were laid during the drouth period of the 1930's, when many state and federal programs were initiated to protect the Nation's lands and waters. Numerous farm, forestry and watershed protection programs were launched, among which was the Civilian Conservation Corps. The latter helped develop a strong base for future management of the timber resources, watersheds and fish and wildlife resources of this country.

Out of that era came a more orderly scientific approach to fish and wildlife management. Major universities began to modify zoology and biology curricula to emphasize specialty undergraduate and graduate degree programs that related directly to fish and wildlife management. Among others, Dr. Aldo Leopold at the University of Wisconsin and Dr. Gustav Swanson at the University of Minnesota came forth to establish some of the best early wildlife training programs. Dr. Leopold is considered to be the "Father of Scientific Game Management" in the United States. These scientists and many others worked hard to instill ecological principles in a surge of new students that entered the fish and wildlife profession following World War II.

Since that time, we in the fish and wildlife business have gone through a series of events ranging from the large-scale habitat preservation programs of the 1930's - 1950's; the big water development projects of that era; the major wetland preservation thrust of the 1960's - 1970's, which is continuing; the environmental era of the 1970's, beginning with "Earth Day," April 22, 1970; the Endangered Species Act of 1969 and amended in 1973; and the National Environmental Protection Act of 1969. This led to a gradual trend toward more balanced research and management efforts in the 1980's. More recently, space age technology has led to greater sophistication in fish and wildlife research and management. This transition dictated that fish and wildlife scientists and managers learn how to manage resources more efficiently and effectively for the benefit of the species, their habitats and the American public.

Wildlife management is largely land management and people management. Fisheries management is a combination of habitat management, maintenance of water quality and people management. Intertwined are a host of biological, sociological, economic and political problems which must be identified and resolved.

43. A HISTORY OF APPLIED GEOLOGY IN NORTH DAKOTA

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Geology, like other scientific disciplines, has both a theoretical and an applied aspect. The two aspects, of course, are closely related and often merge with the passage of time. Changes in geologic research in the state of North Dakota are primarily a function of practical needs and economics. A procedure for applied research in the state was first outlined in 1902 by Dr. Frank Wilder, the University of North Dakota's first professional geologist. His proposal specified first, preliminary surveys; second, detailed studies by county; and finally, exhaustive topical papers.

The earliest recorded geologic observations in North Dakota are from the journals of Capt. Meriwether Lewis. He described strata along the Missouri River and its tributaries and observed scoria beds in the western part of the state. He also noted various lignite deposits and experimented with lignite combustion, using it for the blacksmithing services which were traded to the Native Americans for food supplies. Geologic work done throughout the 1800s involved rough mapping and basic inventorying of natural resources. Paleontological and stratigraphic data more esoteric and academic in nature was also collected, which later led to theoretical explanations of stratigraphic and topographic features. Significant paleontological work was accomplished by Dr. Ferdinand Hayden. Starting in the 1850s, Hayden organized a series of exploratory expeditions throughout the Northern Plains. These expeditions originated in North Dakota and resulted in the first definitive knowledge of North Dakota lignites. Hayden's glowing reports on the potential of the Northern Plains effected a change of attitude concerning western development on the part of the federal government and eastern financial centers, and sparked westward expansion.

In 1899, the North Dakota Legislature mandated that a complete account of all the mineral resources of the state be made, including geological strata and richness in ores, water, and other useful materials, for the purpose of determining their economic value and accessibility. The next 50 years were devoted to studying the state of North Dakota in detail and observing all available resources: water, coal, oil and gas, ores, clays, sand and gravel, cement, and salines. Both Professor E. J. Babcock, the first director of the School of Mines which was established at the University of North Dakota in 1897, and Dr. Arthur Leonard, who was State Geologist for 30 years, contributed significant leadership in this extensive survey. This work represents the first phase of Dr. Wilder's 3-point plan.

Ever since North Dakota became a state, lignite has been considered one of the state's main sources of economic independence. It should be noted, however, that natural gas was discovered in North Dakota prior to 1910. After nearly 50 years of searching for economic petroleum reserves, the state's first oil well was completed in April 1951. The discovery of oil in western North Dakota initiated serious subsurface studies and added a whole new dimension to geologic research in the state. In the 1960s a cooperative program was established by the United States Geological Survey, the North Dakota Geological Survey, and the State Water Commission to do complete geologic and groundwater studies for each county in the state. Also during this period, many state researchers received national acclaim for their work in glacial geology.

Research in the 1970s and 1980s is dominated by environmental concerns. New problems for applied geology arose in the areas of waste management, groundwater contamination, and water resources. The careful inventories and seemingly esoteric information collected throughout the years is now providing a data base for attacking and solving these problems. Applied research in North Dakota has proceeded to the third phase of Dr. Wilder's strategy. From this point research will concentrate more completely on detailed studies of stratigraphic frameworks, geotechnical data, and land-use planning, which will provide information necessary for planning urban development, for the location of roads, pipelines, and transmission lines, and the suitability of areas for landfills, lagoons, and hazardous waste sites.

One of the hallmarks of geological research in North Dakota has always been the researcher's ability to look ahead, to anticipate a problem, and to have the necessary data available when the problem arises. This ability demonstrates the balance between theoretical and applied research.

SYMPOSIUM

on

SCIENCE EDUCATION: AN EMERGING CRISIS

Presiding: L. Elliot Shubert
Biology Department, University of North Dakota
Grand Forks, ND

44. Growing Recognition of a Serious National Problem in Science Education
M. Joan Parent*
National Science Board Commission on Pre-College Education in Mathematics, Science and Technology
Washington, DC

45. The Science Education Debate in Congress
Douglas R. W. Norell*
Senior Legislative Assistant to Representative Dorgan
Washington, DC

46. Science Curriculum: From Sputnik to the Toyota
Vito Perrone*
Center for Teaching and Learning, University of North Dakota
Grand Forks, ND

47. Science Education: Trends in North Dakota
D. R. Scoby*
Botany/Biology Department, North Dakota State University
Fargo, ND

48. The Rise and Fall of Twenty-five Years of Science Education: 1957-1982
Clarence E. Thompson*
Science Department, Central High School
Grand Forks, ND

44. GROWING RECOGNITION OF A SERIOUS NATIONAL PROBLEM IN SCIENCE EDUCATION

M. Joan Parent
National Science Board Commission on Pre-College
Education in Mathematics, Science and Technology
Washington, DC 20550

Over the last year we have seen rising concern about the quality of mathematics and science education in our schools. A teacher shortage in these fields that has reached crisis proportions, a declining student interest in math and science together with declining achievement scores over the last decade, are causing many sectors of society to stop and take notice. Business and the military commonly report that new employees and recruits are unqualified for a broad range of increasingly technical jobs. Colleges and universities report that undergraduate remedial mathematics enrollment has skyrocketed. Schools report they can not find qualified teachers for even today's minimal science and math curriculum, and there are fewer teachers in the pipeline than a year ago.

What are the implications of this? What can we do about it? The National Science Board Commission on Pre-College Education in Mathematics, Science and Technology was established specifically to look at this problem and is now working on its recommendations.

45. THE SCIENCE EDUCATION DEBATE IN CONGRESS

Douglas R. W. Norell*
Senior Legislative Assistant to Rep. Dorgan
Washington, DC 20515

A national debate about the status of science education has gripped educators, students, and elected officials alike. A wider debate in the general public is also evident. Although science education in its broadest sense could include the social sciences, most of the debate in Congress revolves around the physical sciences and mathematics.

In this convocation, one confronts the question of whether there is a crisis in science education. Crisis usually refers to the "decisive state of things." In medicine, for example, it may mean the period that determines the life or death of the patient. In politics, it conjures the memory of something like the "Cuban Missile Crisis" -- a time when the nation's very survival hung in the balance.

For the sake of discussion, one might say that no such life or death drama is at stake in science education. Every day, millions of students pour into science classrooms to learn the application of the scientific method and to master the refined knowledge of various scientific fields. Some would say that all is well and that critics of science education are "crisis mongers."

To test the proposition, one can survey the performance of the nation's students, its schools, its economic standing, and its national security. In other words, does this nation train its students well enough in science and mathematics to insure the national welfare and survival?

Measures of science education include: performance on standardized tests; availability of enough qualified science teachers, scientists, and engineers; quality and quantity of science and math curricula; the technical literacy of the U.S. population; and levels of funding for science programs.

Applying these criteria shows that a serious national debate about science education makes sense. A wider analysis of the declining position of the U.S. economy and the growing challenges to national security reinforces this view. Whether the state or federal government can best meet this challenge remains a matter of debate itself.

Congress has already begun to consider a variety of options to bolster science education at the pre-college, college, and graduate levels. Many responses recall the congressional reaction to the launching of Sputnik in October of 1957. These options include: (1) commissions on science education, (2) loans for science teacher education, (3) grants to states for improving the quality of science and math instruction, (4) National Science Foundation programs, and (5) tax credits for business to provide jobs or equipment that strengthen science education.

Prospects for enacting any or a combination of the above proposals will depend on the extent of public concern, the ability of education interest groups to reach a consensus, and the willingness of Congress and the executive branch to agree on a workable national program of science education.

It seems likely at this time that the 98th Congress will enact laws to aid the states in upgrading science education and to continue federal support for the National Science Foundation as a source of fellowships and teacher improvement programs. It appears less likely that Congress will expand loan forgiveness programs for science education.

(Note: all views expressed in this summary or the oral presentation are those of the speaker alone.)

46. SCIENCE CURRICULUM: FROM SPUTNIK TO THE TOYOTA

Vito Perrone*
Center for Teaching and Learning
University of North Dakota
Grand Forks, North Dakota 58202

In the decade of educational crisis which followed Sputnik there was a resurgence of interest in elementary and secondary school science curricula. Prominent university scholars joined classroom teachers in producing a wide assortment of interesting, experientially-based, inquiry-oriented science materials. To assist classroom teachers in implementing the new materials as well as enlarge their science backgrounds, Science Teaching Institutes emerged at a significant number of the nation's colleges and universities. What was called a "revolution" in science education was, however, short-lived; by the early seventies, such programs as the Elementary Science Study (ESS), Science Curriculum Improvement Study (SCIS), Science, a Process Approach (SAPA), the Chemical Bond Approach (CBA), Chem Study (ChemS), the Biological Science Curriculum Study (BSCS), and the Physical Science Curriculum Study (PSCS) were declining rapidly in their popularity. A major study conducted in 1977 for the National Science Foundation by Robert Stake reported that the 1960's curriculum materials were hardly in use in the nation's schools. The strong college-university ties to schools that had been a cornerstone of the science education revolution seemed non-existent by the mid-1970's, a victim of the rapid decline in NSF education related funds.

Science education in the schools has once again reached a time of crisis. Interest among students is slight, school enrollments in science courses are low, and inquiry-oriented programs appear not to be encouraged. The technological emergence of Japan, France, and West Germany coupled with a declining sense of confidence in our technological capacity, has created again, as was the case in 1957 with the Soviet Sputnik, a climate for re-examining our national commitment to science education in the schools. But 1983 is not 1957! The difficulties in bringing about school reform, regardless of the particular area upon which one wishes to focus, have always been large; however, they may well be greater today than they have been at any time in the twentieth century. Advocates of a new revolution in science education are likely to find obstacles that didn't exist in 1957; the overall decline in support for public education and the significant demoralization which exists among teachers are examples. While some of the strategies that brought some early success in the post-Sputnik period may yield some positive short-term results in this "post-Toyota" period, most of the post-Sputnik strategies are likely to yield little. This is not to suggest that educational reform in general or reform in science education more specifically cannot be brought about. There is a need, however, for a fresh willingness on the part of advocates to engage this time around in a slower process over a much longer period of time and in the process involve those in the schools much more intensively.

47. SCIENCE EDUCATION: TRENDS IN NORTH DAKOTA

D. R. Scoby*
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Fargo, N.D. 58105

Science and Math teacher shortages are now becoming a news item. However, the trend away from teaching has been developing over the past ten years. Shortages, nationwide and in North Dakota, are particularly evident in chemistry, physics, and mathematics.

The N.D. data supporting this trend is given in Table I. As an indication of a possible break in the declining trend the enrollment in my Methods of Teaching Science has the following recent six year pattern: 10,9,7,2,4,9.

Table I

Science Education Majors 1972-1982

	71-72	72-73	73-74	74-75	75-76	76-77	77-78	78-79	79-80	80-81	81-82	Totals
NDSU												
Biology	10	11	2	6	2	3	6	5	3	1	3	52
Composite Science	0	0	0	0	0	1	4	1	2	3	0	11
Chemistry/Physics	1	2	1	1	1	0	1	0	0	0	0	7
Math	7	6	6	3	3	2	5	4	2	0	4	42
Jamestown College												
Biology	0	0	0	0	0	0	3	1	0	0	1	5
Composite Science	0	0	0	0	0	0	0	0	0	0	0	0
Chemistry/Physics	0	0	0	0	0	0	0	1	1	0	0	2
Math	0	0	0	0	0	0	0	1	2	1	0	4
Valley City State												
Biology	-	11	10	4	18	3	9	10	4	2	4	75
Composite Science	-	16	0	0	0	0	0	3	5	3	1	28
Chemistry/Physics	-	4	3	1	3	1	1	2	1	2	1	19
Math	-	0	10	4	10	4	5	6	4	6	5	54
Dickinson State												
Biology	13	4	8	8	3	3	3	3	3	5	2	55
Composite Science	9	2	2	0	2	0	1	0	0	0	1	17
Chemistry/Physics	1	2	3	3	1	3	1	0	1	0	0	15
Math	20	15	18	6	8	9	5	11	4	0	4	100
Minot State												
Biology	7	5	8	13	2	5	2	4	0	1	2	49
Composite Science	2	8	8	8	0	3	1	5	2	2	2	41
Chemistry/Physics	1	2	4	8	0	0	0	0	0	0	0	15
Math	18	12	21	17	4	3	2	1	3	3	1	85
Mayville State												
Biology	-	2	5	1	3	1	6	1	2	6	0	27
Composite Science		6	6	2	4	2	4	2	4	2	1	33
Chemistry/Physics		0	0	0	0	0	0	0	0	0	0	0
Math	-	18	20	9	9	8	7	3	5	3	1	83
UND												
Biology	-	8	5	6	4	4	6	6	6	8	4	57
Composite Science	-	-	-	-	-	-	-	-	-	-	-	-
Chemistry/Physics	-	6	3	3	2	2	2	2	3	3	3	29
Math	-	11	9	12	7	7	5	6	9	3	7	75
Totals												
Biology	-	41	38	38	32	19	35	30	18	23	16	290
Composite Science	-	32	16	10	6	6	10	11	13	10	5	119
Chemistry/Physics	-	16	14	16	7	6	5	5	6	5	4	84
Math	-	62	84	51	41	33	29	32	29	16	22	398

Information to be presented at the symposium will include experiences in teaching a science methods course at NDSU over the last 14 years, a declining emphasis of science courses for the non-major, and perceived solutions to the present problem.

48. THE RISE AND FALL OF TWENTY-FIVE YEARS OF SCIENCE EDUCATION: 1957-1982

Clarence E. Thompson*
Science Department, Central High School
Grand Forks, ND 58201

Twenty-five years ago the United States, upon the emergence of Sputnik, took on an order for more emphasis on science education. That the American educational system filled the order was unquestioned.

The National Science Foundation gave the needed impetus to raise the competency of teaching. And science education received the necessary support from the public sector.

Teachers, former teachers, and students from high schools and universities have some engaging responses to the trends of twenty-five years: interest of students pursuing scientific careers, teacher training, erosion of faculty to other professions, declining test scores over the past ten years, science avoidance by students in high school and colleges, warnings against crash courses to improve teacher qualifications. The emotional demands of teaching take their toll; the teacher realizes that the intellectual challenge is inadequate at the secondary level. Lowering admission requirements in science at the post-secondary level and the attendant grade inflation has resulted in competency being driven backwards.

The current status, locally and nationally, will be presented. For example, the role of the North Dakota Academy of Science with its Junior Academy involvement in North Dakota, and the incentives for scholarships will be presented.

In conclusion, the state of science education in our country will be considered from the conditions of today with an optimistic look to the future.

SYMPOSIUM

on

INNOVATIONS IN GEOGRAPHIC INFORMATION SYSTEMS FOR DEVELOPMENT PLANNING

Presiding: Douglas C. Munski
Geography Department, University of North Dakota
Grand Forks, ND

49. Satellite Meteorology: A Tool for Agricultural Weather Assessment/Impact Statements
William A. Dando*
Geography Department, University of North Dakota
Grand Forks, ND

50. Rural Development Land Use Planning in Enga Province, Papua New Guinea
G. A. J. Scott*
Geography Department, University of Winnipeg
Winnipeg, Manitoba, Canada

51. Use of Digital Techniques for Detecting Erosion in the Vicinity of the Embalse De Tomine, Colombia
Myrian Ardila T.* and Roland D. Mower
Institute for Remote Sensing, University of North Dakota
Grand Forks, ND

52. Land Use Impact Analysis of the Thompson Area, Manitoba
S. A. Hathout* and D. V. Hildebrand
Geography Department, University of Winnipeg
Winnipeg, Manitoba, Canada

53. Development Planning: Curriculum Alternatives for Geographers
D. C. Munski*
Geography Department, University of North Dakota
Grand Forks, ND

49.

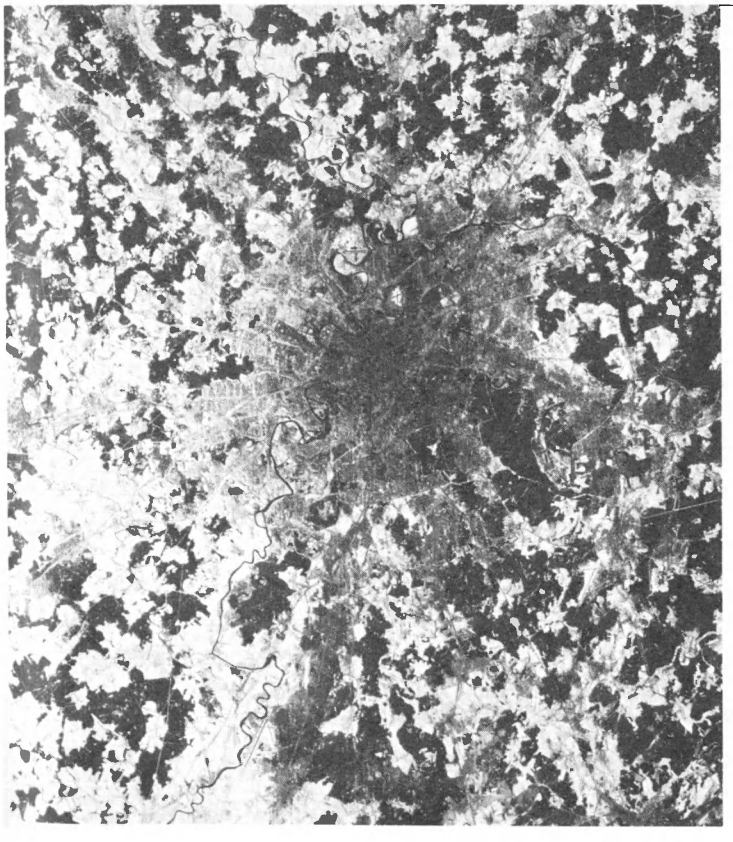
SATELLITE METEOROLOGY: A TOOL FOR AGRICULTURAL WEATHER ASSESSMENT/IMPACT STATEMENTS

William A. Dando*
Geography Department, University of North Dakota
Grand Forks, N.D. 58202

Employing satellite meteorology, a new field merging aspects of remote sensing and meteorological techniques, weather influencing crop production can be assessed from satellites orbiting some 940 kilometers above the earth's surface. Crop weather assessment and impact statements synthesized from satellite gathered data include: 1) early warning of environmental changes, hazards, and plant stress affecting agricultural production and quality; 2) agricultural land use measurements and land use classification; 3) area sown to specific types of crops; 4) harvest progress and production estimates; 5) soil and soil moisture conservation practices, and soil loss assessment; 6) pollution detection and impact evaluation of pollution upon economically significant rural activities; 7) farm-market transportation facilities and condition of infrastructure; and 8) estimate of storage capacity (specifically in centrally planned societies).

Early warning, nowcasting and weather impact statements are dependent upon data gathered by NASA's remote sensing workhorse--Landsat. Each Landsat satellite scans critical food producing areas of the earth once every eighteen days, gleaning information at one sweep from about 34,000 square kilometers. A multispectral scanner gathers digital measurements of variations in electromagnetic radiation from the earth's surface. The resulting electromagnetic images are transmitted to ground stations for visual (see map) or computer analysis. Accuracy of agricultural weather assessment and weather impact is good, 90/90 accuracy at the regional level or within ten percent of the site generated data ninety percent of the time. With grain output from one out of every three acres in the United States now dependent upon export markets, the benefit to American agriculture, to other food importing nations, and to world hunger programs and famine aid is significant.

LANDSAT SCENE OF MOSCOW, OCTOBER 14, 1976



A series of poor wheat harvests in the Soviet Union led party leader L. Brezhnev to demand collective and state farm employees to exceed the 1976 production figures in 1977. Of great concern to Brezhnev and state planners, was the prospect of a poor agricultural year in areas surrounding major urban centers. Moscow, the capital and largest city of the USSR, is located in a food deficit region (1). Although favorable winter wheat sowing weather permitted the wheat to emerge and tiller on agricultural units in the Moscow Region before cessation of growth in early October 1976, light snow cover and unusually cold weather in late October and November "winter-killed" a high percentage of winter wheat plants. October precipitation within the winter wheat growing region around Moscow averaged 55 mm, 128 percent of norm, and the deviation from normal temperatures was -6°C; early October precipitation was in the form of rain and not an insulating blanket of snow. December growthweather, heavy snow combined with seasonable temperatures, induced no further loss of wheat stands but winter wheat production in 1977 was reduced sizably by lack of snow cover in October 1976. The Landsat October 14, 1976, scene of the Moscow Region, using a combination of video and digital techniques, permitted members of the University of North Dakota Institute of Remote Sensing to make normally time-consuming evaluations and mapping the same day the information was received.

1. Dando, William A. (1975) "The Moscow City Region: Land Development Trends in an Expanding Socialist City", The Middle Atlantic, Vol. 6, No. 4, 18-32.

50. RURAL DEVELOPMENT LAND USE PLANNING IN ENGA PROVINCE, PAPUA NEW GUINEA

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Since independence in 1975 Papua New Guinea has made concerted efforts to provide for internal regional development. A number of provinces, including Enga, currently are developing long range plans for development which, as a prerequisite, first require the compilation and evaluation of large amounts of original environmental and social data. Most Engans are sweet potato subsistence farmers; population densities are generally low except in the upper Lai valley. In Enga the major landform elements follow a northwest-to-southeast trend thereby limiting contact with coastal areas outside the province. Bedrock consists primarily of sedimentry facies with the eastern two-thirds of the Province covered by thick layers of Late Cenozoic volcanic ash. The landscape is deeply dissected and elevation ranges from 200-3,800 meters above sea level. Dissection produces steep valley sides where exposed soils are quite vulnerable to erosion. Precipitation exceeds 2,000 mm per year in all areas with no marked dry season being apparent. In spite of human acitivity much of the Province remains covered by lower montane and montane forests. Some large swamps occupy poorly drained valley floors while alpine grasslands can occasionally be found above 3,200 meters. Soils are generally acid, have low base saturations, and reflect soil forming factors in their distribution.

At independence little published data of the type useful for land use planning were available. While some useful CSIRO reports were prepared (1, 2) the Enga Province Rural Development Study group proceeded to produce detailed studies, some of which have been published (3, 4, 5). Land use planning for the Province is now proceeding on the basis of this work. Information systems used in this specific study on land use planning and land potential included: 1) the evaluation of vegetation cover and current land use using Landsat imagery; 2) the synthesis and upgrading of the CSIRO data (1, 2); and 3) and the incorporation of information provided in unpublished form by the Enga Rural Development Study group. Extensive field studies on soil fertility and potential for agriculture were also performed by the author.

It is concluded that a number of land use-land development strategies exist which if followed should allow for a slow but sustained and orderly development of this relatively isolated highlands province. These strategies include the necessity for highland-lowland interaction, the better use of the derived Miscanthus grasslands, the development of a livestock industry for local protein supplies and the expansion of agricultural production through the use of commercial fertilizers and perhaps lime. The strategies must require a parallel improvement in internal transportation networks, the development of outside markets for agricultural and lumber products, disease control particularly at lower elevations (3), the introduction and field testing of exotic crop types and less of a dependence on the traditional use of pigs as ceremonial offerings when they could instead become part of a more balanced diet (4). It was also concluded that some regions would greatly benefit from the introduction of soil conservation techniques while others easily could sustain greater use. In this latter context problems associated with traditional land use practices and tribal customs would have to be given special consideration. The author has produced an Enga Forestry Potential map (5) which summarizes land potential for agriculture and forestry in the province.

1. Perry, R.A., et al. (1965) General Report of the Lands of the Wabag-Tari Area, Territory of Papua and New Guinea, 1960-61, CSIRO Land Research Series No. 15.

2. Bleeker, P., et al. (1975) Explanatory Notes to the Land Limitation and Agricultural Land Use Potential Map of Papua New Guinea, CSIRO Land Research Series No. 36.

3. Pain, C.F. and Scott, G.A.J. (1981) Mtn. Res. & Dev. 1, 71-78.

4. Scott, G.A.J. and Pain, C.F. (1982) in The Enga: Foundations for Development, (Carrad, B., Lea, D.A.M., and Talyaga, K.K., eds.), (in press). University of New England Press, Armidale, New South Wales, Australia.

5. Scott, G.A.J. (1980) "Enga Forestry Potential" (end map) in Enga Yaaka Lasemana, Vol. 4 Enga Resource Atlas. Department of Primary Industry, Waiganai, Papua New Guinea.

51. USE OF DIGITAL TECHNIQUES FOR DETECTING EROSION IN THE VICINITY OF THE EMBALSE DE TOMINE, COLOMBIA

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Soil erosion has been identified by the Colombian government as one of its principal national problems. Recognition of the need to locate, classify, and monitor soil erosion has resulted in strong support for the development of remote sensing techniques. This study focuses upon the use of a small interactive microcomputer system for the analysis of Landsat digital data acquired in January 1977 for a region located approximately 50 kilometers northeast of Bogota (Scene No. E 2716 14184). The Embalse de Tomine region has been severely eroded during the past 80 years, and today its potential for more forms of agriculture has been significantly reduced (1,2). This study located, classified, and mapped erosion in the vicinity of the Tomine reservoir region (Figure 1).

For this analysis, Landsat digital data for the study area were entered into the University of North Dakota IBM 4341 computer from a computer compatible tape (CCT). The CCT is a standard 1600BPI magnetic tape product obtained from the EROS Data Center. Digital scene data were then transferred from the main-frame computer to the IMPAC interactive microcomputer where it was stored on floppy disk. The study area consists of approximately 7,300 hectares (18,000 acres), which could be presented on the IMPAC CRT display as an area of 126 by 126 pixels. Training and classification of data were accomplished using essentially standard IMPAC procedures. Selection of training pixels was done using only Band 5 data. Band ratioing (Bands 5/7) was performed to improve the discrimination of water surfaces. All four Landsat bands and data were compared with ground truth data acquired from Colombia field teams and found to be quite accurate. The distribution of erosion within the study region is shown in Figure 2. Approximately 870 hectares (2,150 acres) within the study area can be classified as severely eroded land.

Figure 1. Regional View

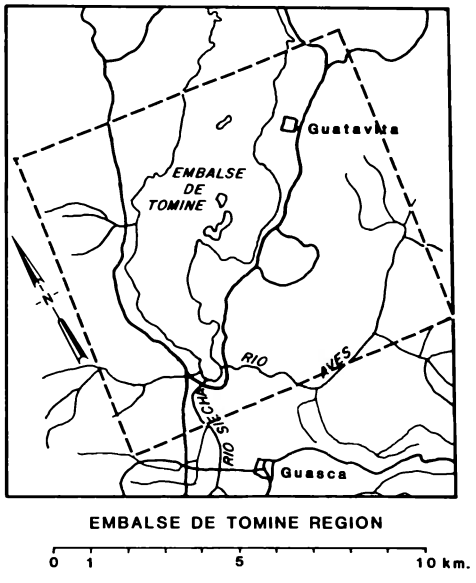
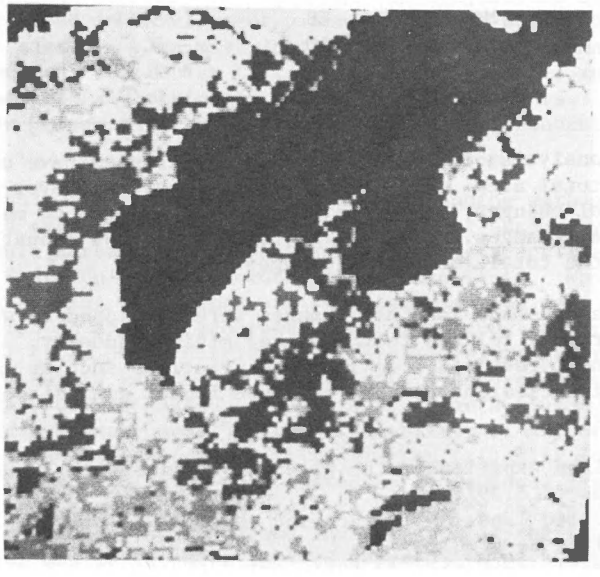


Figure 2. Regional Erosion



1. Forero, C. R., Leon, J. C., Gaona, S., and Jaramillo, D. (1981) Metodologia para la Delimiticion de Areas Homogeneas, CIAF, Bogota.

2. Botero, P. J. (1972) Soils of Guasca-Guatavita (Colombia), ITC, Enschede, The Netherlands.

3. Egbert, D. D. (1980) IMPAC Users Manual, Greenport, N.Y.

52. LAND USE IMPACT ANALYSIS OF THE THOMPSON AREA, MANITOBA

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Winnipeg, Manitoba R3B 2E9

Thompson is a single-resource based center in central Manitoba, located approximately 400 miles north of Winnipeg in the Canadian Shield. Nickel mining, Thompson's only major economic activity since 1963, has had major consequences on the human and physical environment. Pearson and Cushy (1) and Kuz (2) have investigated extensively the impacts of the industry on the human environment.

This paper deals with damage to the physical environment resulting from nickel mining. The impact is assessed in terms of the total land change from natural to man-made land cover. Two sets of aerial photographs covering the Thompson area (22,425 HA), one taken in 1951 at scale of 1:32,000 and a second one taken in 1972 at scale of 1:24,000, were used to compile two land use/land cover maps.

Six land use/land cover categories and six sub-categories (Table 1) were identified by using the standard photointerpretation technique supplemented by ground truth. Each land use/land cover map unit was measured by simple planimetric measurement. The results of the identification and the measurement of land use/land cover of the Thompson area are illustrated below.

Table 1

Measured Changes in Land Use/Land Cover Between 1951 and 1972

Types	Natural Area in HA, 1972	1951-1972 Land Cover Changes in %	Types	Man-Made Land Cover Area in HA, 1972	1951-1972 Land Cover Changes in %
Forest	141	- 5.63	Res./Comm.	591	+23.56
Wetland	1002	-39.94	Industrial	230	+ 9.16
Meadow	88	3.51	Deforestation	160	+ 6.36
River	10	- 0.41	Waste dumping	96	+ 3.83
Lakes	135	+ 5.39	Transportation	34	+ 1.35
Barren	1	- 0.04	Man-made lakes	20	+ 0.81

The analysis of this table shows that changes have occurred on a total area of 2,508 HA or 13.90% of the total area. Conversion from one natural cover type to another occupied 480 HA or 2.49% of the total changes, while conversion from natural to man-made cover occupied 2,058 HA or 11.41% of the total changes. Residential, commercial and industrial land uses represent together 828 HA or 33% of the total land cover changes.

These man-made land use changes were developed on wetland and forested areas and were all directly or indirectly related to the nickel mining industry. Seriously damaging effects to the physical environment resulted from land use practices such as waste dumping, flooding, deforestation and vegetation clearances. The land use impact analysis of the Thompson area can be summarized as follows:

1. Wetland experienced the greatest decline with 39.94%, while there was an increase in the lake areas of 5.39%.
2. Forested land, which occupied the largest area in 1951 (14,111 HA), has experienced a modest decline of 5.63%.
3. A small percentage (2.49%) of land conversion from one natural cover type to another was measured.
4. Residential and commerical areas together made up the largest percentage of the total cover change: twice as much as industrial land cover--and five times as much as waste dumping grounds.
5. The flooded land area declined since 1951 to approximately less than half the area occupied prior to this date. Most of these declines were due to conversions to wetland, resulting from poor drainage systems and sedimentation.

1. Pearson, D., and J. Cushing (1975) City of Thompson Housing Study. Municipal Planning Branch, Thompson.

2. Kuz, T.J. (1976) Thompson: Structural and Behavioral Analysis. Municipal Planning Branch, Thompson.

53. DEVELOPMENT PLANNING: CURRICULUM ALTERNATIVES FOR GEOGRAPHERS

D. C. Munski*
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Geographers should be training for the future. That future is one that will continue to emphasize development planning using up-to-date techniques of geographic research. It will be an environment that demands today's undergraduate in geography become a specialist in geographic information systems if he/she wants employment as a land use planner, retail market analyst, health care delivery analyst, or any type of professional geographer having a career in applied geography. Consequently, it is the responsibility of geographers at colleges and universities to create curriculum in geographic information systems studies. Specifically, curriculum that enhances a student's competence for entering the highly competitive world of applied geography that currently puts a high priority upon geographical research and techniques for development planning, be it in a North American metropolitan center or a Third World agricultural district or anywhere else that professional geographers are called to as a resource planner (1).

Traditionally in geography programs, development planning has focused upon land use management, along with city and regional planning. However, environmental problems both in the Western World and and Third World have attracted the concern of geographers. Seeking solutions to physical-cultural problems, e.g., desertification, has enlarged the scope of development planning and made it a key aspect of applied geography. Increasingly, complex physical-cultural problems require data gathering through remote sensing techniques and analysis through computer graphics. Thus development planning has not only become a broader subdivision within geographic research and applications, it has become a sub-field of geography that is intimately connected with geographic information systems studies.

Education in cartography and remote sensing for applied geography has expanded rapidly over the past thirty-five years (2). This reflects the theme of curriculum development, particularly within North American geography programs, that "it is essential now to train professional and highly specialized workers--urban, rural, and regional planners--who go beyond understanding to actually creating the environments of the future (3)." Thus, technique-related courses must be taught in conjunction with policy-related courses. This means geographers trained in development planning must be well-grounded in information systems management studies. Their academic plan must integrate existing programs that are strong in social geography and political science--a curriculum that is current, flexible, relevant, and fuses with the geographic approach for improving local, regional, and global environments. Increasingly, students need to take a world-oriented perspective to problems of our interdependent planet (4).

Creation of a curriculum in applied geography that focuses upon developmental planning with geographic information systems studies as its base is relatively new, although models for such programs can be taken from the University of California-Santa Barbara, KARS (University of Kansas Applications in Remote Sensing Project), and the South Dakota State University Remote Sensing Institute. While all these model programs emphasize interfacing remote sensing techniques and computer graphics into a geographic information systems studies or concentration in applied geography, each geography curriculum reflects institutional differences. Consequently, creation of curriculum alternatives for geographers in development planning at the University of North Dakota has focused upon a "track" approach; each track emphasizing a particular strength of geography offerings and coursework in cognate fields. Unique to the University of North Dakota's applied geography model is the availability of supporting work in meteorology/climatology (for studying ways to ameliorate drought), aviation (piloting as a skill for emergency work in air photo data collection), and rural policy studies (a regional planning emphasis not found at most institutions). Each student's program is "tailored" to meet the interests of the individual. Special emphasis is given to helping students become involved in international programs, e.g., Colombian coal development studies, and to becoming applied geographers with a global perspective.

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SYMPOSIUM

on

WASTE DISPOSAL AND GROUNDWATER CONTAMINATION IN NORTH DAKOTA

Presiding: Alan Kehew
Department of Geology, University of North Dakota
Grand Forks, ND
and
Gerald Groenewold
North Dakota Geological Survey
Grand Forks, ND

79. Hydrogeologic and Hydrogeochemical Considerations in the Design of Thermoelectric Solid Waste Disposal Sites in Surface Mines
Gerald H. Groenewold* and Daniel Daly
North Dakota Geological Survey and Engineering Experiment Station
Grand Forks, ND

80. Chemical and Biological Characterizations of Solid Wastes from Synthetic Fuels Facilities
Ronald D. Neufeld*
Civil Engineering Department, University of Pittsburgh
Pittsburgh, PA

81. The Effect of Oil-and-Gas Well Drilling Fluids on Shallow Groundwater in Western North Dakota
Edward C. Murphy*
Geology Department, University of North Dakota and
North Dakota Geological Survey
Grand Forks, ND

82. Groundwater Pollution Potential of Municipal Waste Disposal Sites in North Dakota
Alan E. Kehew* and John Betcher
Geology Department, University of North Dakota
Grand Forks, ND

83. Groundwater Contamination from the McVille Waste Stabilization Ponds
David J. Brown*
Geology Department, University of North Dakota
Grand Forks, ND

79. HYDROGEOLOGIC AND HYDROGEOCHEMICAL CONSIDERATIONS IN THE DESIGN OF THERMOELECTRIC SOLID WASTE DISPOSAL SITES IN SURFACE MINES

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and
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Clean air legislation has mandated the reduction of particulate and sulfur dioxide emissions to the atmosphere from thermoelectric facilities. As a consequence, fly ash and flue gas desulfurization waste accumulate at the power plant forming a large volume of waste that must undergo disposal in an environmentally safe manner.

Surface mine disposal can offer a sensible alternative to costly construction of special landfill or pond disposal sites. Mine disposal allows, with proper design, for the encapsulation of the wastes. In addition, attenuation of pollutants by various physical and chemical processes inherent to most surface mine settings can minimize the deterioration of groundwater quality in areas adjacent to the disposal site.

Intrinsic site conditions which significantly decrease the potential for leachate generation and mobility include the presence of low-permeability materials surrounding the site and unsaturated conditions (water table below the disposal site). The semi-arid climate typical of western North Dakota is of particular advantage to disposal site design. The vast majority of precipitation is lost to evapotranspiration. Thus, vertical movement of water from the land surface, through buried wastes and downward to the water table (recharge) is minimal in most settings and commonly can be eliminated with the emplacement of a low-permeability cover over the disposal site. If the wastes must be emplaced in a saturated setting, liners can be utilized to minimize leachate generation and migration.

Various attenuation mechanisms can have a significant impact on leachate quality. Physical attenuation, in the form of dilution, typically occurs slowly in western North Dakota settings. Dilution can result either from dispersion of the leachate plume or by molecular diffusion. Chemical attenuation of leachate can be significant if disposal sites are properly selected. Interactions between leachate and geologic materials result in differential attenuation whereby selected elements or phases are reduced in concentration over time. Important chemical attenuation mechanisms include: 1) cation exchange, 2) complexing with organic matter, 3) adsorption by mineral species, and 4) precipitation. Cation exchange has long been considered the major mechanism.

In western North Dakota, leachates from fly ash are typically alkaline; leachates from FGD waste are typically neutral. Both wastes generate leachate containing higher than background concentrations of calcium, sodium and sulfate. In addition, relatively high concentrations of molybdenum have been observed in some leachates from both wastes. Fly ash leachates also commonly contain elevated concentrations of arsenic and selenium.

In the proper hydrogeologic-geochemical setting, the concentrations of many of these elements can be significantly reduced through chemical and physical attenuation. The relative importance of the various attenuation mechanisms is governed by the texture and mineralogy of the materials surrounding the disposal site.

Calcium can be removed from leachate by cation exchange (for sodium) on clays. Sodium, however, is a highly soluble element and is not easily removed. Under anoxic conditions sulfate reduction by micro-organisms results in the precipitation of insoluble metal sulfides. This mechanism becomes particularly significant at depths below 100 to 150 metres.

Adsorption is the major mechanism for the attenuation of trace metals. Adsorption of trace element species is pH dependent; optimum adsorption occurs at near neutral pH. An acid/base buffering mechanism, one which inhibits acid production and behaves like an acid toward high pH solutions is apparently operative at all the western North Dakota sites. This mechanism is thus extremely significant to trace metal attenuation, particularly arsenic and selenium.

Thus, the intrinsic characteristics of surface mine settings in western North Dakota are often highly favorable to the disposal of fly ash and FGD waste. Proper site selection based upon key hydrogeologic and geochemical parameters will allow for environmentally safe disposal of these wastes with minimal site redesign.

Sites which can be anticipated to remain unsaturated after closure are highly preferable to saturated settings. Clay, by virtue of its small particle and pore sizes, is characterized by a high sorptive capacity, a low permeability and a high potential for molecular diffusion. Clays, particularly montmorillonitic varieties, thus offer high potential for attenuation, minimal potential for leachate migration and generally, are the best materials for waste emplacement.

80. CHEMICAL AND BIOLOGICAL CHARACTERIZATIONS OF SOLID WASTES FROM SYNTHETIC FUELS FACILITIES

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The objective of this research is to develop a better understanding of the characterization of chemical and biological interactions resulting from the land disposal of coal conversion solid waste residuals. In order to accomplish this objective, samples of a variety of types of coal conversion solid wastes were received or generated at the University of Pittsburgh, and subjected to chemical leaching procedures. Derived leachates were analyzed for heavy metal, organic, and biological activity in accord with standard and special procedures. Although most solid waste residuals are acceptable for land disposal in accord with existing RCRA regulations, questions may be raised as to potential environmental interactions resulting from such disposal.

There are many categories, or sources of solid wastes residuals from an integrated coal conversion facility. The most obvious, by its volume, is ash/slag residual resulting from gasification of coal. Since the bottom of most fixed bed gasifiers is a combustion zone, this material is similar in many ways to coal burning utility bottom ash/slag. Indeed, in some oxygen blown gasifiers capable of producing slag, this slag is of a glassy matrix which is environmentally benign. Fly ash from some facilities goes through a pyrolysis zone in the gasifier, thus often causing this material to differ from currently familiar combustion fly ash. Problems may arise from the leaching of heavy metals and trace (biologically active) organics from fly ash. Wastewater treatment facilities will produce sludges and solid wastes requiring special considerations for disposal. These sludges contain organics and heavy metals removed or modified during the treatment process. Lime based sludges from fixed ammonia stripping operations contain sorbed organics. Biological sludges and filter backwash sludges are mainly organic and are difficult to handle. Cooling tower blowdowns pose special problems due to volumes, salinities, precipitation potential, organic content and potential biological activity. Wastewaters from hot gas clean up facilities may be blended in the overall wastewater treatment scheme with results not yet predictable from current data. In addition to wastewater treatment sludges, solid wastes shall be generated from spent catalysts boiler feedwater production and flue gas desulfurization (from coal combusion for power) systems. If deemed non-hazardous, these materials may be disposed of by placement back in the mine.

There are few opportunities for altering coal conversion ash/slag residuals in the process, since the generation of such materials is integral with gasifier design. EPA-"EP" leachates and distilled water leachates of fixed bed gasifier ash/slag residuals have never produced heavy metal levels in excess of RCRA standards in our laboratory; such leachates however, have produced Daphnia toxicity LD-50 forty-eight hour values in the range of 0.2 to 100 mg/L. Daphnia toxicity values have been correlated with summed weighted aquatic metal concentrations of leachates. Leachates from wastewater treatment plant sludges are, in general, more toxic to Daphnia than ash/slag leachates. Solvent extraction, when incorporated into the wastewater treatment scheme, tends to reduce Daphnia toxicity and potentials for bioaccumulation as evidenced by standardized liquid chromatography procedures.

In general, heavy metals concentrate onto sludges produced in wastewater treatment operations. Variations in leaching technique cause changes of one to two orders of magnitude in levels of leached metals. Care should be taken when utilizing results of standardized leaching tests to site specific cases.

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3. Neufeld, R.D. et al "Ash/Slag Residuals and Wastewater Treatment Plant Sludges from Synfuels Facilities: Characterizations and Implications for Disposal" published in "Environmental Aspects of Fuel Conversion Technology-IV" EPA Symposium, October, 1981, Denver

81. THE EFFECT OF OIL-AND-GAS WELL DRILLING FLUIDS ON SHALLOW GROUNDWATER IN WESTERN NORTH DAKOTA

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Upon completion of an oil-and-gas well in North Dakota the drilling fluid is buried in the reserve pit at the site. During drilling, most pits are lined with a synthetic material to prevent loss of fluid. Rapid reclamation of the drill site is achieved by digging a series of trenches which radiate out from the reserve pit. The majority of buried drilling fluid is contained within these 5-7 metre deep trenches. These fluids are commonly salt-based, i.e. they contain a concentration of 300,000±20,000 ppm NaCl. In addition, these drilling fluids also contain additives including toxic trace-metal compounds.

The purpose of this study was to determine whether or not chemical components were being leached out of reclaimed drilling fluid sites in western North Dakota. If so, to determine the extent, character, and geochemical controls influencing the movement or attenuation of the leachate. The results were also evaluated with respect to the potential health risks to both humans and livestock resulting from consumption of shallow groundwater in the vicinity of these pits.

Four reclaimed oil-and-gas well sites were chosen for study in western North Dakota. The ages of these sites ranged from 2 to 23 years. These sites were chosen in an effort to encompass as many as possible of the geologic and geohydrologic variables that exist in this area. A total of 31 piezometers and 22 soil water samplers were installed in and around the drill sites. Quarterly groundwater samples were obtained from these instruments during the period between September, 1980 and October, 1981. In addition, water analyses were performed on 12 elutriated sediment samples obtained from shelby-tube cores. These samples were analyzed for 28 chemical parameters by the North Dakota State Department of Health Laboratory in Bismarck. Surface electrical earth resistivity surveys were run at two of the sites. The vertical electrical sounding method was used in conjunction with "a" spacings of 12, 30, 40, 60, and 80 feet.

Results of both the water analyses and earth resistivity surveys concur that leachate is being generated at all of the sites. Water obtained from the unsaturated zone beneath the buried drilling fluid exceeds many of the maximum permissible concentration limits for trace metals. These values are greatly reduced in the underlying saturated zone. This reduction is assumed to be the result of attenuation of these ions by cation exchange on Na montmorillonitic clays. The chloride ion was chosen as an indicator of maximum leachate extent in the saturated zone due to its high mobility and lack of attenuation other than by dispersion. This ion returned to background levels within the saturated zone 60 to 90 metres downgradient of two of the pit sites. The saturated zone was not encountered at the other two monitored sites.

There are a number of factors which help to minimize the effects of drilling fluids on the shallow groundwaters in western North Dakota: 1) the volume of the buried drilling fluid (1530 to 2550m^3) is relatively small in comparison to that of most waste disposal sites, 2) the semi-arid climate in this region results in relatively small amounts of subsurface infiltrating water which can in turn generate leachate from this buried material, 3) when leachate is generated it generally has a long distance to travel through low hydraulic conductivity sediments in the unsaturated zone to reach the water table (often several tens of metres), 4) the near-surface sediments in this area contain a high percentage of Na montmorillonite clay and therefore a high capacity for ion attenuation by cation exchange.

Concern should now be focused on oil-and-gas well sites in north-central North Dakota. Sites situated in glacial meltwater channels have a high potential for large-scale leachate contamination of the shallow groundwater. The trenching of the reserve pits in this area may also increase the amount of leachate that enters the saturated zone.

82. GROUNDWATER POLLUTION POTENTIAL OF MUNICIPAL WASTE DISPOSAL SITES IN NORTH DAKOTA

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Disposal of municipal wastes in North Dakota includes burial of predominantly solid refuse in sanitary landfills and impoundment of predominantly liquid sewage in waste stabilization lagoons. Since few, if any, of the disposal sites are constructed in, or lined with, impermeable materials, the potential exists for contamination of groundwater in the vicinity of the sites. The potential for degradation of usable groundwater supplies is a function of the unique hydrogeologic setting of the site. During the past few years, the pollution potential of all the landfills and lagoons in North Dakota has been evaluated. The landfill evaluation is currently being updated to include recently permitted sites. The assessments of pollution potential at both landfills and lagoons were made primarily from existing published or unpublished information.

Despite the wide variety in near-surface geological conditions in North Dakota, the state can be divided into five "type" hydrogeological settings for discussion of waste-site suitability.

(a) Coarse-grained glaciofluvial or glaciolacustrine sediments. These sediments have high permeability, frequently contain near-surface, unconfined aquifers, and almost always have a high potential for groundwater contamination and rapid contaminant migration.

(b) Alluvium. These settings, adjacent to modern streams, are composed of fine-to coarse-grained sediments with highly variable permeability. The pollution potential of these sites, for both surface water and groundwater, is usually high.

(c) Glacial till. Sites in till cannot usually be accurately evaluated without site-specific investigation. The intergranular permeability of till is very low, but the bulk permeability of the material may be several orders of magnitude higher because of narrow joints, or fissures, which cut through the material. In addition, buried aquifers not easily detected from the surface are common in till. In the landfill inventory, sites in till are classified as having moderate pollution potential, even though the actual potential could range from low to high.

(d) Pre-Pleistocene bedrock. These materials, exposed only in the southwestern part of the state, are composed of alternating beds of sand, silt, clay, and lignite. Landfills in this category are also given a moderate pollution potential rating because of highly variable site-specific conditions.

(e) Fine-grained glaciolacustrine sediment. This category includes sediments with very low permeability which usually lack aquifers and contain poor-quality groundwater. Sites in these materials usually have low pollution potential.

North Dakota currently has 114 active, permitted landfills. Methods of construction include the trench (most common), area, and depression types. The depression category includes landfills in unreclaimed lignite mines, abandoned gravel pits, and natural ravines. The pollution potential of the landfills was evaluated by examination of all available hydrogeological data concerning the area surrounding each site. Site visits afforded the opportunity to observe and sample material from the trench walls. The results of the inventory are shown in the table below. The percentage of sites in the moderate category is high mainly because of the lack of information about type settings (c) and (d). Many of these sites could be assigned to either the high or low categories if site-specific information were available.

Waste stabilization lagoons were evaluated according to a numerical rating system devised by the U.S. Environmental Protection Agency (EPA) for a national assessment of surface impoundments. All impoundments in North Dakota, not only municipal types, were included in this study (1). The numerical ratings were based on very specific criteria concerning the materials in the unsaturated and saturated zones, the groundwater flow system, the wastes involved, the proximity to wells and surface water bodies, and other information. Parameters were estimated because of the lack of site-specific data. The table below summarizes the results of the municipal category.

The evaluations discussed in this paper indicate that significant percentages of North Dakota waste disposal sites are located in poor or unknown hydrogeological settings. More field studies should be conducted to determine the actual effect of municipal waste disposal upon North Dakota's groundwater resources and to determine the safest geologic environments for waste disposal.

GROUNDWATER POLLUTION POTENTIAL OF MUNICIPAL WASTE SITES (Percentages)

	Number of sites	High Potential	Moderate Potential	Low Potential
Landfills	114	22	72	6
Lagoons	360	30	37	33

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83. GROUNDWATER CONTAMINATION FROM THE MCVILLE WASTE STABILIZATION PONDS

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The use of waste stabilization ponds to dispose of municipal wastes has become popular with many North Dakota towns. When managed properly, they are an efficient and economical method of waste disposal and may not adversely affect groundwater quality. One of the prerequisites to proper operation is that the pond be built in sufficiently impermeable sediment to inhibit percolation of wastewater into the groundwater. Some North Dakota towns have not met this basic requirement in the construction of their ponds. Hence, insufficiently treated pond liquids are allowed to reach the water table, potentially contaminating groundwater supplies. One such site in McVille, N.D. was chosen for this study.

The four objectives of the project were to: 1) determine the geologic setting of the pond site; 2) determine hydrogeologic properties of the subsurface materials, including rate and movement of groundwater and background chemical quality of the aquifer; 3) determine the changes in chemical composition of groundwater caused by seepage of wastewater from the ponds; and 4) make recommendations to the State Health Department concerning regulation of such waste stabilization ponds.

Fourteen monitoring wells were installed at the site to allow periodic water level measurements for determination of the flow system and to obtain water samples for chemical and biological analyses by the Health Department in Bismarck.

Three cells are avaiable for use at McVille. However, only Cell I is consistently used; approximately twice a year excess wastewater is discharged from Cell I into Cell II. Cell III has never been used since the ponds were built in 1974. A dump near the nortwest corner of Cell I also influences groundwater chemical quality at the site.

The water table is not significantly affected by variations in precipitation throughout the year except for a slight rise during the spring. Groundwater flows very slowly from north to south under the site toward its discharge area, the Sheyenne River. The water table gradient is approximately 0.06 inches per foot in the vicinity of the McVille ponds.

Monitoring well analyses indicate that groundwater downgradient from the ponds is contaminated by wastewater percolation. Concentrations of most parameters increase in that direction. In some cases, the elevated values exceed drinking water standards set by the U.S. EPA.

The behavior of the contaminant plume is complex and dependent on redox conditions both in the pond-bottom sediments and the groundwater. Sulfur, in the form of sulfate in wastewater, is reduced to H_2S or HS^- in the sludge layer of the pond. Thus, sulfate concentrations decrease immediately downgradient from the pond. Nitrogen in the form of nitrate is injurious to humans in concentrations in excess of 10 mg/L (N). The pond is not likely a source of nitrates as concentrations in wastewater sampled were less than 1 mg/L. Concentrations of nitrate in the upgradient wells are high; downgradient from the pond, however, ammonium from pond seepage is the dominant nitrogen species. Concentrations of chloride (Fig. 1), total dissolved solids, total hardness, iron, and other parameters define the contaminant plume downgradient from the pond. The periodic Cell II floodings are a major contributor of contaminants to the groundwater, but continuous percolation of wastewater from Cell I and leachate migration from the dump also contribute contaminants.

Some contaminants in the water are present at high levels at the McVille site. Although existing domestic wells are probably beyond the area of influence of the contaminant plume, construction of wells near the site is inadvisable. The plume likely will continue to migrate in the future, as adsorptive capacity of subsurface sediments decreases with time.

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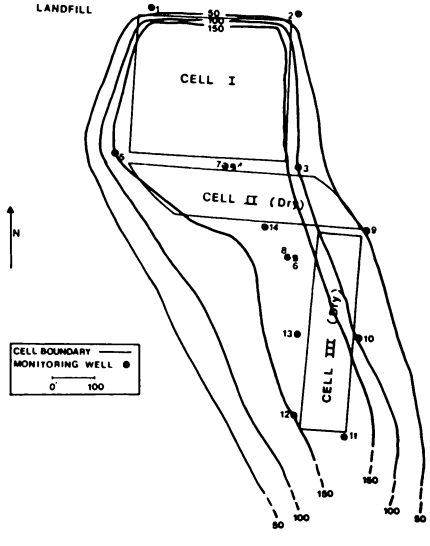

Fig. 1 Chloride concentrations (mg/L) at the McVille site.

SYMPOSIUM

on

INCREASING THE PARTICIPATION OF WOMEN IN SCIENCE AND TECHNOLOGY

Presiding: Phyllis E. Johnson
Human Nutrition Research Center-ARS-USDA
Grand Forks, ND

84. Expanding Your Horizons
Doris M. Hertsgaard*
Mathematical Sciences, North Dakota State University
Fargo, ND

85. Math Anxiety
Glenn R. Prigge*
Mathematics Department, University of North Dakota
Grand Forks, ND

86. Women in Engineering
J. I. Medalen*
School of Engineering and Mines, University of North Dakota
Grand Forks, ND

87. Women in Science Program
LuAnn K. Johnson*
Human Nutrition Research Center-ARS-USDA
Grand Forks, ND

88. Social and Self Evaluations of Men and Women and How They Affect Success: A Review of the Literature
Lila E. Tabor*
Psychology Department, University of North Dakota
Grand Forks, ND

89. Women in Science: Why Aren't There More?
Phyllis E. Johnson*
Human Nutrition Research Center-ARS-USDA
Grand Forks, ND

84. EXPANDING YOUR HORIZONS

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The "Expanding Your Horizons" conferences held annually at NDSU are designed to increase junior high girls' interest in mathematics and science. Yourng women are graduating from high schools with only a minimum number of mathematics courses and, thus, effectively being filtered out of many careers. These conferences foster an awareness of career opportunities and emphasize the need for a strong mathematics and science background. Over 200 women provide role models and an opportunity for the students to meet and form personal contacts with women working in traditionally male occupations.

The conference participants have their choice of four of seventy "hands-on" experiences such as identifying rocks, studying embryos, setting a speed trap, taking apart an engine, and programming a computer.

A survey of 7^{th}, 8^{th} and 9^{th} graders (boys and girls) was taken in February, 1982 previous to the 1982 conference. Girls who were planning to attend, as well as those not planning to attend, were surveyed. Significant differences were found between the two groups of girls regarding their career aspirations and attitutdes toward Science and Mathematics. No differences were found in their attitude toward English.

All 1980 and 1981 conference participants were surveyed in November, 1982. This survey was designed to measure the participants' perceptions of the effect of the conference on their career aspirations, number of math and science courses taken in high school, and attitude toward mathematics and science.

It is felt that these conferences positively influence young women; they make them aware of career opportunities and encourage them to prepare in high school so that they have more opportunities and alternatives after high school.

85. MATH ANXIETY

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Mathematics anxiety is one of the most difficult problems to deal with in our education process today. Math anxiety is a fear of performing mathematics-related tasks. A person suffering from mathematics anxiety may panic when confronted with problems involving computational or reasoning skills.

A small amount of anxiety may show that an individual is concerned about solving a problem and therefore is related to performance. However, a high degree of anxiety can trigger a stress reaction, blocking the ability to think clearly. Math anxiety is related to math avoidance, both academically and in real-life situations. This report is an attempt to explore the problem of math anxiety in North Dakota students.

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2. Kern, M. L. Sex Differences in Mathematics Achievement and Related Affective Factors in College Algebra Students. Unpublished Independent Study, University of North Dakota, Grand Forks, 1981.

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86.

WOMEN IN ENGINEERING

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There were very few women engineering graduates in the United States before 1970. During the 70's changes began to take place. Why had it taken so long? Why and how were the changes accomplished? The traditional view of a woman's role in society and the false notion that an engineer should be a man were myths that had to be dispelled. So why in the 70's did we begin our efforts to interest, enroll, retain and graduate women in engineering programs? We needed engineers! The engineering schools in the U.S. could not supply new graduates fast enough for our growing technology. And, we realized that we had been ignoring a large segment of our talented population--the women.

One of the earliest efforts to bring about the change was the program implemented by the School of Engineering and Mines at the University of North Dakota. From 1971 thru 1974 the School of Engineering and Mines held engineering institutes for high school junior and senior girls to make them aware of the opportunities available to them in engineering. These institutes allowed the young women to interact with women engineers, faculty, and students in a nonthreatening environment. Along with this exploration of the engineering disciplines, we also began the process of confidence building. We have found that confidence building is extremely important at this level, as well as at the college level, for individuals who are entering a non-traditional field. By providing a support system for the women who enrolled in engineering we continued the process of counseling and of confidence building. An effort was made to acquaint the students with women engineers who were practicing their profession. In 1974 a Student Section of the Society of Women Engineers was chartered on the UND campus and thus provided a link with women engineers and women engineering students from all parts of the United States. This organization promotes professional growth in ways that supplement the classroom work.

What were the key issues that had to be assessed and implemented for change? We needed to make young women aware of engineering. We needed to test the hypothesis that if you can get a number of them started, others will follow. We needed to provide a support system. Through the high school institutes, through high school and college visits, through correspondence with young women from all over the U.S., through interaction with alumni, and by providing a focal point for consultation and support the process was implemented. It is a gradual process. With any program of significant change you must provide a ramp for the change to take place. These women need to enter an environment where there is encouragement and opportunity to develop their potential as engineers. The continuation and development of the early work has produced a program that provides opportunity to many talented students.

87. WOMEN IN SCIENCE PROGRAM

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The National Science Foundation (NSF) sees the lack of women in science careers as a serious waste of national talent. In an effort to motivate female students to consider and pursue careers in engineering, mathematics, and the sciences, the NSF funded a pilot Visiting Women Scientists program. In 1978 and 1979, ninety women scientists visited 247 secondary schools. Nearly 40,000 students were given an opportunity to meet with women scientists and use them as role models, to learn about career opportunities, and to see examples of women scientists who have successfully combined careers with full personal lives. From these pilot programs, the NSF developed a working model for other groups to follow.

A group of about 25 women scientists from the Grand Forks community are developing a Women in Science Program using the NSF model as its basis. The goals of the Women in Science Program are:

1. To provide opportunities for women scientists to interact with one another, develop new methodologies, and evaluate themselves professionally.
2. To promote the attitude that science careers are appropriate for women.
3. To provide information about the preparation needed for various science careers and the importance of keeping various options open.
4. To provide an opportunity for students to interact with women scientists from a variety of sciences as role models.
5. To encourage teachers, counselors, and parents to provide support and encouragement to women who are considering science careers.
6. To provide evidence of women who have combined successful careers with their personal lives.
7. To encourage students to seek additional information about women in scientific careers.
8. To provide information about the importance of science and scientists in solving world problems.
9. To provide information about science and technology job opportunities for women in the future including equal opportunity/affirmative action guidelines to assure job opportunities.

Various options will be offered to local schools. Large group assemblies may be held with all of the girls or with all of the students in a particular grade. Two women scientists from contrasting fields will describe various careers in different scientific disciplines. These assemblies will be followed by small group meetings of 20-30 girls to allow for more detailed discussions and to offer the students the chance to ask specific questions. Other options offered to the schools include visits to individual science classes and sessions with science teachers, counselors, and administrators. A collection of brochures about careers in science and an annotated bibliography of resource material will be left at each school visited.

It is important that this program reach all girls, not only those already interested in science. Many career options are lost if courses such as algebra, chemistry, and physics are not taken early in high school. It is also important that the women scientists meet alone with the female students at some time during the school visit. The first NSF pilot program included groups of both males and females; however, the females rarely raised questions about the problems associated with combining family lives and careers when males were present. Also, males often dominated the discussions about science careers, which NSF felt reinforced the notion that science is male territory.

88. SOCIAL AND SELF EVALUATIONS OF MEN AND WOMEN AND HOW THEY AFFECT SUCCESS: A Review of the Literature

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Although male and female roles and occupations are fairly precisely defined within a given culture, cross-culturally women and feminine occupations are ascribed lower status than men and masculine occupations (1).

Recent feminist movements have worked to upgrade the status of women, but despite the passage of Title VII of the Civil Rights Act of 1964, women are still underrepresented in traditionally masculine professional, technical, and managerial positions even though by 1978, 43% of the entire workforce was female (2).

This paper concerns itself with possible reasons for the continuing underrepresentation of women in high status positions, reasons which emerge from research investigating societal as well as self evaluations of male and female success or failure.

Since feminine occupations are devalued it is not surprising that several studies have reported that individuals presented data showing men and women performing a task equally well tend to rate male performance more favorably, e.g. (3).

Male and female subjective appraisals of their own abilities also differ. Men prefer games requiring skill while women choose games in which success or failure is determined by luck (4), possibly because after completing a task men rate their performance more favorably than women do theirs, even when objective scores are equal (5). Females are also less confident of success than males and are more likely to attribute both success or failure to luck (6).

Thus females underrate their abilities and therefore are less expectant of successful task completion and tend to attribute success or failure to luck.

Since both men and women may be afraid to succeed in non-traditional activities, (7) and for women high status professional and technical positions are non-traditional, women who do succeed must overcome both social and internal sanctions.

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89. WOMEN IN SCIENCE: WHY AREN'T THERE MORE?

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In spite of gains made in many areas during the last decade, women are still severely under-represented in the sciences. In 1980-81 women received only 3.9% of doctoral degrees in engineering, 15.4% in math, 11.3% in the physical sciences, 11.2% in computer science, 26.4% in the life sciences. In comparison, 47.2% of doctoral degrees in education and 41.3% of arts and humanities degrees were awarded to women.

Are these differences due to nature or nurture? Or do they result from discrimination? Vera Kistiakowsky (1) has grouped possible reasons for low participation of women in physics into five categories; these five categories apply equally well to other fields of science. They are:

1) differences in innate ability between men and women
2) environment
3) discrimination
4) career conflicts
5) the Matthew effect

Possible differences in innate ability, especially in mathematics (2), have received wide publicity in the last few years. However, most authorities seem to believe that measurable sex differences in aptitudes are not genetic, but are related to differing societal expectations for boys and girls.

Environmental pressures begin at an early age, with the parents' selection of "girl's toys" and "boy's toys". Once in school, many girls actively avoid math and science courses. In recent years a number of programs designed to counteract this avoidance have been established across the country. At the college level also, women have been reluctant to pursue programs of study in traditionally "male" areas.

Discrimination as a factor has been documented statistically, particularly in terms of salary. In the last ten years, lawsuits by women alleging discrimination in promotion or tenure policies have received nation wide publicity, and large universities have been forced to change their ways. Nepotism rules have operated to exclude even Nobel-prize-winning women from regular academic appointments.

Conflicts between career obligations and the demands of personal life have generally been considered the wife's problem. Women have had to care for home and family while trying to carry on teaching and research equivalent to that of colleagues with wives. Many have moved to follow a husband's career and have been unable to find suitable employment.

Finally there is the Matthew effect first identified by Merton (3):

> "For unto everyone that hath shall be given and he shall have abundance; but from him that hath not shall be taken away even what he hath". (Matthew 13:12)

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3. Merton, R.K. (1968) Science, 159, 56.

SYMPOSIUM
on

PROTECTION OF NORTH DAKOTA'S BIOLOGICAL DIVERSITY

Presiding: Pam Soine
North Dakota Natural Heritage Program
Bismarck, ND

90. The 1973 Natural Areas Inventory 10 Years Later
Bonnie Heidel*
North Dakota Natural Heritage Program
Bismarck, ND

91. Protection of North Dakota's Wetlands
Lloyd A. Jones*
U. S. Fish and Wildlife Service
Valley City, ND

92. Inventory of a Rare Wetland, Karlsruhe Bog: First Step toward Preservation
Dennis T. Disrud*
Department of Biology, Minot State College
Minot, ND
Richard H. Warner
North Dakota Natural Heritage Program
Bismarck, ND

93. U. S. Forest Service Research Natural Areas - Selection and Use
Janet L. Johnson
USDA Forest Service
Missoula, MT

94. The North Dakota Natural Areas Registry Program: A New Protection Tool
Robert Horne*
The Nature Conservancy
Bismarck, ND

90.

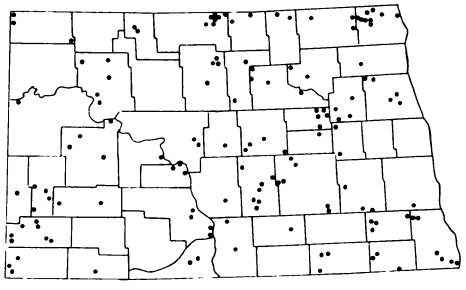
THE 1973 NATURAL AREAS INVENTORY 10 YEARS LATER

Bonnie Heidel
North Dakota Natural Heritage Program
Bismarck, North Dakota

The 1973 Natural Areas Inventory (NAI), a project of the Natural Science Society, heralded one of the first organized efforts to catalogue and protect sites of North Dakota's natural diversity. It is now the basis for continued State preservation work, in two ways.

First, the Natural Science Society NAI Committee compiled information on potential natural areas across the State which had special biological or geological significance (1). It was a major step in identifying important sites in the State. The NAI sites are shown on the map.

NATURAL AREAS INVENTORY SITES



Second, the NAI site inventory work was complemented by efforts of the same NAI Committee to prepare and launch State natural areas legislation. Its Nature Preserve Act took two sessions to pass (2). The preservation and environmental review responsibilities in this Act were placed with the State Parks and Recreation Department.

The sequence of NAI activities is given below.

1968 Executive Council of Natural Science Society creates Natural Areas Inventory (NAI) Committee, chaired by Harold A. Kantrud.
1973 Kantrud publishes NAI list of sites (1).
1973 NAI Committee introduces nature preserves legislation; defeated.
1975 NAI Committee reintroduces nature preserves legislation - Nature Preserves Act passes (2).

In the ten years since publication of the NAI list, there have been 30 sites considered for National Natural Landmark status, many of them on the NAI list (3,4). Three of them have been designated to date.

Other inventory work has been initiated for the development of preservation decisions on public lands, including NAI sites. These efforts are described in other symposium talks.

Furthermore, the entire set of NAI sites are being reviewed by the North Dakota Natural Heritage Program to assist the State Parks and Recreation Department in carrying out their responsibilities under the Nature Preserves Act. The review is based on special biological features: rare species and exemplary communities (5). This work stems directly from the legislative action of the NAI Committee, and perpetuates its inventory work.

On the grim side, at least five of the NAI sites have been completely destroyed in the past decade. A large percentage are also in serious states of degradation. Most of the remaining areas cannot be expected to persist indefinitely without deliberate measures of protection.

Irrevocable losses of natural areas testify to the need for natural areas conservation. Ongoing public and private conservation endeavors across North Dakota have a sound foundation in the 1973 Natural Areas Inventory. The challenge in identifying and protecting natural areas still exists, and the need grows with time.

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3. Cringan, A.T. and R.L. Dix. (1975) Ecological Theme Analysis and Inventory of the Great Plains Region. National Park Service Rep. Ft. Collins, Colorado.
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91. PROTECTION OF NORTH DAKOTA'S WETLANDS

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As the last glacier retreated from the plains of North Dakota approximately 10,000 years ago, four to five million acres of prairie wetlands were created. These wetlands evolved into one of the most diverse, dynamic, and productive ecosystems in the world. With the advent of agricultural intensification, these wetlands were drained and by 1950 one-half of all prairie wetlands which once existed were destroyed. From then and continuing today 15-20,000 acres of wetlands are lost to drainage each year in North Dakota.

The U. S. Congress recognized the loss of this important resource and in 1958 passed the Small Wetlands Acquisition Act. The Act specifically addressed the destruction of wetlands in the prairie region in an effort to slow this loss and directed funds from the sale of federal "duck stamps" to initiate the program. The two part program, one of being an easement agreement between the U. S. and landowners not to drain, burn, or fill wetlands on private land and the other being outright fee purchase by the U. S. Congress again emphasized the need for an active program and extended the Act with a total $200 million loan in 1961, 1968, and then again in 1976 authorizing the program until 1983. The program has protected 764,500 wetland acres and purchased 216,500 acres of waterfowl production areas which average about forty percent wetland in North Dakota. In 1977, however, the State enacted legislation restricting both the fee and easement and since then no additional wetlands have been protected by this program.

Other programs such as the federal water bank program, a state enacted water bank program which has no operating funds and the State Game and Fish Department acquisitions have had an insignificant impact on preserving wetlands. North Dakota State drainage regulations and U. S. Corps of Engineers 404 restrictions also have had a negligible effect on curbing the loss of wetlands.

Presently no effective alternative exists for preserving one of our Nation's most precious resources. Programs have been developed and some do have the potential to actively protect wetlands from destruction, however, all are entangled in political or legal controversy. This important resource provides many values to many people both locally and nationally; many values which are beyond the accepted wildlife benefit such as in flood control, water quality, ground water recharge, etc. Without immediate initiation of effective preservation programs, this resource and the many benefits it provides will be lost forever.

92. INVENTORY OF A RARE WETLAND, KARLSRUHE BOG: FIRST STEP TOWARD PRESERVATION

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In order to preserve remnants of North Dakota's natural heritage, attempts are being made to identify and evaluate those areas which are unique and significant ecological systems. One area that has been identified is the Karlsruhe Bog in east-central McHenry County (1). This wetland is located in Sections 24, 25, 26, 34, 35, and 36 in T155N, R77W, and includes an estimated 1,400 acres (570 hectares), parts of which are extensively disturbed. Elevation above mean sea level ranges from ca. 1465-1500 feet (447-457 meters). Karlsruhe Bog was developed in an abandoned channel of the Souris River (2). The area is strongly influenced by ground water flows from numerous springs flowing from sandy and gravelly deposits. Soils on the area consist of mucks and peats. Pockets of marl associated with Chara spp. also occur.

The first step leading toward the preservation of a unique ecological system consists of preparing a biotic inventory. The inventory of Karlsruhe Bog was initiated in 1968 with visits by Harold Kantrud and Robert Steward and by Dennis Disrud. During the period of 1968-1974, Disrud and his co-workers made a total of 22 plant collecting trips to the site. Additional collections were made by Disrud and Warner during 1982. Voucher specimens are deposited in the personal herbarium of the senior author, at Northern Prairie Wildlife Research Center, Jamestown, North Dakota (3) and at North Dakota State University, Fargo.

The native wetland flora of Karlsruhe Bog consists of approximately 130 species. In addition, some 15 species of grassland and weedy forms occur on drier tussocks and at disturbed locales. The Cyperaceae account for 28 of the 130 native wetland species.

The vegetation consists of a complex mosaic of communities which have and continue to be influenced by a number of natural and man-caused phenomena. These include ground water flow and seepage, aperiodic flooding of the Souris River, burning, grazing, mowing, and attempts at drainage. Dominants include Betula pumila var. glandulifera, Salix spp. and Carex spp.

Six species which are new additions to the flora of North Dakota were collected from Karlsruhe Bog during the period of 1968-1971. The six species are Carex brunnescens, C. castanea, C. gynocrates, C. limosa, Juncus brachycephalus, and Potamogeton obtusifolius. Other plant species rare to North Dakota that are found in Karlsruhe Bog include Thelypteris palustris, Carex capillaris, Eleocharis pauciflora, Galium labradoricum, Menyanthes trifoliata, Salix pedicellaris, and Utricularia intermedia.

Many of the rare plant species, as well as numerous other native wetland elements in Karlsruhe Bog, have boreal affinities. It thus appears that the native wetland community of Karlsruhe Bog represents a relict southern outlier of communities which would be encountered in the boreal forest formation.

Karlsruhe Bog represents a unique natural ecological system in North Dakota. Preservation of this area must include a resolution of land use problems. Future research, in part, must be directed toward developing an ecologically sound management plan for the area.

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93. U.S. FOREST SERVICE RESEARCH NATURAL AREAS - SELECTION AND USE

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Historically, the Forest Service has provided some of the earliest efforts to preserve natural diversity through the establishment of RNA's. The Northern Region RNA program dates back 50 years to the establishment of four areas. Currently, there are 15 RNA's in the Northern Region: 10 in north Idaho, 4 in Montana, and 1 in North Dakota.

Reflecting the current emphasis of long-range planning for the Nation's public lands and resources (National Forest Managment Act 1976), the Northern Region has developed a systematic approach for the protection of the Region's natural diversity. The Regional plan outlines the framework of the terrestrial and aquatic situations needed to complete the Regional system of RNA's. This scheme utilizes the habitat-type level of classification for identifying forest, shrubland, and grassland needs. An aquatic classification developed in Idaho was selected as the basis for establishing wetland, stream and lake RNA needs. Use of these terrestrial and aquatic classifications reflect the program's intent to include a representative array of the Region's diversity. Special situations, such as disjunct populations or threatened or endangered species, may also be set aside.

Selection of RNA's is based primarily on long-range objectives outlined by the Northern Region's plan. Each National Forest, assisted by the RNA Committee and State natural area organizations, is responsible for establishing a number of RNA's inclusive of situations described in the Regional plan.

As a general guide, these areas should show no evidence of major disturbance by man such as livestock grazing or timber cutting, for at least the past 50 years. Occasionally, for some vegetational communities, an area that best represents unmodified conditions will be selected. Research Natural Areas may be located within Forest Service wilderness or natural recreation areas. Ideally, they should be located near manipulative research areas so as to provide an undisturbed counterpart, or control, for baseline information.

Research Natural Areas should be large enough to provide essentially unmodified conditions in their interior portions. The Forest Service manual specifies 300 acres (120 ha) as the minimum size of a Research Natural Area. Unfortunately, it is difficult to find acceptable grassland areas of this size. Additionally, many special areas of vegetation, aquatic, or geologic situations are smaller in size. High quality areas less than the specified size should be considered when larger areas cannot be found. Additional guidance for the selection of suitable RNA's is provided in section 4063 of the Forest Service Manual dealing with conditions, location, and size of areas.

Research Natural Areas are limited to research, study, observations, monitoring, and educational activities that are nondestructive and nonmanipulative. Research Natural Areas are intended to serve as (1) gene pools, (2) baseline areas or controls, (3) reference areas for studies of succession and long-term environmental monitoring, and (4) educational use. The Forest Service encourages use of RNA's by qualified scientists and educators. Special permits or cooperative agreements are generally prepared and approved by the Forest Service prior to use of a Research Natural Area.

Research Natural Areas are managed to protect natural processes and conditions. Logging activities are not permitted. Grazing is permitted where essential to maintain a specific vegetative type. Public use is discouraged. Research Natural Areas should be withdrawn from mining.

Vegetation management may be authorized to preserve the vegetation for which the RNA was created. These practices may include grazing or prescribed burning. The criterion here is that the management practice must provide a closer approximation of the RNA's vegetation and ecological processes than would be possible without management.

Ensuring years will witness the establishment of a considerable number of RNA's as Forest plans are approved. Although efforts will remain focused on completion of the Northern Region's network of RNA's, increasing emphasis will be directed toward management and baseline monitoring of these areas.

94. THE NORTH DAKOTA NATURAL AREAS REGISTRY PROGRAM
A NEW PROTECTION TOOL

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Bismarck, North Dakota

Preserving representative samples of North Dakota's rich natural heritage has been the goal of both individuals and agencies for many years. Some have had this as their main mission; others have protected natural areas while accomplishing different goals. Preservation efforts have taken a new turn in the form of the North Dakota Natural Areas Registry Program.

In the past, the federal government had the greatest impact on State preservation. The U.S. Fish and Wildlife Service established National Wildlife Refuges and Waterfowl Production Areas throughout the State. The U.S. Forest Service became the managing agency for two large National Grassland areas. The National Park Service acquired a state management role when Theodore Roosevelt National Park was created.

State agencies have also protected natural areas. Probably the largest area of state lands are under the North Dakota Game and Fish Department and its network of Game Management Areas. The North Dakota Forest Service has important natural areas, as does the North Dakota Parks and Recreation Department.

It is important to note that the Legislature in 1975, gave the North Dakota Parks and Recreation Department the authority to establish a nature preserve system and the responsibility to protect the best of our natural heritage. A thorough inventory of the State is currently being conducted by the Natural Heritage Program within the North Dakota Parks and Recreation Department to carry out the legislative mandate.

Private preservation efforts in the past have not been as numerous. The UND Alumni Association acquired two significant natural areas for University research purposes. More recently, The Nature Conservancy purchased and designated the Cross Ranch as a nature preserve.

At present, individual landowners also have the potential to help protect North Dakota's natural diversity. Individuals can benefit from the use of conservation easements and/or wetland easements. An individual can also dedicate his or her land, or register it in the Natural Areas Registry Program if it qualifies.

The Natural Areas Program is a recent innovation. It is being implemented in cooperation with the North Dakota Parks and Recreation Department. The Registry Program signifies cooperation between a public agency and a private organization encouraging volunteerism for the public good.

The Natural Areas Registry Program is based on the premise that landowners take pride in what they have on their land and that they are concerned about the preservation of unusual species of plants or animals. This has proven true in six other states where the program is now in operation. There are three basic steps to the Registry Program.

First, a site is identified by the North Dakota Natural Heritage Program to either contain habitat for rare, threatened, or endangered plant or animal species, to be a good example of a natural community, or to contain some other significant natural feature.

Next, a personal visit is paid the landowner who is informed of the uniqueness of his site and urged to voluntarily agree to continue protecting this important resource. This is an oral pledge, with no legal document signed.

Lastly, in recognition of his or her cooperation, the landowner is presented a plaque identifying the site and listing him or her as a participant in the North Dakota Natural Areas Registry Program. He or she will also receive a certificate of commendation from the governor, expressing his appreciation on behalf of the people of the state.

The Natural Areas Registry Program is very efficient and cost-effective. It has proven effective as a first-level means of protection in several states -- over 90% of those landowners contacted have agreed to participate. It can be used with both private or public land (state, federal, county, or city). It is not a preservation panacea, but it often leads to higher levels of protection. Furthermore, it costs much less to protect many sites through the Registry than to purchase one or two sites. This approach addresses the key issues of private landowner involvement and formal, systematic recognition of North Dakota's outstanding natural areas.

SYMPOSIUM

on

MUSCLE METABOLISM DURING EXERCISE

Presiding: William W. Bolonchuk
Department of Health, Physical Education and Recreation
University of North Dakota
Grand Forks, ND
and
Henry C. Lukaski
Human Nutrition Research Center-ARS-USDA
Grand Forks, ND

95. Exercise Metabolism
William W. Bolonchuk*
Department of Health, Physical Education and Recreation
University of North Dakota
Grand Forks, ND

96. Carbohydrate and Fat Metabolism during Exercise
William A. Siders*
Department of Health, Physical Education and Recreation
University of North Dakota
Grand Forks, ND

97. Protein Metabolism during Prolonged Exercise: A Selective Review
H. C. Lukaski*
Human Nutrition Research Center-ARS-USDA
Grand Forks, ND

98. Muscle Energy Metabolism: Some Relationships to Exercise
Harvey R. Knull*
Biochemistry Department, University of North Dakota
Grand Forks, ND

99. Muscle Metabolism during Exercise - Potassium Redistribution versus Radon Uptake
G. I. Lykken*
Physics Department, University of North Dakota and
Human Nutrition Research Center-ARS-USDA
Grand Forks, ND

100. Planning Diets for Physically Active People
Louise K. Henriksen*
Human Nutrition Research Center-ARS-USDA
Grand Forks, ND

95. EXERCISE METABOLISM

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Energy metabolism increases instantly with the onset of exercise and may change by a factor of 30 or more (1). Physiologic function lags behind energy production and may require several minutes before transition from resting to adjustment occurs. Since energy production requires the presence of oxygen, this substance or the absence of it has been used to describe the events of energy metabolism before, during and after exercise.

The work of Hill (2) describes the response of oxygen consumption during exercise and post exercise. This response is exercise specific and demonstrates that different intensities of exercise produce different transition, adjustment and post exercise values for oxygen consumption. As transition time increases, oxygen deficit increases and contributes to greater oxygen debt. As exercise intensity increases, oxygen consumption after adjustment increases. Each of these changes contribute to an increase in oxygen requirement. Transition oxygen deficit is associated with anaerobic metabolism and oxygen consumption after adjustment is associated with aerobic metabolism.

Astrand (1) has summarized the work of several investigators to illustrate the aerobic and anaerobic components associated with maximal muscle effort over various durations. Short time (ten seconds) maximal effort required 85% anaerobic and 15% aerobic metabolism. Long time (two hours) maximal effort required 1% anaerobic and 99% aerobic metabolism.

The type of exercise, static or dynamic, affects muscle metabolism (4). Tension in the muscle compresses vessels and restricts or occludes blood flow during contraction. If blood flow is reduced during exercise, the energy for metabolism will be anaerobic. Muscle function may enhance, not restrict, blood flow when exercise is dynamic and allows for rest between contractions. Circulation through the muscle during this type of exercise results in aerobic metabolism.

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96. CARBOHYDRATE AND FAT METABOLISM DURING EXERCISE

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Carbohydrates and free fatty acids (FFA) become the primary energy sources for the healthy human striated muscle during exercise (1). Ingested carbohydrates are converted to glucose which can be utilized directly as an energy source or stored as glycogen in muscle and liver tissue. Fats used for energy by striated muscle are in the form of FFA hydrolyzed from the triglycerides of adipose tissue (2).

The availability of oxygen to the exercising muscle is the determinant of whether glucose or FFA will be the major energy source. At rest, glucose and FFA contribute equally to the utilized energy supply (3). When the circulo-respiratory system has not yet adjusted to meet the oxygen and energy demands of the working muscle (as in the start of exercise) or is unable to adjust to meet those demands (as in static, dynamic explosive, or dynamic sustained exercise), the relative hypoxia progressively restricts the usable energy source to glucose. This anaerobic oxidation of glucose proceeds only as far as lactic acid formation (4).

During light to moderate (up to 75% of maximum capacity) dynamic rhythmic exercise, when the circulo-respiratory supply to the exercising muscle approximates the demand, the oxidation of FFA is enhanced because oxygen becomes available as a hydrogen acceptor. As the duration of the exercise bout increases, the contribution of FFA to the utilized energy supply may increase, from the near 50% at rest, to 80% (5).

At a given work load, the use of glucose as an energy source is potentiated by prior ingestion of carbohydrates. The use of FFA as an energy source is increased during the postabsorption state, by a high fat diet, and by training.

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97. PROTEIN METABOLISM DURING PROLONGED EXERCISE: A SELECTIVE REVIEW

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It is widely recognized that carbohydrate and free fatty acids constitute the principal energy sources during exercise bouts of moderate duration (<60 min). Recently, evidence has accumulated which supports an active protein utilization particularly during prolonged (1-4 hr), continuous, rhythmic exercise at moderate to severe work intensities. Although early studies suggest that protein metabolism is affected to a greater extent than is generally recognized, protein has seldom been considered as a significant contributor to the total energy requirement of an activity. The skeletal musculature, which constitutes about 40% of the fat free body (1), is the largest tissue in the body of healthy man and represents a potentially important energy reserve.

One effect of prolonged aerobic exercise appears to be an increase in protein catabolism. In vivo studies of adult men participating in prolonged intense athletic competitions have repeatedly shown large increases in urea production which are equivalent to protein degradation rates of 2.5-11.0 $g \cdot hr^{-1}$ depending upon the age of the subject (2). The calculated urea excretion during exercise was more than twice that occurring in the men during normal daily activity. During 4 hr of exercise, plasma concentrations of the branched-chain amino acids and alanine decreased after 1 hour, while circulating levels of the sulfur-containing amino acids increased progressively during the competition.

Quantitative estimates of protein turnover in man during a long term exercise bout have been derived using the labelling of urinary ammonia from ^{15}N-glycine ingestion (3). Based upon estimates of ^{15}N flux through the total nitrogen metabolic pool, the exercise bout was associated with a 50-75% increase in protein breakdown and a 14-18% reduction in protein synthesis. This exercise-induced amino acid catabolism contributed 8% of the energy cost of this activity.

The most prevalent theory to explain the observed increased protein utilization during prolonged exercise is derived from an integration of branched-chain amino acid metabolism and the glucose-alanine cycle (4, 5). Amino acids are transaminated within skeletal muscle to alanine from glucose-derived pyruvate carbon. Also, the rates of deamination and decarboxylation of the branched-chain amino acids in skeletal muscle are accelerated during exercise particularly when muscle glycogen stores are low. Branch-chained amino acids released from the liver and taken up at working skeletal muscle may provide the $-NH_2$ and C skeleton for de novo alanine synthesis. Also, branched-chain keto acids may provide an additional C skeleton for intramuscular oxidation.

Evidence to support the concept that protein metabolism during heavy exercise is influenced by initial glycogen levels is available (6). Serum urea levels increased progressively during exercise and into recovery in glycogen-depleted men. Total nitrogen excretion, calculated from urinary and sweat urea nitrogen outputs, increased dramatically and was equivalent to a protein breakdown of $14 g \cdot hr^{-1}$ which contributed about 11% total energy cost. This was greater than the $5.8 g \cdot hr^{-1}$, 4.4% energy requirement, in the glycogen-repleted group.

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98. MUSCLE ENERGY METABOLISM: SOME RELATIONSHIPS TO EXERCISE

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The regulation of muscle energy metabolism has been a subject of considerable experimentation. Concepts that developed to describe its regulation include phosphate control, ADP control, phosphate potential and energy charge. The significance of such terms in relation to control in muscle tissues is that there can be a huge change in demand for energy in these tissues. The ability to meet the energy demand depends on a number of factors. First, the type of muscle is important. The most significant difference between muscle types is the enzymatic content and presence or absence of mitochondria. A second important factor is the level of training. Training leads to an increase in the levels of many muscle components. These components include not only the contractile apparatus and the oxygen delivery system, but also enzymes involved in anaerobic and aerobic metabolism. Depending on dietary habits "glycogen loading" can occur in muscles. In general training causes muscles to become much more efficient in their utilization of carbohydrate. These concepts will be described.

The contractile process as it is presently seen to lead to muscle contracture, directly consumes ATP producing ADP. Regardless of the technique utilized, creatine phosphate is found to be quickly consumed to rephosphorylate the ADP. There is little doubt that creatine phosphate levels decrease significantly immediately following initiation of exercise. On the contrary the ATP levels are sustained for long periods of time and depend upon the intensity of the exercise and the state of training. Evidence in older studies (1,2), perhaps using more drastic techniques, suggest that ATP levels are nonetheless also depleted. This older evidence will be contrasted with new data obtained by NMR techniques (3,4) that indicate ATP levels are maintained at all expense and states of pain are reached before ATP falls.

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99. MUSCLE METABOLISM DURING EXERCISE - POTASSIUM REDISTRIBUTION VERSUS RADON UPTAKE

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Recent studies of total body potassium estimations in well-conditioned long distance runners by whole body gamma ray scintillation counting attributed apparent increases in potassium-40 counts as a result of strenuous exercise to potassium redistribution such that counting efficiencies increased (1,2). Based upon the high penetrating ability of potassium-40 gamma ray emissions we show how potassium redistribution can have little effect upon total body potassium estimation by whole body counting and propose that radon-222 was responsible for these observations.

Radon is highly soluble in body tissues and body retention may be described with a five component model as can body retention of krypton and xenon. Of these five components, one is associated with removal of inert gas attached to hemoglobin molecules in the circulating blood and another is associated with inert gas clearance from resting muscle and lean body tissues (3).

We have demonstrated that radon may be distributed in the working muscle by monitoring total body and regional gamma ray activities of a daughter, bismuth-214, in a subject before and after exercise bouts in a room containing radon and radon progeny (10 pCi/liter) and illustrate how gamma ray activity from bismuth-214 may be incorrectly attributed to potassium-40. Measurements of regional potassium-40 and bismuth-214 gamma ray activities in three well-conditioned subjects prior to and after outdoor rides of up to 62 miles further substantiated our supposition that atmospheric radon resulting from decay of radium-226 may become distributed throughout muscles as a result of exercise and may introduce errors in total body potassium estimation by whole body scintillation counting (4).

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100. PLANNING DIETS FOR PHYSICALLY ACTIVE PEOPLE

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Energy Expenditure. Energy needs of athletes who participate in physically demanding sports, that have a high intensity or long duration, may be two to three times the Recommended Daily Allowances (RDA). Athletes are faced with the need to maximize energy intake while minimizing eating time because of heavy training schedules and fatigue. Since large volumes of food are required, it may be necessary for the athlete eating more than 3500 kcals daily to increase the nutrient density of food by eating an increased proportion of energy as fats. (1)

Weight Reduction. Athletes who participate in sports that have weight classes, often rely on last minute crash dieting or dehydration to "make weight". Not only is dehydration dangerous, but athletic performance will suffer due to reduced energy stores.

For the average person, recreational activity is often undertaken to lose weight and is often associated with a weight reduction diet. Activity of a moderate intensity, such as walking, can be accomplished after an adjustment period at energy intakes as low as 800 kcal (2), although long term intakes at such low levels are potentially dangerous. Energy cost of thirty minutes or less of moderate exercise is not great, but it may contribute to long term weight maintenance or loss for the average person.

Protein, Fats, and Carbohydrates. At present, there is little evidence that athletes need protein intakes greater than the RDA. An individual participating in athletics may require slightly more protein for muscle growth and repair, but it appears that the margin of safety in the RDA provides for this need. In addition, the usual American intake of protein far exceeds the RDA, thus there is no reason for athletes who eat normally to consume additional protein.

Athletes who participate in endurance events may benefit from an increased intake of carbohydrate. Elevated carbohydrate intake increases tissue stores of glycogen and appears to fascilitate replenishment of glycogen stores after strenuous exercise. Data suggest that complex carbohydrates may be better for enhancing glycogen 24-48 hours post-exercise than are simple carbohydrates. (3)

Fats can be utilized by fit athletes during aerobic activity. However, fats should not be emphasized by athletes unless increased nutrient density is necessary to allow adequate energy intake. Recovery of glycogen stores post-exercise is not fascilitated by fat.

Vitamin and Mineral Requirements. There is at present no evidence that supplemental vitamins or minerals in excess of the RDA will improve exercise performance or recovery. When athletes consume balanced diets, there is less reason to anticipate deficiencies in them than in the average person, because energy intakes of athletes are larger and therefore vitamin and mineral intakes are correspondingly greater. Requirements for three of the B vitamins, thiamin, niacin, and riboflavin, are related to energy intake; these are provided by a balanced diet. Adequate iron intake may be difficult for female athletes and growing adolescent athletes to obtain, unless they select foods rich in available iron. If proper food selection is made. supplementation is not necessary. Sodium supplementation in the form of salt tablets is probably unnecessary unless very high sweat losses occur. Usually, salting food to taste will adequately replenish lost sodium.

Pre-event Meals. Pre-event meals consist primarily of carbohydrate and can be consumed four hours prior to competetion. This time interval allows blood levels of glucose and insulin to normalize thereby allowing the liver to release stored glycogen as needed. With less time between eating and an athletic event, blood insulin may remain elevated and gluconeogenesis may be hampered.

Nutritional Knowledge. Athletes search for methods to improve performance. Nutritional concepts are often inappropriately used as psychological motivators. Recent research showed that nutrient intakes improved when athletes received appropriate nutritional education. (4) Good nutrition is probably more helpful to performance than is nutritional "psych" with concurrent nutritional inadequacy.

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12. COMPOSITION OF ATMOSPHERIC DEPOSITION IN WESTERN NORTH DAKOTA

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To determine the composition of atmospheric deposition in North Dakota and the effect of this deposition on the hydrologic system, the U.S. Geological Survey operated dual wet-dry deposition collectors at Wibaux, Montana, and Gascoyne and Beulah, North Dakota, during 1980 and 1981. Wetfall as rain and snow was collected at these sites on an event basis, and dry deposition was retrieved monthly at these sites. Both wetfall and dryfall were analyzed for 8 principal mineral, 3 nutrient, and 15 trace constituents. All sites also were instrumented with weather stations to determine the relationship of deposition quality to meteorological conditions. Similar sites are currently being operated in North Dakota by the North Dakota State Health Department at Dunn Center and Woodworth, jointly by the U.S. Geological Survey and the North Dakota State Health Department near Canfield Lake, and by the National Atmospheric Deposition Program in the North Unit of Theodore Roosevelt National Park.

Preliminary evaluation of the data collected at these sites indicates North Dakota is receiving acidic deposition. The pH calculated from the volume-weighted mean annual hydrogen-ion concentration of rain and snow collected on an event basis has been less than 4.8 at all sites. Sulfate and nitrate are the principal acid anions in wetfall samples collected. They contribute about equally to the acidic content of the precipitation and, combined, account for almost all the acidity of the samples.

Wetfall pH decreases during the course of a precipitation event, as available atmospheric dust that buffers the precipitation at higher pH levels is removed. There also is an apparent general trend for precipitation pH within a single storm to increase as it passes across North Dakota, with lowest pH values measured within and just east of the principal gas-flaring areas in the western part of the State. Analysis of the sulfur- and oxygen-isotopic composition of a single October wetfall sample from the Canfield Lake site indicated that approximately 45 percent of the acid-producing sulfate was derived from high-temperature processes like gas-flaring, approximately 40 percent from intermediate-temperature processes like coal-fired power generation, and 15 percent from biogenic sources. At all sites with several years of data, the pH calculated from the mean annual volume-weighted hydrogen-ion concentration of wetfall appears to have decreased with time. However, the data base currently is too small to define this trend confidently or to relate to increased emissions of sulfur and nitrogen oxides associated with escalating energy development.

Most trace elements are present in wetfall at or near their detection limits. Their concentrations in precipitation are controlled principally by dissolution of wind-blown soil components. Additional sources for a trace element are suspected if the element is enriched in precipitation relative to the Earth's crust. Crustal-enriched factors (EF) are calculated from the expression

$$EF_{crust} = \frac{(x/Mn)_{precipitation}}{(x/Mn)_{crust}}, \quad (1)$$

Where (x/Mn) refers to the quotient of the concentration of element x divided by the concentration of manganese, an element for which soil is the only known source. The ratio of this quotient for precipitation to the quotient for regional soils is defined as the crustal-enrichment factor. Of the enrichment factors calculated for trace elements, only those for mercury, molybdenum, and selenium significantly exceed 1.0, indicating interactions of precipitation and atmospheric dust alone could not explain their concentrations. These three volatile elements also are enriched in fossil fuels relative to soil and are released to the atmosphere as gases during fuel combustion.

The ratio of estimated mean annual deposition of analyzed constituents as wetfall to deposition as dryfall appears to be relatively constant both temporally and spatially within North Dakota. Except for nitrate, ammonia, and sulfate, most constituents are deposited predominantly as dryfall. Analysis of dryfall with scanning-electron microscopy and energy-dispersive, X-ray fluorometry indicates flyash components contribute significant quantities of potassium, magnesium, silica, nickel, and germanium to dryfall. Germanium may prove to be the best indicator of metal contribution from fossil-fuel combustion as it has no other known local source.

Most surface waters in North Dakota have significant alkalinities, making them resistant to acidification from acidic atmospheric deposition. However, water in prairie potholes underlain by non-calcareous glacial clays typically is characterized by carbonate alkalinities of less than 50 mg/L during the spring and less than 100 mg/L during summer and fall. During early spring, decreases in pH and increases in trace metal concentrations are observed in pothole waters of this type adjacent to the Canfield site. Metal ratios in affected potholes mimic those determined in snow cores and indicate an atmospheric source for the spring trends. No additional hydrologic impacts of acidic atmospheric deposition have been determined to date.

13. IONIC COMPOSITION AND TRACE ELEMENT CHEMISTRY OF RAINFALL IN RURAL NORTH DAKOTA

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Prior to the late 1940's, the chemical purity of rainfall received little scientific attention. The discovery of "excess acidity" in precipitation by Barrett and Brodin (1), however, fostered widespread interest in the phenomenon known today as acid precipitation. Subsequent investigators documented the importance of precipitation as a medium for the transport of air pollutants to natural and agricultural ecosystems. By the beginning of this decade, several ongoing, systematic studies of rainfall chemistry were implemented. This report addresses one such study, coordinated by the North Dakota State Department of Health and funded, predominately, by the Bureau of Land Management, United States Department of the Interior.

Selected chemical properties of rainfall are monitored at three rural locations in North Dakota. These locations, in Stutsman, Burleigh and Dunn counties, are representative of major geological and land use regions within the state (2). Automated precipitation collectors facilitate the event sampling of rainfall at each site. Field determinations for sample pH and electrical conductivity are performed at onsite, environmentally controlled laboratory facilities. Remaining analyses are conducted at the State Public Health Laboratory in Bismarck, via ion chromatography (nitrate, sulfate, ortho-phosphate, chloride, fluoride), automated colorimetry (ammonium), flame atomic absorption spectroscopy (filterable and nonfilterable calcium, magnesium, sodium, potassium, zinc), flameless atomic absorption spectroscopy (filterable and nonfilterable manganese, cadmium, lead, copper, molybdenum, nickle, vanadium, chromium, iron, silver, aluminum), cold vapor atomic absorption spectroscopy (filterable mercury), and hydride generation (filterable selenium, arsenic). Stringent quality assurance procedures are applied routinely to all aspects of the program (2).

At this writing, statistical analyses have been completed for chemistry data from the collection period, August 1, 1980 to December 31, 1981. Based on these data, which reflect only the Dunn and Stutsman county monitoring locations, it is evident that rainfall is characterized by higher free hydrogen ion activity and by lower ionic strength than generally has been reported for the northern plains. The comparatively high free hydrogen ion activity of rainfall is due more to a paucity of alkaline earth and alkali metals in solution than to the observed levels of sulfate or nitrate anions (Table 1). Metal concentrations in rainfall at both monitoring locations are represented best by median values (Table 2). Volume-weighted average concentrations of lead, zinc and iron are 1-3 orders of magnitude less than those reported recently for the eastern United States (3), whereas observed concentrations of aluminum, cadmium, copper, lead, manganese and zinc agree with levels documented previously for the northern plains (4).

TABLE 1. Median and Volume-Weighted Mean Concentrations of Major Ions in Rainfall ($\mu eq\ L^{-1}$)

Location	NH_4^+	H^+	NO_3^-	Cl^-	$SO_4^=$	Ca^{++}	Na^+	Mg^{++}	K^+
Dunn County									
Median	22.78	17.00	16.45	14.08	5.20	3.99	1.30	0.82	0.77
Weighted mean	25.47	13.40	19.74	16.34	7.49	5.51	1.78	1.51	1.07
Stutsman County									
Median	27.22	8.51	17.58	14.08	10.41	3.49	3.48	0.82	0.51
Weighted mean	27.68	10.40	15.12	14.08	8.53	3.46	2.91	1.00	0.91

TABLE 2. Median Concentrations of Selected Metals in Rainfall ($\mu eq\ L^{-1}$)

Location	Al	Cd	Cu	Fe	Mn	Pb	Zn
Dunn County							
Filterable	0.22	8.9E-4	0.01	0.02	0.07	0.01	0.21
Total recoverable	1.22	1.8E-3	0.02	0.58	0.07	0.02	0.23
Stutsman County							
Filterable	0.11	1.3E-3	0.02	0.02	0.05	0.01	0.17
Total recoverable	0.81	2.2E-3	0.03	0.43	0.05	0.02	0.19

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14. CHEMICAL CHARACTERISTICS OF WATERS IN NORTHERN PRAIRIE WETLANDS

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An overview of the chemical characteristics of waters in 143 surveyed wetlands (1966-1971) typically found in the northern prairie pothole region indicates various ecochemical influences in the natural habitats of waterfowl and waterbirds. Very different waters can exist in wetlands that are within 30 m or less of one another. Environmental guidelines (1) were used to select chemical parameters. Anions were determined by standard methods (2). Cations were analyzed by means of atomic absorption spectrometry (3). Wetland classification was based on the field manual for northern prairie wetlands (4).

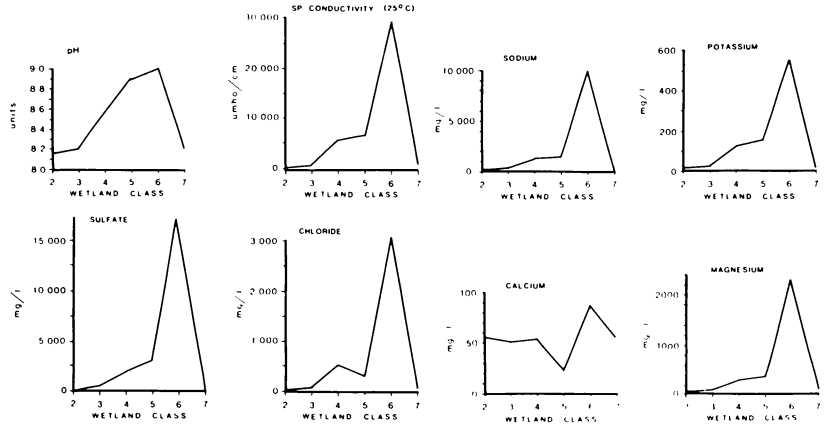
The lowest values of chemical characteristics are for temporary (Class II) [10] and seasonal (Class III) [26] wetlands. These similar waters have averages of pH 8.2 (range 7.1-8.9), specific conductivity 570 micromhos (150-2,800), total alkalinity 170 mg/L (50-500), chloride 17 mg/L (5-115), sulfate 180 mg/L (2-2,000), sodium 20 mg/L (0-280), potassium 20 mg/L (7-75), calcium 50 mg/L (3-170), and magnesium 30 mg/L (4-200).

Medium values of major chemical constituents are prevalent in semipermanent (Class IV) [70] and permanent (Class V) [20] wetlands. The Class IV,V waters average pH 8.7 (7.2-8.9), specific conductivity 6,000 micromhos (180-60,000), total alkalinity 800 mg/L (90-2,600), chloride 370 mg/L (5-13,500), sulfate 2,300 (5-24,000), sodium 1,200 mg/L (0-22,000), potassium 130 mg/L (5-2,000), calcium 40 mg/L (1-180), and magnesium 290 mg/L (4-4,000). The chemical composition of these wetlands is the consequence of a natural equilibrium resulting from a combination of surface runoff, groundwater, and biochemical activity. The highest chemical values superabound in alkali (Class VI) [11]. Although considered to be of little value by many observers because of their extreme chemical content, alkali wetlands provide excellent habitat for shorebirds, sandhill cranes, and other species of migratory birds. The chemical parameters average pH 9.0 (8.3-9.6), specific conductivity 29,000 micromhos (4,000-67,000), total alkalinity 3,600 mg/L (380-23,000), chloride 3,000 mg/L (15-11,500), sulfate 17,000 mg/L (1,200-62,500), sodium 11,000 (400-55,000), potassium 550 (60-1,300), calcium 90 mg/L (1-270), and magnesium 2,200 mg/L (1-12,000).

Fen (Class VII) [6] waters are chemically similar to those found in temporary and seasonal wetlands. The averages are pH 8.2 (7.8-8.4), specific conductivity 800 micromhos (570-1,000), total alkalinity 370 mg/L (150-560), chloride 16 mg/L (10-25), sulfate 85 mg/L (4-200), sodium 23 mg/L (5-46), potassium 13 mg/L (2-22), calcium 55 mg/L (23-86), and magnesium 46 mg/L (26-64).

Analyses of other parameters generally followed the same order as above. Detailed reports on the chemical aspects of waters in wetlands are in preparation. The figure of eight chemographs presents a general view of the chemical water types for the six classes of northern prairie wetlands.

Acknowledgement is made to B. Hanson for slides and M. Meyer and R. Thielman for graphics.



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15. JÖKULLHLAUPS ON THE GREAT PLAINS: A STUDY IN DEDUCTIVE REASONING

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The essence of the deductive method of scientific study is to 1) set forth a tentative hypothesis, 2) deduce the logical consequences of the hypothesis and 3) confront these deduced consequences with actual observations (1). The purpose of this paper is to test, using the deductive method, a hypothesis which suggests continental glaciation on the Great Plains was simultaneous with glaciation in the Rocky Mountains.

The furthest generally recognized advance of glaciation on the Great Plains extended somewhat south and west of the modern Missouri River (2)(3). Maximum glaciation in the Rocky Mountains consisted of icecaps covering such regions as the San Juan Mountains, the Front Range, the Uinta Range, the Wind River Range, the Bighorn Mountains, the Crazy Mountains and the Beartooth-Absaroka-Yellowstone Plateau (4). The hypothesis being tested in this paper assumes these icecaps were present at the same time as the continental ice sheet which produced the southwestern limit of glacial erratics on the Great Plains.

Significant quantities of meltwater from alpine icecaps logically would have flowed away from the Rocky Mountains toward the continental ice sheet margin to the north and east. Such meltwater rivers should have been dammed by the continental ice sheet resulting in a series of proglacial lakes extending from Alberta to Kansas. Meltwater rivers today transport and deposit enormous volumes of sediment (5). The meltwater rivers deduced in this paper should have transported large volumes of sediment into the deduced proglacial lakes resulting in features which would be easy to recognize today.

A large icecap covering a major geothermal region, such as the Yellowstone Plateau, should be expected to behave in a manner similar to modern icecaps covering geothermal areas in Iceland. The Icelandic icecaps are noted for gigantic floods which occur at periodic intervals and have discharges as great as 2.0×10^5 m^3/s (6)(7). These sudden bursts of water, known as jökullhlaups, transport huge volumes of sediment, including material of unusually large size. Jökullhlaups on the Great Plains, if they existed, should have left abundant and distinctive sedimentary deposits especially in the proglacial lakes along the margin of the continental ice sheet, where floodwaters would have been temporarily ponded and then diverted to the southeast.

Maps of glacial deposits on the Great Plains do not show the various proglacial sedimentary deposits deduced in this paper (8), although some workers have hypothesized glacial lakes at various positions along the continental ice sheet margin (2)(3)(4). The missing proglacial sediments suggest either the hypothesis being tested in this paper is incorrect, or sediments currently identified as something else should be reinterpreted as proglacial sediments. Sediments mapped as Oligocene in age are located in almost precisely the geographic positions deduced for the missing proglacial sediments both in the Rocky Mountain region and on the Great Plains (9). The composition of at least some of the Oligocene material is consistent with the nature of material which might result from meltwater rivers and jökullhlaups coming from the Rocky Mountains (10). Paleontologic data has, however, built a very strong case for the Oligocene age given to the material (11). Yet the possibility exists the paleontologic correlations are all between deposits of the same type and origin found over a large area on the Great Plains and in the Rocky Mountain region. If the hypothesis proposed at the beginning of this paper is correct, then a new interpretation of most, or all, of the Oligocene sediments and fossils on the Great Plains and in the Rocky Mountain region may be necessary to account for the missing proglacial deposits deduced in this paper.

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16. SELECTED TRACE ELEMENTS IN A STRATIGRAPHIC SEQUENCE AT THE CENTER LIGNITE MINE, NORTH DAKOTA

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Inorganic constituents can play a positive or negative role in the utilization of low-rank coal. To describe the distribution of selected inorganics, a stratigraphic sequence enclosing of a lignite seam from the Center Mine, Oliver County, North Dakota, was chosen for analysis. This seam, the Hagel Bed, is a part of the Sentinel Butte Formation (Paleocene) of the Fort Union Region in the Williston Basin.

Neutron activation analysis (NAA) was performed on underclay, coal, and overburden. The concentration of many elements was found enhanced near the margins of the coal/overburden/underclay interfaces. Figure 1 shows a concentration of Zn in the upper and lower margins of the coal. Other elements showing a similar trend are Al, U, Sb, La, Cl, V, Ba, Yb, Cr, Th, Se, Cs, Ni, Sc, Ru, Fe, Ti, Ag, Co, Ce, and Sm. Bromine was the only element concentrated towards the center of the seam. Other elements showing no observable trend (by NAA) were Cd, As, K, Eu, Ca, Mn, Mg, and Na. In addition, most elements show extreme concentration or depletion in the concretion zone of the stratigraphic section.

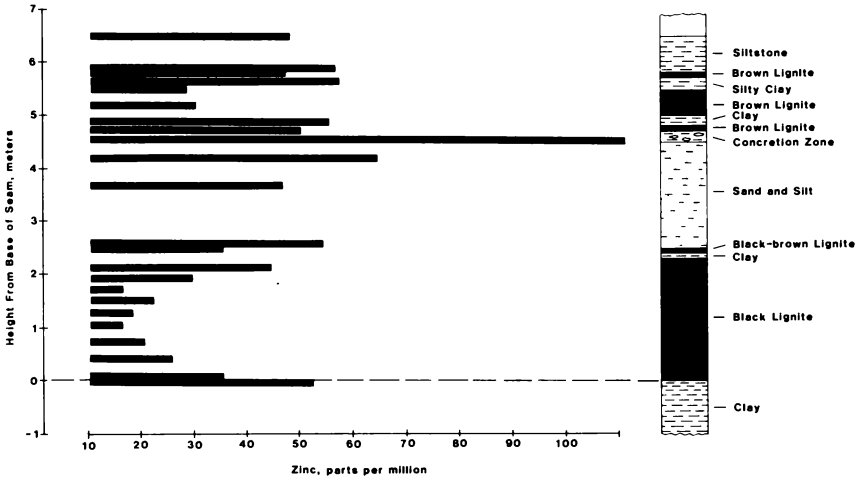

FIGURE 1. Zinc distribution in Center Mine seam.

Results from the Center Mine are similar to results from other studies dealing with coal seam geochemistry. Gluskoter and others (1) in a float-sink study found that Ge, Be and B appear to have an organic affinity; Zn, Cd, As, Mn, Mo, and Fe appear to an inorganic affinity. At the Center mine Ge was detected only in the coals with a concentration of <30-120 ppm. Boron and Be were not studied. Zinc, Mn, and Fe are concentrated in the silts and clays, and within the lignite are somewhat enriched in the seam margins. However, results on Cd and As do not necessarily agree with Gluskoter's studies. Cadmium and As are variable but tend to be concentrated in the lignite and enriched in the upper and lower margins. NAA results from the Center mine differ from those found, by Zubovic (2) for lignite in a comparison of float-sink fractions. Zubovic found Ge, Be, Ba, Ti, B, V, Ni, Cr, Co, and Y to have organic affinities, with Mo, Ca, Sa, La, and Zn showing little or no organic affinity. Results from Center Mine show Ti, V, Ni, Cr, and Co not concentrated in the coal. Results with Zn do agree however. Most elements in Illinois coals concentrate towards the margins of coal seam (1). This compares favorably with Center Mine analysis. A major enrichment of Be, U, Ca, Yb, Sc, Ge, Ga, and acid-soluble Ti was found at the margins of lignites (3). The Center Mine seam showed a similar trend for U, Yb, Sc, and Ti.

Concentration towards the margins of the seams may indicate infiltration due to groundwater. Concentration towards the center of the seam may indicate enhancement of inorganics by plant material at the time of deposition. However, formation of minerals in situ and influx of detrital minerals also affect coal seam geochemistry.

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17. LATE QUATERNARY ENVIRONMENTS AT A PREHISTORIC SITE IN WESTERN N.D.

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Late Quaternary climatic fluctuations have been described and modeled in Europe and in North America using pollen, other biotic material, and stratigraphic evidence for support. In North Dakota, evidence of climatic change has utilized similar lines of evidence (1, 2, 3). However, little verification currently exists to tie climatic change of the Holocene to discrete time periods. Research conducted on Anderson Divide, a ridgeline within the Badlands of the Little Missouri River, has provided several links between the above mentioned lines of evidence.

During 1981 seven archaeological sites were excavated along Anderson Divide by University of North Dakota Archaeological Research (UNDAR). Soil profiles were analyzed by detailed field observation including Munsell color comparison and mapping of each profile. Of the seven sites initially tested two yielded the most promising results, the Marsh Hawk site (32BI317) and 32BI249 (unnamed). At each of these sites, preliminary testing indicated significant cultural stratification and excavations exposed distinctive buried soils (Paleosols). Because of the relatively uniform grain size (well sorted) of the sediments and the upland position of the site, it was determined that the mode of deposition was principally eolian. A soil column was collected from 32BI317 and submitted for palynological analysis. Techniques used for pollen extraction, from this sample, are relatively new and are designed specifically for use with soils that are typically poor in preserving pollen (4). Charcoal samples were located in both 32BI249 and 32BI317. All charcoal samples were submitted to GEOCHRON Laboratories for radiocarbon dating.

Pollen analysis of samples from 32BI317 indicates that there have been several changes of climate within the study region. Of particular interest are fluctuations in the relative abundance of Cyperaceae (sedge) and Artemesia (sage) pollen through the soil profile. Cyperaceae pollen is an indicator of cooler-moister conditions while Artemesia pollen is an indicator of warmer-drier conditions. Cyperaceae pollen abundance increased within three separate levels of the excavation at 32BI317; at 10-15 cm below surface, at 35-40 cm below surface, and 45-50 cm below surface. The abundance of Artemesia pollen was essentially the inverse of the Cyperaceae pollen distribution. Peaks of Cyperaceae pollen abundance within the profiles correspond with the occurrence of Paleosols, indicating that these buried soils represent periods of soil development during cooler-moister climatic conditions.

Charcoal recovered from 32BI317 produced radiocarbon dates of 440 $\pm$ 160 BP, at the 10-20 cm level and 1905 $\pm$ 130 BP, at the 35-45 cm level. Radiocarbon dates for 32BI249 (also from charcoal) are 255 $\pm$ 125 BP, at the 10-20 cm level and 3030 $\pm$ 145 BP, at the 70-80 cm level. The two oldest radiocarbon dates correspond roughly to the same excavation levels as the paleosols and the two lower peaks in abundance of Cyperaceae pollen. Younger radiocarbon dates correspond with the upper peak in abundance of Cyperaceae pollen, however, no visible buried soil (humic enriched horizon) was present at that level.

Results of this research strongly support established theories on Holocene climatic fluctuations and indicate at least four periods during the last three-thousand years (including the present) that were relatively moist. Dividing these periods of increased moisture were three separate intervals when the regions climate was distinctively drier than at present.

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18.

POPULATION OF CHINA: A STUDY OF RECENT TREND FROM THE 1982 CENSUS

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According to a government communique released on October 27, 1982, at the completion census, the total population in China is 1,031,882,511 (at the official time, zero hour on July 1, 1982) (1).

Since the task of taking the census in a country with a population of nearly 1,000 million was unprecedented in world history, it had attracted international attention and won the support from the UN Fund of Population Activities.

This paper is an attempt to explain some important findings of the census by using computer-generated maps and charts. Several facts of the population census to be examined in this paper include:

1. The average rate of natural increase in population between 1964 and 1982 is 2.1% (Figure 1).
2. The coastal area is much higher in population density than the inland area (Figure 2).
3. The rate of increase in population density is faster in the inland area than the coastal area.
4. The minority nationalities have experienced a faster rate of increase than the Han nationality.
5. The level of literacy has improved since 1964.
6. The rate of population increase has been very small in cities and towns.

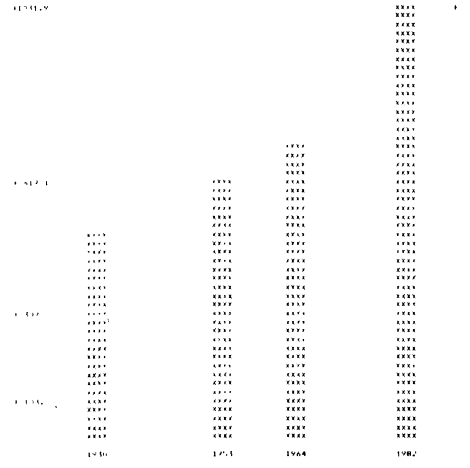

Figure 1 China's population in 1930, 1953, 1964, and 1982 (in millions)

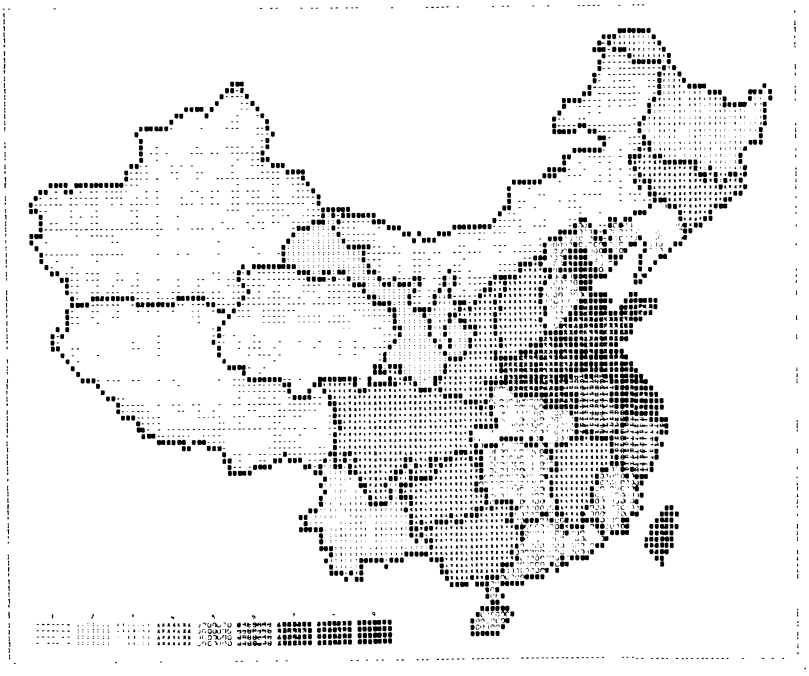

Figure 2 Population density of China in 1982 (person/sq. kilometer)

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19. EYE MOVEMENT ANALYSIS OF MAP DESIGN

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Over several centuries cartographers have developed principles of map construction designed to optimize the kind and amount of information conveyed to an observer in a map. Interestingly there is little empirical evidence bearing on the relationship between the degree of adherence to these principles and the effectiveness of map communication. In the field of psychology the study of communication by the printed word and with pictures has been facilitated by an analysis of the eye movements of observers engaged in reading or picture viewing (1). It was the purpose of this study to apply eye movement analyses to map reading in order to examine the effectiveness of map design in map communication. The map design principle which was investigated involved the organization of the map elements.

The experimental design called for each of forty undergraduate student subjects to view a well-organized and a poorly-organized map while their eye movements were recorded. The maps were thematic maps of fictitious places displaying either population information or farm product information. A well-organized and poorly-organized version of each of four maps were constructed and each subject saw two different maps. Well-organized map versions presented the major map elements (see Table 1) in typical and traditional locations. The same elements were presented in an atypical arrangement in the poorly-organized versions of the maps. Each map was viewed for twenty seconds and eye movements were monitored by a Gulf and Western Eye View Monitor and the data were digitized, recorded, and reduced (off line) by a PDP 11/34 minicomputer. After the second map was shown, the subjects were given a questionnaire which tested their memory for the content of the maps.

One important measure of how the observers were able to process the maps is the locational distribution of eye fixations, where the eyes paused. Particularly revealing is the distribution of eye fixations in the early stages of viewing which shows the immediate effects of the map design manipulation. Table 1 presents the distribution of the first ten eye fixations on several different elements of the well-designed and poorly-designed maps. The three most highly informative elements of these maps are the body, legend, and subtitle, and they received the highest proportion of eye fixations on the well-organized maps. This was not the case for the poorly-organized maps; fixations were prominent on the less informative areas. There were no significant differences in memory.

The distribution of eye fixations on the well-organized maps is consistent with the pattern of eye fixations on informative elements in picture viewing research (2). This pattern was evident early in viewing, supporting the idea that subjects identify important areas very quickly. That the map design manipulation produced significant differences in the distribution of attention (eye fixations) indicates the importance of proper organization in highlighting informative elements for the viewer. The results also suggest that eye movement analysis may be an effective way of studying map design and map communication.

Table 1
Proportion of First Ten Fixations on Different Map Elements

	Map Organization	
Map Element	Good	Poor
Body	.47	.30 *
Title	.13	.17
Legend	.23	.14
Subtitle	.14	.04 *
Data source	.02	.24 *
Scale	.01	.05

*difference significant at $p < .05$

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20. ASTRONOMY 1982. ECLIPSES AND OCCULTATIONS

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et al (1)

Three total eclipses of the Moon and four partial eclipses of the Sun, two weeks before and/or after the lunar eclipses, occurred during 1982 (2). Some thirty-five occultations of SAO/BD stars brighter than tenth magnitude by minor planets were predicted by the calculations of the International Occultation-Timing Association (IOTA) (3). The paths of twelve of these were over the United States and Canada; none were over North Dakota.

LUNAR ECLIPSES

The lunar eclipse of January 9, was visible only in the Eastern Hemisphere and the Arctic. The eclipse of July 6 of m = 1.72, with the Moon in Sagittarius, was visible in the Western Hemisphere. The evening of July 5 was cloudy in Fargo-Moorhead, the Moon gradually disappeared as the partial eclipse began around 2:00 a.m. Due to clouds the total eclipse was not visible and we dismantled our equipment around 3:40 a.m. Two of us took "one last look"; the fully eclipsed Moon, at ca. 4:10 a.m., had emerged from the cloud layer, as a dark russet, or red-brown color, the upper half (north) considerably lighter than the lower portion. Then at 4:24 a.m. a thin white sliver appeared at clock-dial 1:30, and gradually grew to a sickle by 4:35, a half moon by 5:00 a.m. The lunar eclipse of December 30, 1982, of m = 1.18, with the Moon in Gemini, was visible in most of the Western Hemisphere. It occurred one Metonic cycle of almost exactly nineteen years after the lunar eclipse of December 30, 1963. Both eclipses were preceeded by nine months of exceedingly (4) intense volcanic eruptions; that of 1963 by Mount Agung in Bali, that of 1982 by El Chichon in Mexico.

For both eclipses the upper atmosphere had large amounts of very fine particulate volcanic matter (5). Although the sky was fairly hazy on the night of December 29-30, the beginning of the partial eclipse was definitely visible from 4:00 a.m. on. By 4:57 a.m., as observed from the roof of the Sceince Hall at Concordia College, only a thin silvery sliver remained. But instead of disappearing more or less sharply at 4:58 a.m., this thin sliver persisted for at least five minutes. The eclipse was extremely dark, differing very markedly from the russet eclipsed Moon face of July 6, 1982, and of May 25, 1976. Unless our eyes were fully dark-adjusted we could not see it at all. Through binoculars it was very faintly visible and very slightly silvery white, but featureless, contrasted with the very silvery white and clearly defined Moon face of May 25,1976. Even with the Celestron it was impossible to make out any of the lunar landscape. The end of the eclipse was indefinite. A vague illumination appeared at around "two o'clock", brightened up only very slowly at first. It was several minutes after 6:00 a.m., rather than 5:59 a.m., before we could say definitely "the eclipse is over."

OCCULTATIONS OF STARS BY THE ECLIPSED MOON AND BY MINOR PLANETS

Occultations of stars by minor planets (asteroids) are very useful for precise determinations of the orbits of the asteroids, and hence for perturbations of the orbits due to the planets and of other matter in the solar system. The darkness of the December 30 lunar eclipse should have been very favorable for observations of the occultations of stars in the path of totality from R.A. 6^h30^m to 6^h35^m. Due to the haze we were unable to see any stars in the area subject to occultation. A similar situation occurred in 1963. Only three occultation observations were reported. (6)

On September 14, Dr. David W. Dunham called from IOTA headquarters to report that new photographs at the Lick Observatory indicated that an occultation-path would be shifted northward from that predicted earlier. Fargo-Moorhead was now nearly on the centerline for the occultation of the m = 9.2 star SAO 92517 by the m = 9.7 asteroid No. 19, Fortuna. The central path occultation of 60 seconds (most last less than 20 seconds) would be 9:16 p.m. (9:10-9:20). At the moment of occultation the combined brightness m_1+m_2 of the star and asteroid, equivalent to 8.7 m, should suddenly change one whole magnitude to 9.7 m. At the end there would be a flash increase from m = 9.7 to m = 8.7, and then the separation into m = 9.7 and m = 9.2.

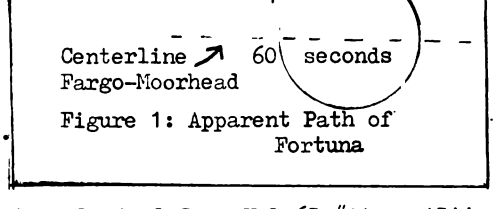

Figure 1: Apparent Path of Fortuna

We were able to observe this star-field in Pisces, around 9:00 p.m. September 16. The sky was cloudy on September 17, - rain. A 14 second occultation observed in Colorado (7) near the southern edge of the path indicates that the center line was slightly south of Fargo-Moorhead.

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21. APPLICATIONS OF 200 MHZ PROTON NMR TO THE CHARACTERIZATION OF COAL DERIVED LIQUIDS

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Direct liquefaction of coal under high temperature and pressure uses a process-derived solvent to disperse the coal as a feed slurry, and to act with the reducing gases as a hydrogen donor. Proton NMR was used to characterize solvents for compound types, phenolic content, potential H-donor ability, and to predict cracking tendencies. The unavailability of process-derived oils for experiments on specific coals requires that coal-derived substitutes such as anthracene oil be used in batch autoclave experiments and as startup solvent in recycle mode continuous process experiments. Using NMR, various batches of anthracene oil were found to vary from 2 to 34% in alkane content. High alkane content corresponded with high yields of C_1 to C_4 hydrocarbon gases obtained when using the anthracene oil as a liquefaction pasting solvent at 460°C (1). Products were analyzed from tests in which the various anthracene oils were heated to 460° to 500°C in an autoclave. The methyl and methylene signals in their proton NMR spectra were greatly reduced by the resulting cracking reactions. Alkanes are an undesirable component of solvents for direct coal liquefaction since they tend to form gases.

The use of high field Fourier transform proton NMR to examine milligram quantity fractions from separations of coal derived liquid products has led to an understanding of their complexity (2). Assignment of most of the proton NMR signals in a complex mixture of coal derived liquids became possible after 200 MHz spectra of some 400 pure compounds found in coal liquids were published (3). Areas of overlapping proton NMR signals were identified which emphasize the necessity for separations prior to NMR analysis. These include: 7.0-6.2 ppm (aromatic protons on phenols and hydroaromatics such as tetralin and partially hydrogenated phenanthrene), 1.2-3.2 ppm (alkyl substituents on phenols and on aromatics), 0.5-1.7 ppm (alkanes and alkyl substituents on aromatic rings). Signals from hydrogen donors (1.1-2.9 ppm) underlie the whole aliphatic proton region.

The identification of isomers in mixtures of coal liquids is easily accomplished by proton NMR. The methylene bridge signals of fluorene and its derivatives are readily observed by proton NMR of mixtures. They are fluorene 3.893 ppm, 2-methylfluorene 3.864 ppm, 4-methylfluorene 3.905 ppm, 1-methylfluorene 3.799, 1,2-benzofluorene 4.195 ppm, and 2,3-benzofluorene 4.088 ppm. The methyl signals for the methylbiphenyls occur at 2.272 (2-methylbiphenyl) 2.440 (3-methylbiphenyl) and 2.396 (4-methylbiphenyl). Triphenylene and chrysene have the same mass and capillary GC retention index, but are easily distinguished by proton NMR.

The methylbenz(a)anthracene isomers are readily identified by proton NMR. The methyl signals of some of the isomers are: 2.657 (2-methyl), 2.570 (3-methyl), 2.731 (5-methyl), 2.802 (6-methyl), 3.121 (7-methyl), 2.832 (8-methyl), 2.576 (9-methyl), 2.592 (10-methyl), 3.368 (12-methyl), 3.226 and 3.109 (1,7-dimethyl), 3.248 (1,12-dimethyl), 2.572 (3,9-dimethyl), 3.054 and 2.743 (5,7-dimethyl), 2.848 and 2.807 (6,8-dimethyl), 3.360, 3.061 and 2.601 (2,7,12-trimethyl), 3.112, 2.964 and 2.894 (6,7,8-trimethyl), and 3.386, 2.872 and 2.779 (6,8,12-trimethyl).

The best understanding of the composition of coal liquids is obtained by fractionating the sample into fractions with minimal proton NMR signal overlap, then analyzing each fraction by capillary gas chromatography, capillary GC/MS and high field proton NMR.

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22. INTERESTING PHOTOCHEMISTRY OF DIARYL ETHERS

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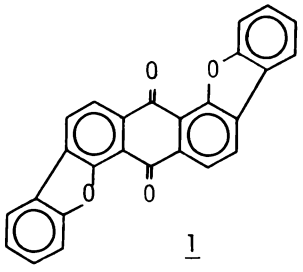
As part of an ongoing project to prepare model compounds of coal derived liquids for use as gel permeation chromatography (GPC) molecular weight standards, we desired the polycyclic molecule shown below (1). The route chosen for synthesis of 1 involved nitration of anthraquinone to give



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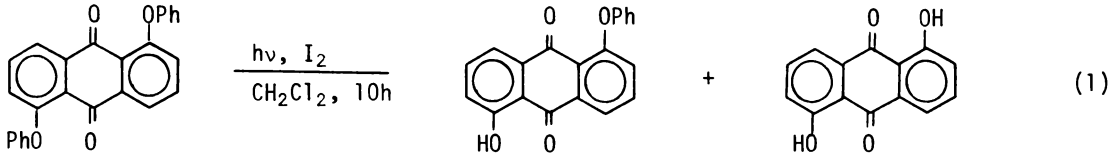
1,5-dinitroanthraquinone, which was then coupled with phenol in the presence of potassium carbonate to give 1,5-diphenoxyanthraquinone (2).[1] The final step, a photochemical cyclization, was not successful. Unlike the analogous conversion of diphenyl ether to dibenzofuran,[2] irradiation (254nm) of a CH_2Cl_2 solution of 2 yielded two products of ether cleavage (eq 1) and recovered 2.



(1)

2 3 (20%) 4 (30%)

1-Phenoxy-5-hydroxyanthraquinone (3), a new compound, and the known 1,5-dihydroxyanthraquinone (4)[3] were both characterized by melting point, elemental and spectral analyses. Data are shown in Table 1. Similarly, irradiation of bis-1,5-(o-chlorophenoxy)anthraquinone (5) also resulted in cleavage rather than cyclization.

Table 1. Analytical Data for Photochemical Ether Cleavage Products

		Calc, %			Found, %			Infrared
Cmpd	mp, °C	C	H	O	C	H	O	C=O (cm^{-1})
3	190-192°	75.90	3.79	20.31	75.89	3.81	20.30	1640, 1672
4	280-281°(lit 280)[3]	70.00	3.34	26.66	69.87	3.56	26.57	1638

A potential key feature in the different photochemical behavior of diphenyl ether vs. 2 or 5 is the presence of carbonyl moieties in 2 and 5. To assess the role of the quinone, 2 and 5 were reduced to the corresponding dihydroanthracene derivatives (6 and 7, respectively) with $LiAlH_4/TiCl_4$ in tetrahydrofuran.[4] Irradiation (254nm) of a CH_2Cl_2 solution of either 6 or 7 for 10h afforded only starting material. No products from cyclization or cleavage could be detected. Thus, it appears that the quinone chromophore is essential to the cleavage reaction.

In summary, this communication describes the first example, of which we are aware, of a photochemically induced cleavage of diaryl ethers. Further investigations to establish the scope and mechanism of this reaction are underway.

We acknowledge support from the U.S. Department of Energy under contract No. DE-FG22-81PC40810.

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23. DETERMINATION OF CHLORIDE IN COAL GASIFICATION WASTEWATERS BY WAVELENGTH DISPERSIVE X-RAY FLUORESCENCE SPECTROMETRY

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The Grand Forks Energy Technology Center (GFETC) is involved in the assessment of coal gasification wastewater treatment simulating of the commercial coal gasification project in Beulah, North Dakota. Of primary concern is the effectiveness of wastewater pretreatment for reuse in a cooling tower. The function of the cooling tower is to concentrate the waters by a factor of ten before final disposal. Chloride concentration was chosen for monitoring the cycles of concentration.

The wastewater treatment scheme used at GFETC is shown in Figure 1, with sampling points designated S-2 through S-13. In the solvent extraction column wastewater is extracted with diisopropyl ether (DIPE) to remove a major portion of the soluble organics. Wastewater then proceeds to the nitrogen stripping column, to strip out excess DIPE solvent. The wastewater is steam stripped in the last column to remove ammonia and dissolved acid gases. This treated wastewater is used as makeup for the cooling tower where it is concentrated by evaporation.

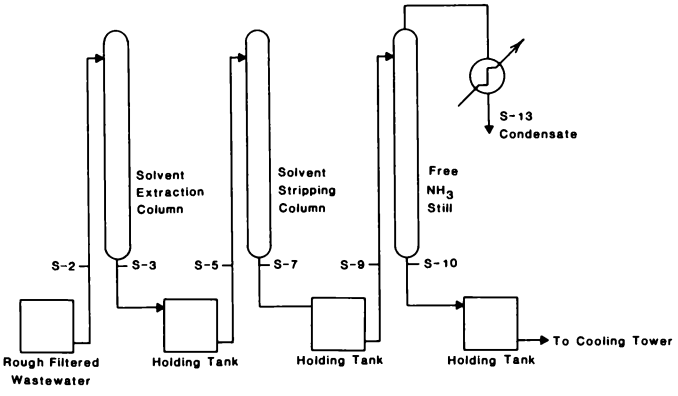

FIGURE 1.
Gasification wastewater pretreatment scheme.

The raw wastewater is strongly buffered at a pH near 8.5. The presence of sulfides, cyanides, thiocyanides, and sulfates make analysis for chloride very difficult. Ion chromatography has been used successfully but we do not have one in our laboratory. Because of this, wavelength dispersive x-ray fluorescence spectrometry was selected as the only available means for monitoring chloride concentrations in the cooling tower.

In wavelength dispersive x-ray fluorescence, x-rays radiate the sample, forming secondary x-rays which are then diffracted by a crystal according to Bragg's law. As the crystal is rotated, x-rays of different wavelength are diffracted. The detector is rotated to the proper position to detect the secondary x-rays characteristic of a particular element.

The instrument used in this work is a wavelength dispersive x-ray fluorescence spectrometer equipped with chromium x-ray tube and a pentaerythritol (PET) crystal. The detector angle was set at 65.4° corresponding to the chlorine kα line. The instrument was set up to measure the time required to register 10,000 counts of radiation to achieve a counting precision of 1%. Standard chloride solutions of 10, 20, 30, 50, and 100 ppm were prepared using deionized water. The results of the analyses are shown in Table 1.

TABLE 1
RESULTS OF CHLORIDE ANALYSIS

Standard	Counts/sec	Sample	Counts/sec	ppm
Blank	36.29	S-2	59.63	92.8
10 ppm	37.25	S-5	59.61	92.8
20 ppm	39.76	S-9	--	--
30 ppm	43.43	S-13	--	--
50 ppm	48.40	S-10	41.17	23.8
100 ppm	61.33			

The blank value was higher than expected and was therefore excluded from the curve fit. The correlation coefficient for the curve was 0.9982 and slope of the curve was 0.268 (count/sec)/ppm. With such a low slope it is critical that enough measurements be taken to insure high precision.

With samples S-9 and S-13, unstable measurements prevented accurate analysis. The variability of the readings appears to be due to high levels of volatile organics in these samples.

Sample S-10 was sent to Dionex Corporation for analysis on an ion chromatograph. The chloride concentration was found to be 18 ppm compared to 24 ppm with wavelength dispersive x-ray fluorescence using a standard curve and 19 ppm using standard additions. These results indicate that wavelength dispersive x-ray fluorescence is a viable method for determining chloride concentrations in coal gasification wastewaters.

24. SIMULTANEOUS DETERMINATION OF MAJOR, MINOR, AND TRACE ELEMENTS IN WET DIGESTED BIOLOGICAL SAMPLES BY INDUCTIVELY COUPLED ARGON PLASMA SPECTROSCOPY

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Inductively coupled argon plasma emission spectroscopy (ICAP) was investigated as a relatively new analytical tool in our laboratory for simultaneous multielement determinations in biological samples for human nutritional studies. The inherent physical properties of a plasma system offer analytical performance characteristics that permit extended linear dynamic ranges, low detection limits, and relative freedom from matrix, chemical and ionization interferences.

Combustion flames and argon plasmas provide a means for converting inorganic analytes in solution into free atoms. Once the free atoms are formed they may be detected and determined quantitatively at the trace level by atomic absorption (AAS), emission (AES), or fluorescence (AFS) spectroscopic techniques. AAS and AFS require an auxiliary primary source; and true simultaneous multielement determinations on large numbers of samples with varying mineral concentrations pose operational problems for these techniques. The purpose of this investigation was to determine to what extent the inductively coupled argon plasma excitation source could overcome some of the limitations of mineral determinations by AAS procedures in analyses of biological tissue, and how these results compare with respect to specificity, precision and sensitivity.

In this study ICAP has been used to determine nine elements (Zn, Cu, Fe, Ca, Mg, Mn, Na, K, and P) in a broad range of biological materials: well characterized National Bureau of Standards Reference Materials (NBS SRM, orchard leaves, bovine liver, oyster tissue and spinach) and human diet and fecal composites obtained from human volunteers during metabolic balance studies.

Samples were homogenized, dried, then wet-ashed in Baker "Instra-Analyzed" nitric acid and perchloric acid (6:1). Dry weights ranged from 0.2 to 0.5 grams and wet weights ranged from 4.0 to 5.0 grams for the blended diets. Samples were then analyzed by ICAP, and by AAS for Cu, Zn, Fe, Ca, Mg and Mn. Na and K were determined by flame photometry and P analyzed colorimetrically. Solution concentrations ranged from less than 30 ppb for the trace elements to more than 800 ppm for the major elements.

Table 1. AAS versus ICAP µg/g

	Liver Standard			Spinach Standard		
	NBS Cert. Value	Standard Method	ICAP	NBS Cert. Value	Standard Method	ICAP
Cu	193±10	186±4	185±3	12±2	10.9±0.5	11.7±0.5
Zn	130±13	136±2	127±4	50±2	52.2±1.1	48.5±1.9
Fe	268±8	265±4	261±4	550±20	538±3	534±6
Ca	124±6	126±4	130±3	13.5±0.3	13.2±0.3	12.9±0.1
Mg	604±20	609±9	593±9	--	8.5±0.1	8.3±0.1
Mn	10.3±1.0	11.1±1.0	11.0±1.2	165±6	170±3	161±2
Na	2.43±0.13	2.51±0.1	2.2±0.1	--	14.5±0.9	13.8±0.6
K	9.7±0.6	10.5±0.9	9.1±0.1	35.6±0.3	35.8±0.9	34.5±0.5
P	11.0	11.5±0.5	10.7±0.1	5.5±0.2	6.0±0.3	5.2±0.1

As seen in Table 1, ICAP methods compare favorably with AAS and standard methods both from the standpoint of precision and accuracy. Real detection limits (ng/ml) determined experimentally are as follows: Zn, 23; Cu, 5; Fe, 10; Ca, 308; Mg, 183; Na, 12; K, 300; P, 296; and Mn, 9. In most cases, these limits are superior to those obtained by AAS. A major advantage of ICAP is the ability to determine, accurately and precisely, large numbers of elements simultaneously in a single sample.

25. CHARACTERIZATION OF REACTOR SOLIDS FROM THE LIQUEFACTION OF SELECT LOW-RANK COALS

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The liquefaction of low-rank coals to distillable products has undergone extensive research at the Grand Forks Energy Technology Center (GFETC). One of the areas of research investigates the incomplete conversion of the feed coal to liquid or gaseous products. Some tarry and brittle coke-like solids form and remain in the reactor, causing unscheduled shutdowns for removal of the solids. This study analyzed solids extracted from the liquefaction reactor at GFETC. Feed coals were Beulah (N.D.) #3 and Big Brown (Texas) #2 lignites.

A Unitron Unimet Series MR† metallographic (reflected light) microscope was utilized to study the mineral matter in the reactor solid samples. The samples were mounted in clear epoxy cement and polished to accentuate mineral and maceral matter. Minerals were identified using automated powder x-ray diffraction (XRD). A Philips APD3600-02† x-ray diffractometer with a standard goniometer, generator and Data General Nova 4† computer was used. In addition, a JEOL JXA-35† Electron Probe microanalyzer/Scanning Electron Microscope and elemental mapping techniques were utilized to further identify mineral phases in the samples.

Microscopic examination of two mounted samples, Run 47-3 (Beulah) and Run 82-2 (Big Brown) revealed different internal morphologies. Figure 1 is a photomicrograph of a reactor solid sample from Run 47-3. Shown are large (0.5-1 mm) sub-angular to sub-rounded domains of partially reacted or unreacted macerals and finely dispersed mineral matter. Samples from Run 82-2 displayed generally smaller (.01-.5 mm) sub-rounded to rounded domains of macerals and mineral matter. Along the outside edge of the Run 82-2 plug was a whitish crust, approximately .05 mm wide, which is a highly mineralized zone resulting from a more complete reaction of the coal near the reactor walls.

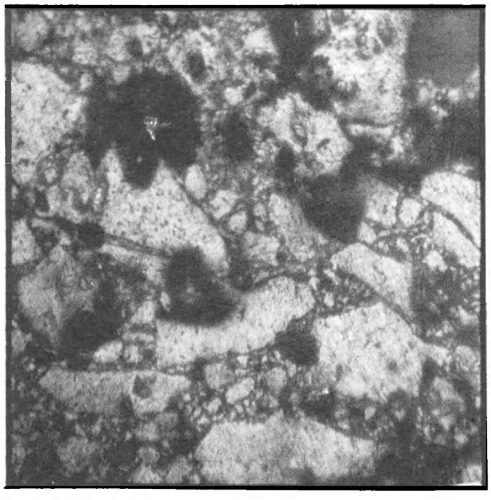

Figure 1. Photomicrograph of Run 47-3 solid.

Minerals in the original coals included quartz, pyrite, calcite, kaolinitic clays, gypsum, and trace amounts of feldspars. These minerals persisted in the reactor solids with the exception of gypsum and pyrite. All of the pyrite was reduced to pyrrhotite during the reaction.

It has been noted in the literature that H_2S gas, added to enhance coal conversion, also decreases atomic iron percentage in reactor solids (1). Such a correlation was studied for samples in this study with an analytical method using XRD data (2). Results from this study indicate that addition of H_2S did not decrease atomic iron percentage in the solids.

A correlation between feed coal and macroscopic and microscopic characteristics of the reactor solids could not be made, as solids from both feed coals exhibited a wide variety of external features and both were comprised of similar mineral matter. Reflectance work revealed some differences in size and shape of macerals and minerals in the reactor solids.

1. Montano, P.A. and Granoff, B., Fuel 1980, 59, p. 214-216.

2. Lambert, J.M., Simkovich, G., and Walker, P.L., Fuel 1980, 59, p. 687-690.

†Reference to specific brand names and models is done to facilitate understanding and neither constitutes nor implies endorsement by the Department of Energy.

26. USE OF NOVEL EQUIPMENT IN LIGNITE LIQUEFACTION

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A versatile autoclave system and tubing bomb apparatus have been built at the University of North Dakota to continue liquefaction studies of low-rank Western Coals. Innovations include constant pressure direct displacement charging to a hot autoclave, flush-mounted liquid-phase sampling valve, and multiple gas-phase sample retention system. Innovations in both gas and slurry charge systems have resulted in accurate and reproducible charges to the reactor. In the series of runs represented in Table 1, Beulah lignite was contacted with various aqueous salt solutions prior to charging. The standard charge of moisture- and ash-free coal (MAF) for this series was 200.00 grams. Feed gas was charged by positive displacement and produced charge values close to the standard charge of 9.80 gmoles. Material balances greater than 95 percent were achieved in all of these time sampled runs.

The tubing bomb apparatus includes twelve 20 cc high pressure reactors mounted on a variable speed vertical agitator. Heat is supplied using an electrically heated fluidized sand bath. The tubing bombs and agitator are mounted on a hydraulic ram cylinder to facilitate the easy loading of the tubing bomb/agitator assembly into the pre-heated sand bath and to aid quick removal and quench in a 10-gallon water bath at room temperature.

TABLE 1

Reproducibility of Charge and Material Balance

Run Number	Gms. of MAF Coal Charged	Gmoles of Gas	% Material Balance Closure
N-113	199.59	9.78	95.37
N-114	199.36	9.79	95.08
N-115	200.80	9.79	98.55
N-116	200.53	9.81	95.93
N-117	200.51	9.75	96.06

27. SUGAR BEET PROCESSING WASTEWATER TREATMENT BY THE ACTIVATED SLUDGE PROCESS

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The treatment of wastewaters from beet sugar refineries is drawing more attention due to the large amount of water used in the process as well as the undesirable impacts of untreated effluents on the environment. Sugar beet processing occurs in the northern climates of the U.S. and Europe. The annual production of refined sugar is more than three million tons from sugar beet raised in 29 states in the U.S. The population equivalent in terms of BOD (biochemical oxygen demand) loading for an average beet sugar refinery of processing 2000 tons of sugar beets per day is equivalent to a city of 250,000 people. In order to reduce the pollution effect of processing wastewaters, treatment processes such as gravity settling and biological treatment have been employed. Tertiary treatment method using flocculation/coagulation was also proposed (Leentvaar and Koppers, 1979). Due to the low cost and high treatment efficiency, biological treatment process is the most commonly used method in treating high organic wastewaters including sugar beet processing wastewaters. The objective of this study is to determine the feasibility of using activated sludge process in treating sugar beet processing wastewaters and to determine effects of anaerobic pretreatment and powdered activated carbon (PAC) addition on the performance of activated sludge process.

Effluents from the primary settling tank in a beet sugar refinery located in the Red River Valley were used in this investigation. Wastewater were stored at 0°C in the freezer prior to use. Wastewaters were pumped to the anaerobic filter for pretreatment prior to secondary treatment received in the two complete mix activated sludge (CMAS) reactors operated in parallel. The CMAS reactors had a hydraulic detention time of 3 days and a sludge age of 10 days. CMAS reactor 1 operated as a conventional activated sludge reactor without PAC addition, while CMAS reactor 2 operated as a PAC activated sludge reactor with an addition of 2 g/l of Westvaco Nuchar S-A powdered activated carbon in the aeration tank of the activated sludge unit. Since wastewaters were deficient in nitrogen and phosphorus nutrients, Na_2HPO_4, $NaH_2PO_4.H_2O$ and NH_4Cl were added to the wastewaters to yield a BOD :N:P ratio of 100:5:1.

The anaerobic filter and activated sludge reactor performance data is shown in Table 1. The feed wastewaters had a relatively high COD (chemical oxygen demand) of 13,700 mg/l. Pretreatment by anaerobic filter removed 40% of the feed COD with an effluent COD of 8,240 mg/l. CMAS reactor effluents contained 2,570 mg/l COD for reactor 1 without PAC addition and 2,040 mg/l COD for reactor 2 with 2 g/l PAC addition. These corresponded to 81 and 85% COD removals for these two reactors. Addition of PAC improved CMAS reactor performance with a further COD reduction of 500 mg/l in the PAC reactor. It also enhanced sludge settling. For the PAC reactor effluent TSS was 1,640 mg/l, while for the non-PAC reactor it was 2,240 mg/l. Effluent VSS was 1,240 and 1,450 mg/l for the PAC and non-PAC reactor, respectively. In this study, high levels of mixed liquor suspended solids (MLSS) and mixed liquor volatile suspended solids (MLVSS) were maintained in the CMAS reactors. This was due to the high concentration of COD presented in the feed wastewaters. Higher levels of MLSS and MLVSS were observed in the PAC reactor partially due to the addition of PAC in this reactor.

In conclusion, the activated sludge process can be used effectively in treating sugar beet processing wastewaters. Anaerobic filter pretreatment reduced significant amount of COD in the wastewaters and reduced the volume requirement for the activated sludge treatment units. PAC addition to the activated sludge treatment units improved both the COD removal efficiencies and the sludge settling properties.

Table 1 Anaerobic Filter - Activated Sludge Reactor Performance Summary

Reactor	Hydraulic Detention Time (day)	PAC (g/l)	Infl. COD (mg/l)	Effl. COD (mg/l)	%COD Removal	MLSS (mg/l)	MLVSS (mg/l)	Effl. TSS (mg/l)	Effl. VSS (mg/l)
Anaero. Filt.	2.5	-	13,700	8,240	40	-	-	-	-
CMAS 1	3	0	8,240	2,570	81	11,600	8,040	2,240	1,450
CMAS 2	3	2	8,240	2,040	85	14,300	9,640	1,640	1,240

Leentvaar, J. L., and Koppers, H. W. (1979). Coagulation/flocculation of beet sugar wastewaters. Jour. Water Pollution Control Federation, 51 (10): 2457-2466.

28. PREDICTION OF OPTICAL FIBER PROPAGATION CHARACTERISTICS USING THE SELLMEIER EQUATION

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The bandwidth for single-mode optical fibers is maximum when operation of the system takes place at the wavelength for minimum total dispersion, $\hat{\lambda}$. Theoretical research concerning dispersion in monomodal step-index optical fibers has been based on assumed prior knowledge of the core radius and of the materials that constitute the core and the cladding, so that the wavelength, $\hat{\lambda}$, can be found. In a previous publication (1) the exact characteristic equation and numerical methods for differentiation and interpolation for calculating the value of $\hat{\lambda}$ for monomodal step-index optical fibers have been used. The results thus obtained were compared with those that were arrived at utilizing asymptotic formulas. In spite of the excellent results obtained and of having made possible the extension of the analysis that had been developed to other cases, the large quantity of calculations required the availability of a medium to large computer system. When such a system is not available, some approximate methods, with acceptable precision in these circumstances, allow the implementation of of programs to calculate the value of $\hat{\lambda}$ using programmable calculators or microcomputer systems. Utilizing the well-known total dispersion formula derived with the objective of calculating $\hat{\lambda}$, together with the approximate formulation for the eigenfunction U proposed by Miyagi and Nishida (2), we prepared some programs for a programmable calculator that make possible the design of monomodal step-index optical fibers.

The value of the wavelength for minimum total dispersion, $\hat{\lambda}$, depends on: (a) physical characteristics of the materials that constitute the core and the cladding, (b) the core radius, and (c) the propagation constant of the dominant HE_{11} mode and some of its derivatives. This value is calculated for the core radius, a, with a predetermined value (for a known fiber), by solving the total dispersion equation. In this paper, we assumed that the wavelength dependence of the refractive indices is given by the three-term Sellmeier equation.

The value of $\hat{\lambda}$ may be the value for which the lowest loss has been found. The idealized fibers studied possess different concentrations of GeO_2 in SiO_2 as core materials and fused or quenched SiO_2 as cladding materials. Some values of $\hat{a}$ at constant values of $\hat{\lambda}$ were calculated for the fibers. The results, obtained to a precision of 10^{-5} for $\hat{a}$, are presented in Table 1. The average computational time necessary for calculating each of the ideal radii using the TI-59 programmable calculator was four (4) minutes.

TABLE 1

Values of $\hat{a}$ for fused SiO_2 cladding.

$\hat{\lambda}$	CORE MATERIAL	
(μm)	13.5% GeO_2 - 86.5% SiO_2	7.0% GeO_2 - 93.0% SiO_2
	$\hat{a}$ (μm)	$\hat{a}$ (μm)
1.45	2.2143	2.3874
1.50	2.0773	2.1650
1.55	1.9791	1.9918

Due to the behavior of the normalized propagation constant for some values of normalized frequency, attributed to the approximate formula used for the parameter U, the method of synthesis used here does not permit us to find, for a single value of $\hat{\lambda}$, two values of the core radius. This fact is the only limitation imposed on the theoretical development established here.

1. Pires, P. S. M. et al. (1982) IEEE Trans. Microwave Theory Tech. MTT-30, 131-140.

2. Miyagi, M. and Nishida, S. (1979) J. Opt. Soc. Amer. 69, 291-293.

29.

MICROSTRIP DIELECTRIC RESONATOR FILTERS FOR MICROWAVE COMMUNICATION

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The highly stabilized and extremely low loss filters at microwave frequencies can be achieved by coupling a microstrip line with a dielectric resonator of high dielectric constant, high Q and high temperature stability. The dielectric resonator filters [1] in microstrip form have the inherent property of frequency stability over wide temperature range, spurious free response, small size and very high Q.

Simple techniques of analysis of microstrip dielectric resonator bandpass and bandstop filters have been developed and some useful numerical results for design of such filters have been obtained. The simple coupling mechanism [2][3] between microstrip and dielectric resonator is shown in Fig. 1(a) and the equivalent circuit in Fig. 1(b). The input impedance of this circuit is given as,

$$Z_{in} = j \frac{(1+\omega L_p - \frac{2}{\omega C_p}) \frac{2\omega_r L_r \omega_f}{\omega^2 L_m^2}}{\frac{4\omega_r L_r \omega_f}{\omega^2 L_m^2} + \frac{\omega C_p}{2} - \frac{\omega_r L_r \omega_f}{L_m^2} L_p C_p} \quad \text{------(1)}$$

where, L_r, C_r, L_p, C_p → inductance and capacitance of resonator and microstrip respectively, L_m is mutual inductance, ω_r is the resonant frequency and $\omega_f = \frac{\omega - \omega_r}{\omega_r}$.

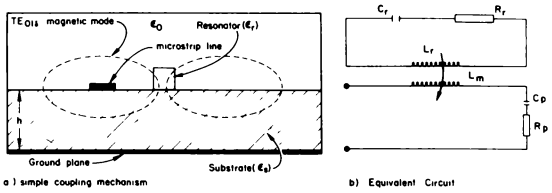

Fig 1 Dielectric resonator coupled to a microstrip line

The external Q is obtained as, $Q_e = \frac{4Z_p^2}{Z_o Z_c} + \frac{Z_p}{Z_o}$ (2)

where, $Z_p = (\omega_r C_p)^{-1}$, $Z_c = \omega_r L_m^2 / L_r$ i.e. the coupling impedance and Z_o is characteristic impedance.

For a bandstop filter, the external Q is obtained as, $Q_e = \frac{4Z_o W}{\omega_r \mu_r^2 M^2} \frac{1}{H/I}$ -----(3)

where, W is the energy stored in the resonator, M is the magnetic dipole moment, H is the magnetic field produced by current I and μ_r is the relative permeability of the dielectric material.

External Q as a function of Z_p and Z_c for a bandpass filter is shown in Fig. 2. It is observed that higher Q_e is obtained for lower values of coupling impedance Z_c. This requires lower mutual inductance and higher resonator inductance values. The lower value of coupling impedance is obtained for microstrip with lower impedance for the same value of external Q. The lower impedance microstrip results in wide strip with small losses and easy for fabrication.

The external Q for a bandstop filter depends upon W/M^2, H/I and frequency as shown in Fig. 3. It is observed that Q_e and W/M^2 are linearly related and the rate of increase of Q_e is higher at lower values of W/M^2 and H/I. For a fixed value of W/M^2 and H/I, the larger external Q is obtained at lower frequencies. This is true as the losses are small at lower frequencies.

Based on these analyses the simple lumped element circuit models for microstrip bandpass and bandstop filters using dielectric resonators have been developed. These numerical results are quite useful for the design of microstrip dielectric resonator filters.

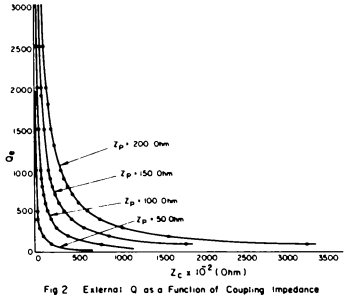

Fig 2 External Q as a Function of Coupling Impedance

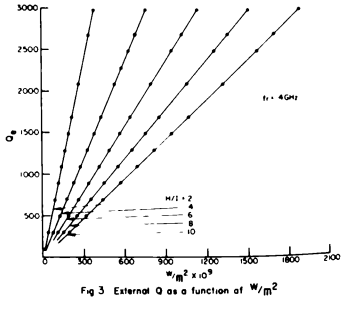

Fig 3 External Q as a function of W/m^2

[1] Wakino, K., IEEE, MTT-S Int. Symp. Digest, pp. 230-232, May 1979.

[2] Bonetti, R., Atia, A. E., IEEE Trans. MTT-29, pp. 1333-1337, Dec. 1981.

[3] Guillon, P., et al, Proc. IEE, 128, Pt. H, pp. 151-154, June 1981.

30. DETERMINING RANGE CONDITION ON THE NORTH DAKOTA STATE SCHOOL LANDS

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Large tracts of original grant lands still remain in public ownership in North Dakota as State University and School Lands. These lands are leased and managed by the State Land Department. Of this 708,014 acres, approximately 97% are rangelands and grazing is the major use. Until recently, most of these tracts had not been analyzed by a range management specialist and were leased to the highest bidder without sound management recommendations.

During the summers of 1980-82, the State Land Department contracted with the Botany Department of NDSU to conduct a range inventory on these rangelands. The objectives of the study were to: 1) determine range type and condition; 2) determine grazing capacity and calculate stocking rates; 3) make recommendations for maintanence and improvement of each tract; and 4) provide information which would increase the management effectiveness of the State Land Department if it is to insure the proper use of this public resource.

Initially, the range condition of each management unit was determined by range site. Due to the large number of acres to be appraised strict quantitative techniques were impractical, therefore, plant species composition was based on ocular estimates by weight for each range site. A species list was compiled and the proportion that each species contributed to the community was recorded. The percentages of decreasers, increasers, and invaders in the community were then determined, and a range condition class of excellent, good, fair or poor was assigned (2). SCS range technician guides were used in the final assessment of range condition and to compute stocking rates in Animal Unit Months (A.U.M.).

Additional information pertinent to the management of each grassland tract was gathered. A brief description was given for each tract's physiography, grazing history, presence and condition of woody draws and forests. Plant vigor, seedling establishment, presence of litter and soil erosion were noted, as well as a list of any rare plant or animal species observed, and the approximate area occupied by noxious weeds.

Although the inventory was completed for 12 counties (Benson, Bottineau, Burleigh, Eddy, Emmons, McHenry, Morton, Oliver, Pierce, Ramsey, and Wells; a total of 164,871 acres) over the past three summers, the final percentages of range sites, range condition ratings, and stocking rates have been determined for only six counties (65,770 acres) thus far. Overall, the range condition ratings have been slightly higher than previously expected, however, there is a large percentage of land that is in need of improvement. Approximately 67% (44,066 acres) were in good, high good, or excellent range condition. No special management plan will be implemented for these units. The remaining 33% (21,704 acres) were in low good, fair, or poor condition. These tracts have been overutilized and will require immediate management decisions to alleviate the problems. A simple adjustment in the stocking rates should suffice for most units, while poorer tracts may require several years of complete rest.

This inventory is part of an on-going ten year project. With its completion, a multiple-use management plan will be implemented (1). The State Land Department has now halted the sales of these public lands and is changing their role from that of passive lessor to that of an active cooperative manager. This type of plan should insure the proper use and management of this valuable public resource.

1. Brand, M. D. 1979. Multiple-use range inventory and analysis plan: North Dakota State Land Department. Submitted to the Board of Univ. and School Lands, Bismarck, ND. 10 p.

2. Dyksterhuis, E. J. 1949. Condition and management of rangeland based on quantitative ecology. Jour. of Range Mange. 2:104-115.

31. GROWTH CHARACTERISTICS OF WESTERN SNOWBERRY IN THE NORTH DAKOTA BADLANDS

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Symphoricarpos occidentalis Hook., commonly called western snowberry, buckbrush, or wolfberry is one of the characteristic and abundant shrubs of the Northern Great Plains. It's an important component of many of the woody vegetation types found in the Badlands. These vegetation types provide food and shelter for a variety of wildlife species. They also provide shelter for livestock and, in times of stress, become an important source of forage. In spite of the relatively important role filled by western snowberry in these woody vegetation types, there is little baseline ecological information for the species. This paper reports the results of a growth and production study conducted from 1979 to 1981.

Four woody vegetation types were selected for study, including brushy hillside, upland depression, cottonwood bottom, and sagebrush flat. One site of each type was established in Theodore Roosevelt National Park and another in the Little Missouri National Grasslands. On each site, quadrat locations were marked with stakes on each of 4 transects. One-half of the quadrats on each transect were randomly selected in order to determine growth factors using twig length measurements, and the other one-half were used to estimate production by clipping and weighing current annual growth. Data were collected from all stems occurring within a quadrat.

Growth and production appear to be affected by early spring precipitation. Annual precipitation totals recorded at Medora, N. D., were 24.8, 28.7, and 31.7 cm in 1979, 1980, and 1981, respectively. Monthly totals from April through September each year were all 2.5 cm or greater, except in the spring of 1980 when no precipitation was recorded in April and only 0.7 cm in May.

Mean twig length for all sites was 60, 25, and 86 mm in 1979, 1980, and 1981, respectively, reflecting the variation in precipitation. Mean total length per stem followed a similar pattern, with values of 383, 166, and 379 mm in each year, respectively. In 1980, growth was 84% complete by June 1 (Figure 1) and 96% by July 1. In 1981, growth was 71% complete on June 1 and 91% on July 1. Mean twig length peaked and leveled off early in the growing season in the dry year, and continued to increase until the end of the growing season in the wet year.

Separation of growth data by age class indicated that mean twig length and age of the shrub are related. The seedling age class had the longest mean twig length with an average value of 187 mm over the 3 years of the study. This value steadily decreases as the shrubs age and are recruited into older age classes. Mean twig lengths for the resprout, young, mature, and decadent age classes were 153, 67, 42, and 41 mm, respectively. Mean total length per stem, on the other hand, increases with age due to the greater number of twigs.

Average above ground production (Table 1) for all sites in 1979, 1980, and 1981 was 608, 232, and 734 kg/ha air dry, respectively. Upland depression had the greatest yield followed by sagebrush flat, brushy hillside, and cottonwood bottom. Separation of above ground production by age class showed that mature stems were highest in production with a 3-year average of 246 kg/ha. This is followed by the seedling, young, resprout, and decadent age classes with values of 124, 93, 51, and 28 kg/ha, respectively. Relative percent of twig material was 29, 20, and 40% for the three years, respectively. This converts to 173.3, 46.4, and 293.6 kg/ha of winter browse for each year of the study.

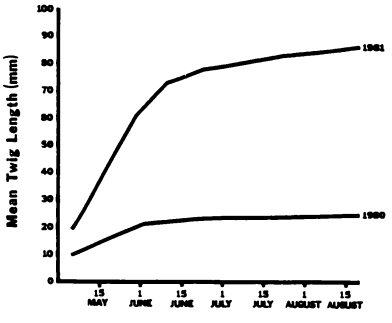

FIGURE 1. GROWTH RATE CURVES FOR MEAN TWIG LENGTH

TABLE 1. ABOVE GROUND PRODUCTION IN KG/HA ± S.E. (N)

Veg. Type	Site	1979	1980	1981
Brushy Hillside	1	320 ± 91 (232)	216 ± 54 (215)	475 ± 16 (320)
	5	348 ± 94 (252)	92 ± 23 (179)	720 ± 239(432)
	Mean:	334	154	598
Upland Depression	2	1300 ± 325(235)	540 ± 73 (195)	1540 ± 113(343)
	6	840 ± 108(237)	250 ± 43 (201)	754 ± 150(231)
	Mean:	1070	395	1147
Cottonwood Bottom	3	452 ± 25 (326)	174 ± 24 (289)	472 ± 22 (300)
	7	275 ± 34 (295)	112 ± 30 (217)	509 ± 47 (269)
	Mean:	364	143	490
Sagebrush Flat	4	898 ± 305(313)	368 ± 75 (290)	1129 ± 82 (499)
	8	436 ± 84 (487)	100 ± 12 (362)	276 ± 39 (381)
	Mean:	667	234	702

32. A VEGETATION SURVEY OF SELECTED MAPLE-BASSWOOD STANDS IN THE PRAIRIE-FOREST TRANSITION ZONE, OTTER TAIL COUNTY, MINNESOTA

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The sugar maple-basswood (Acer saccharum-Tilia americana) community in west-central Minnesota occurs at the northwestern edge of the temperate deciduous forest biome. The community-type is a distinctive part of Minnesota's forests. As part of an inventory of natural areas, 8 sites, each 6 hectares (ha) or larger and having a relatively low degree of recent disturbance, were sampled using the relevé method. Within the relevés, cover was estimated for overstory, shrub, sapling, and herbaceous components using the Daubenmire cover-class method. All trees with diameter at breast height (DBH) of 7.5 centimeters or greater were counted and measured. Sapling numbers were tallied. Smaller nested quadrats were used to estimate herbaceous cover. Cores for age-determination were taken from selected trees.

Importance values (I.V.) for trees, based on relative values of frequency, density, and basal area, showed A. saccharum was the leading species for the 8 stands (Table 1). Tilia americana and Ulmus americana ranked second and third, respectively. According to relative density and frequency values, A. saccharum was the leading constituent of the sapling stratum, followed by Ostrya virginiana and T. americana. Dominant shrubs within the 8 stands were Corylus cornuta, Dirca palustris, Viburnum Rafinesquianum, Ribes spp. and Prunus virginiana. Major herbaceous species were Carex pensylvanica, Uvularia grandiflora, Aralia nudicaulis, Thalictrum dioicum, and Amphicarpa bracteata. Within the tree seedling category, A. saccharum again ranked highest, followed by U. americana and O. virginiana.

Table 1. Overstory composition for 8 forest stands in Otter Tail County.

Species	Density (#/ha)	Basal Area (cm^2/ha)	I.V.
Acer negundo	17.8	9083.7	7.1
Acer saccharum	255.4	78214.5	67.1
Betula papyrifera	3.6	3344.8	3.9
Fraxinus nigra	39.3	19216.2	17.5
Ostrya virginiana	94.6	12626.6	27.2
Populus grandidentata	44.6	23890.7	15.5
Populus tremuloides	7.1	9755.7	6.0
Prunus serotina	5.4	2055.4	2.5
Quercus alba	5.4	8048.8	5.4
Quercus borealis	33.9	25956.8	17.4
Quercus macrocarpa	46.4	19153.6	17.0
Tilia americana	176.8	93021.0	63.5
Ulmus americana	151.8	62923.4	49.9
Totals	882.1	367291.2	300.0

Comparisons between forests of Minnesota and Wisconsin reveal similar overstory composition and structure. Acer saccharum, T. americana, and Ulmus spp. were leading species in total density and basal area in Otter Tail County as well as in southeast Minnesota (1) and southern Wisconsin (2).

Within the past century, mesic deciduous forests have been changed by human settlement. For the 8 stands in Otter Tail County only a few trees were 100 years old or greater, while the majority were 45 to 80 years old. Currently, much of the forested region is used for grazing and cutting. Thus, the remaining comparatively undisturbed examples of this unique forest-type merit further study and preservation.

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33. REGENERATION AND PIGMENT FORMATION IN IN VITRO CULTURES OF LEAFY SPURGE (EUPHORBIACEA).

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Plants have been regenerated from callus, cell suspension and isolated root cultures of leafy spurge (genus Euphorbia). Cultures were grown in liquid B5 medium (Gamborg and Wetter, 1975) with 1 mg/L 2,4-dichlorophenoxyacetic acid (2,4-D). Striking variations in cellular morphology of cultures that originated from four biotypes ranged from nearly single spherical cells, to elongated cells attached end to end, to extremely large clumps. Tracheary elements were formed in all of the cultures, but in varying amounts ranging from 1 to 10% of the cells present. One culture formed tracheids and proembryo masses readily, and produced light-induced red pigments (presumably anthocyanins), in contrast to other cultures in which no red pigments and very little callus were formed under similiar conditions. Pigmented cells grew on the surface of the callus.

In media without 2,4-D, roots formed within a few weeks in liquid shake cultures of three of the biotypes (arbitrarily called 1, 2 and 19). In biotype 1 this appeared to occur more rapidly in MS medium (Murashige and Skoog, 1962) than in B5 medium. The addition of 0.1% activated charcoal (AC) increased the rate of root formation in biotype 1 so that roots formed within 3 weeks. Both B5 and MS media were also tested with or without AC but solidified with agar. One ml of cell suspension from each biotype was dispensed onto 50 ml of agar medium and the cultures were left 90 days to establish the long term potential for growth and regeneration. Dry weights of the calli after 90 days are shown in Table 1.

The growth of the cultures varied widely according to biotype (Table 1). Biotype 11 produced the most callus in the absence of AC, but grew poorly in its presence. Biotype 17 formed almost no callus in any of the media. The root-forming capacities of these same biotypes in media ± AC were ranked from 0 to 10, wherein a rank of 1 indicated some root initials and 10 indicated many actual roots (some several cm long) in all of the replicates. In B5 ± AC biotype 1 ranked 9 and biotype 19 ranked 3 (-AC) or 4 (+AC). In MS media (with or without AC) both biotypes 1 and 19 ranked about 2. All other biotypes ranked zero (or close to it) in all of these solid media. No shoots were formed in these studies.

In other studies, a few plants were produced from biotype 1 under a variety of conditions: in liquid cultures in the dark or light without growth regulators, and in callus on agar with 10 μM abscissic acid followed by transfer to light on medium with or without 4.6 μM kinetin. A single, well defined and reproducible procedure for regeneration has not yet been worked out.

TABLE 1.--GROWTH OF LEAFY SPURGE CALLUS ON B5 OR MS SOLID MEDIA WITHOUT GROWTH REGULATORS. ACTIVATED CHARCOAL (AC) WAS ADDED TO ONE-HALF OF THE MEDIA. VALUES ARE IN MG AND ARE AVERAGES ± STANDARD DEVIATIONS.

Biotype	Inoculum	Dry Weights, mg			
		- AC		+ AC	
		B5	MS	B5	MS
1	3 ± 1	345 ± 28	444 ± 177	399 ± 37	188 ± 179
2	7 ± 1	90 ± 101	60 ± 67	45 ± 16	30 ± 12
7	4 ± 2	208 ± 280	202 ± 165	69 ± 82	18 ± 4
11	8 ± 0	372 ± 15	576 ± 20	61 ± 16	60 ± 7
12	4 ± 2	196 ± 208	8 ± 6	26 ± 29	6 ± 2
17	5 ± 1	13 ± 2	20 ± 6	12 ± 1	14 ± 4
19	9 + 4	222 + 32	210 + 13	225 + 59	98 + 49

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34.

A FAST, EFFICIENT TECHNIQUE FOR THE EVALUATION OF BARLEY HORDEIN PROTEINS USING AN SDS-POLYACRYLAMIDE MINI-GEL SYSTEM

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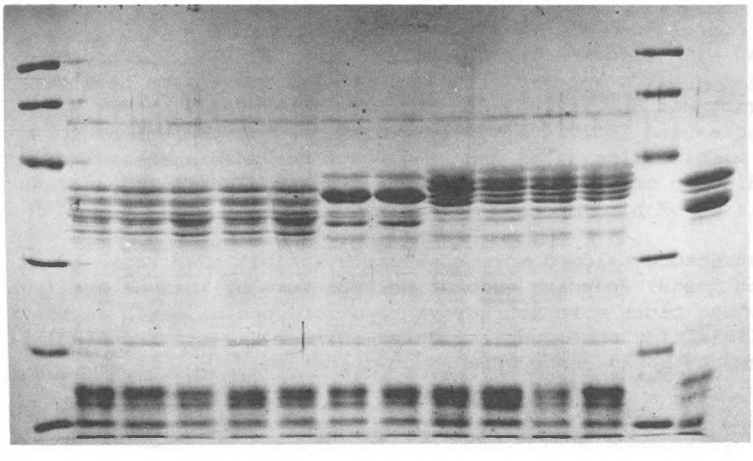
A problem confronting barley workers is cultivar identification based exclusively upon morphological seed characters. Only a limited number of seed characters exist and many workers have reported the use of seed protein electrophoresis as a means of 'fingerprinting' barley cultivars (1,2). Published procedures require extensive inputs of time, reagents and equipment. This paper reports a procedure for the extraction and electrophoretic analysis of barley hordein proteins that is substantially faster and cheaper than previously reported techniques.

Materials and Methods A modification of the method of Doll and Andersen was used (3). Individual barley seeds are ground in a mortar and pestle and transferred to 1.8 ml Beckman microfuge tubes. To each tube .8 ml of buffered alcohol (50% (v/v) isopropyl alcohol-50mM Tris-HCl pH 8.6) is added, and tubes are vortexed periodically over a period of 10 minutes. Samples are spun 1 minute in a Beckman Microfuge B, and .4 ml of the supernatant of each tube is removed and placed in another 1.8 ml tube. To each tube containing the supernatant 10 ul .2M dithiothreitol is added, and the tubes are placed in an 85°C water bath for 2 minutes. Tubes are then removed and 10 ul .5M iodoacetamide is added, and they are returned to the 85°C water bath for an additional 2 minutes. Samples are removed from the water bath, allowed to cool to room temperature and 1.2ml -20°C acetone is added per tube. Samples are immediately spun for 2 minutes at 4°C, the supernatant is poured off, and the small hordein pellet is either air dried or briefly placed in a vacuum desiccator to remove residual acetone. The dry pellets are resuspended in 25-100 ul Laemmlis (4) treatment buffer (depending upon size of the pellet) and the protein concentration is determined using the technique of Bradford (5) with BSA as the reference. All samples are diluted with Laemmlis treatment buffer in 250 ul microfuge tubes to a concentration of 1 ug/ul. Tubes are placed in a 95°C water bath for 3 minutes to dissociate the proteins and the tubes containing the protein samples can be stored indefinitely at -20°C and reused when needed by simply thawing and reheating at 95°C.

Sodium dodecyl sulfate polyacrylamide gel electrophoresis was carried out according to Laemmli (4). Gels were cast using the mini-slab system of the Idea Scientific Company with standard size 1.5 mm thick gels run as controls. The .8mm thick separating gels contained a total acrylamide concentration of 12.5% of which 2.7% was Bis-acrylamide, while the 1cm long stacking gel contained 4% total acrylamide with 2.7% Bis. Five ug of hordein protein was applied to each well using a Hamilton syringe and at least one well of each slab contained Pharmacia's low molecular weight standards as a reference. Once all samples are loaded, 50 ul of .1% bromophenol blue in 50% glycerol is added per slab as the tracking dye. The gels are run at 200 volts constant voltage at room temperature which gives an initial current of approximately 50 mA. The dye front reaches the end of the gel in 50-60 minutes. Slabs are stained with Coomassie Blue R-250 for 1 hour and destained 1 hour.

Figure 1



1:1 Reproduction of a Mini-Gel Run with Hordein Proteins

Results and Discussion Figure 1 is a 1:1 reproduction of a mini-gel. There is no difference in resolution between mini-gels and conventional sized gels run with identical samples. The main advantages in using this procedure are the savings in time and money. It is possible to see the results of an assay in about 3 hours whereas conventional procedures often take 24 hours. Small amounts of reagents are used per assay and it is less costly to equip a lab with the mini-slab unit. The reason electrophoresis is not widely used for cultivar identification may be that most procedures are too time consuming and expensive. The resolution of this technique is excellent, and it is hoped that it will become a routine assay for the identification of barley cultivars.

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35. VEGETATION STRUCTURE AND AVIAN COMMUNITIES OF SOME RANGELAND TYPES OF WESTERN NORTH DAKOTA

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Most native rangelands of North Dakota are situated in the western portion of the state. The vast majority of these rangelands are either pastured by livestock or mowed for hay. The objective of this study was to investigate the influence of vegetation structure on the composition of the avian communities of some relatively undisturbed rangeland types.

During the summer of 1979, the breeding birds and vegetation were surveyed on eight plots representing three rangeland types: mixed-prairie, shrub, and shrub-steppe. All plots were located in the South Unit of Theodore Roosevelt National Park, in central Billings County. All plots were 6.1 ha in area and were lightly grazed by bison (Bison bison) and other native herbivores. The composition of the breeding avifaunas was determined by censusing territorial male birds or segregated pairs of birds on their breeding grounds. Two measurements were used to assess the complexity of vegetation structure: foliage height diversity, an index of the diversity of vertical foliage layering (1), and mean vegetation height. Indices of bird species diversity and foliage height diversity were calculated with the Shannon Function (2).

The plant cover of the four mixed-prairie plots was dominated by a mixture of grasses. The coverage of grasses ranged from 54 to 65%. The mean vegetation heights were 12 to 24 cm. The most important grasses were needle and thread grass (Stipa comata) and western wheatgrass (Agropyron smithii). The vegetation of the two shrub plots was dominated by shrubs. Shrub cover was 30 and 35% and mean vegetation heights were 29 and 37 cm. Silver sage (Artemisia cana) was the most common shrub. The two shrub-steppe plots were a mixture of prairie and scattered tall shrubs. The coverage of shrubs was 27 and 47% and mean vegetation heights were 44 and 57 cm. Common shrubs on these plots were greasewood (Sarcobatus vermiculatus) and buffaloberry (Shepherdia argentea). Indices of foliage height diversity ranged from .530 to .829 for the four mixed-prairie plots and 1.030 to 1.081 for the four shrub and shrub-steppe plots.

The six mixed-prairie and shrub plots supported 3-5 breeding bird species, while the two shrub-steppe plots supported 8 and 10 species respectively. The density of nesting pairs on the mixed-prairie plots ranged from 59-79/40 ha, while the density of pairs on the shrub and shrub-steppe plots ranged from 132-167/40 ha. The western meadowlark (Sturnella neglecta) and grasshopper sparrow (Ammodramus savannarum) comprised 55 to 88% of the nesting pairs on the mixed-prairie plots. The rufous-sided towhee (Pipilo erythrophthalmus) and field sparrow (Spizella pusilla) accounted for 40 to 68% of the nesting pairs on the shrub and shrub-steppe plots. Bird species diversity (H') was lowest on the mixed-prairie plots (.974-1.227), higher on the shrub plots (1.415 and 1.429), and highest on the shrub-steppe plots (1.799 and 2.074).

Foliage height diversity showed no strong correlation with bird species diversity ($r = .49$, $P > .05$). Mean vegetation height was stronly correlated with bird species diversity ($r = .92$, $P < .01$) and appeared to measure a dimension of the habitat the birds were relating to, namely, vegetation height. Increasing shrub cover and vegetation layering did not increase the foraging opportunities for birds. The food habits overlapped greatly. Most species and individuals were ground seed or omnivorous foragers. Increased vegetation height did afford more nesting sites and song posts for more species. Mean vegetation height appears to be a better indicator of within habitat type structural differences than foliage height diversity, and a better predictor of bird species diversity.

It was evident that increased vegetation structure allowed more species to inhabit some range types by providing more nesting substrates and song posts. Reducing vegetation structure by intense grazing or range type conversion would likely make these plots more attractive to other species, such as the horned lark (Eremophila alpestris), while eliminating some species. Maintaining a diverse breeding avifauna on native rangelands will be achieved by sound range management practices.

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36. The Role of Experience in a Polyandrous Mating System

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The Spotted Sandpiper (Actitis macularia) is a long distance migratory bird species in which females obtain multiple mates through resource control. An island population of this polyandrous species was studied over a 10 year period.

Experience differentially influences return of the sexes. Females, if successful at reproducing, return at a uniform rate through 5 years of age. Young males, on the other hand, even if successful, return significantly less often than old males and all females. Unsuccessful birds of all age/sex classes return less often than successful birds.

Females arrive to the breeding grounds significantly earlier than males, and experienced breeders arrive before new breeders. Early arrival of experienced birds results in pairing by age: old birds breed with old, young with young.

Females RS+ improves significantly through their third breeding season, i.e. they obtain significantly more mates, eggs, hatchlings, and fledglings. Older females achieve higher RS+, in spite of their providing minimal parental care. Males, on the other hand, obtain more replacement eggs with experience, but do not hatch or fledge more chicks. Experienced males receive less assistance with parental care than do inexperienced males.

While improvement in female RS+ between breeding years 1 and 2 may be due to earlier arrival, this cannot account for improvement between years 2 and 3 as there is no difference in arrival times of members of these age classes. Increased female RS+ in the third year and beyond probably is due to their having a greater number of old mates in the population that prefer to breed with them.

+ RS = reproductive success as measured by numbers of chicks fledged.

37. Diplostomum spathaceum in ecologically different fish*

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Diplostomum spathaceum is a strigeoid trematode causing eye fluke disease in fish. During the course of an impact study striking variations in incidence and intensity prompted us to investigate its distribution. The developmental cycle of D. spathaceum is typical of strigeoid life cycles. Metacercariae may be observed in the lens although this is not the exclusive or routine procedure in detecting them. In the laboratory each eye is dissected free and carefully examined. The condition of the lens, especially herniation, is noted. It is then removed to a watch glass where the lens is ruptured and the number of worms counted. The metacercaria of D. spathaceum has a foliaceous forebody, which is concave ventrally. The hind body is indistinct. The lateral organs on either side of the oral sucker, sometimes called pseudosuckers, are conspicuous. They are suggestive of "shoulders" and have been employed in preliminary species recognition. The metacercariae are free within the lens.

Styczynska-Jurewicz (1) quarantined fish in laboratory aquaria to permit metacercarial growth in order to differentiate pre-experimental forms. Fish were then placed in wire net boxes at different distances from the shore. The average number of metacercaria per infected fish decreased as the distance from shore increased. Sweeting (2) concluded from the study of 165 fish in four genera that pelagio-benthic and littoral species were not more heavily infected that a limnetic form.

Thus we attempted to relate incidence and intensity of infection with position of the host in the ecosystem. Only fish species of which 15 or more had been examined were selected for study. These hosts were then distinguished as littoral (inshore waters), pelagio-benthic (free-swimming bottom dwellers) and limnetic (offshore waters). The arbitrary nature of these groupings, although based on field observations and the literature is immediately apparent. Fish are dynamic organisms. In addition, our collecting gear appear to have selected the size and to the degree associated the age of the fish gathered.

Twelve genera and species containing 1,445 fish were examined and 225 were infected (Table 1.) The average incidence was 15.57%. No previous study has attempted to relate incidence of fish infected with D. spathaceum and habitat of host. The incidence is higher in littoral (range 5.88 - 25.00, mean 13.03) and pelagio-benthic (6.02 - 75.68, 34.96) than limnetic species (2.07 - 4.62, 2.99). The range of the littoral and pelagio-benthic incidence does not overlap the incidence range of limnetic forms but there is no large discontinuity. Nevertheless, the two incipient populations distinctly differ with regard to mean values. However, the number of fish infected does not steadily decline as one would anticipate from studies on intensity from littoral to pelagio-benthic to limnetic habitats. Pelagio-benthic fish have much higher mean incidence (34.96) than littoral (13.03) or limnetic (2.99).

The intensity data reveal that the pelagio-benthic forms harbor more worms per infected fish (12.28) than either of the other groups (littoral - 3.75; limnetic - 3.00). It also has the highest incidence. The limnetic group seems to be composed of distinct populations based on incidence. To assess this we pooled intensity data from littoral and pelagio-benthic groups and evaluated the differences of means compared with the limnetic group. The observed difference is not statistically significant.

INFECTION PARAMETERS FOR DIPLOSTOMUM SPATHACEUM

HOST AND ECOLOGICAL GROUPING	SAMPLE SIZE	NUMBER INFECTED	INCIDENCE (PERCENT INFECTED)	INTENSITY (NUMBER/FISH) MIN.-MAX. (MEAN)
LITTORAL				
Culaea inconstans (Brook Stickleback)	17	1	5.88	1-1 (1)
Lepomis macrochirus (Blue Gill)	21	2	9.52	1-1 (1)
Morone chrysops (White Bass)	28	7	25.00	1-4 (2)
Pimephales promelas (Fathead Minnow)	94	11	11.70	1-52 (11)
			Mean 13.03 Range 5.88-25.00 Standard Error 3.61	
PELAGIO-BENTHIC				
Aplodinotus grunniens (Freshwater Drum)	37	28	75.68	4-230 (48)
Catostomus commersoni (White Sucker)	149	19	12.75	1-13 (3)
Cyprinus carpio (Carp)	83	5	6.02	1-1 (1)
Ictalurus melas (Black Bullhead)	317	128	40.37	1-115 (7)
Ictiobus cyprinellus (Bigmouth Buffalo)	15	6	40.00	1-5 (2)
			Mean 34.96 Range 6.02-75.68 Standard Error 11.04	
LIMNETIC				
Esox lucius (Northern Pike)	290	6	2.07	1-1 (1)
Perca flavescens (Yellow Perch)	264	6	2.27	2-8 (5)
Stizostedion vitreum (Walleye)	130	6	4.62	1-5 (3)
			Mean 2.99 Range 2.07-4.62 Standard Error 0.67	
TOTAL	1,445	225		

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*Project I-146. National Marine Fisheries Service and Game & Fish Department.

38. RIFFLE DWELLING DIPTERA IN A NORTHERN PRAIRIE STREAM

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Immature stages of Diptera living on two rocky, usually algal covered riffles in the Turtle River, a small stream draining farmlands 20 miles WNW of Grand Forks, North Dakota, were collected over 1969-71. Sampling began as soon as possible after recession of the spring freshet and continued until shortly after freeze-up. Frequency was biweekly during the first two years and weekly in 1971. The collection device was a Surber sampler.

Twenty three forms of Chironomidae, not considered an exhaustive list, were recovered from these samples. Most forms were Chironominae but individuals of Orthocladiinae were generally more numerous. The Tanypodinae were represented on by Albabesmyia. Chironomid density, maximum 750 individuals per sq. m, was considered low for the bottom type and algal cover, but two samples taken in May, 1973, had densities above 2,000 per sq. m, a productive level more typical of this type pf environment (1).

The common crane fly larva in this stream, Tipula abdominalis (Say), overwintered in the river and adults emerged over a rather long period from May until early July. They produced at least two age classes of larvae that hatched in July and August. Tipula larvae never exceeded 30 per sq. m, but their large size, especially in spring, accounted for a considerable percentage of the macrobenthos biomass. These larvae were quite susceptible to displacement by spring freshet discharges.

Black flies (Simuliidae) belonged to two groups, the Simulium (S.) venustum complex and Simulium (N.) vittatum Zetterstedt. Immatures could be separated reliably only when pupae were present and comparison of group densities was not possible when both forms occurred in large numbers. The venustum complex had only one brood that overwintered as larvae and pupated in May and June, but vittatum persisted in small numbers over the open water season (see 2). Larval increase toward the end of the collection period was assumed to include both groups. The greatest density found was 2,000+ per sq. m in May, 1971. Sampling began on later dates in 1969 and '70 and annual comparisons were not justified. Attacks by black fly adults were never experienced near the Turtle River.

The only member of the Tabanidae found on these riffles was the deer fly Chrysops carbonarius Walker. Biting adults were quite annoying in May and June and larvae apparently overwintered in the stream. The largest concentration found was 32 individuals per sq. m. Larvae were more numerous on the downstream riffle.

The Family Rhagionidae, snipe flies, was well represented by Atherix variegata Walker. Its larvae occurred in quite modest numbers, maximum 35 per sq. m, in 1969, but they became one of the more numerous benthic organisms during the latter halves of the open water periods of 1970 and '71. Size of individual larvae and numbers they attained, frequently more than 500 per sq. m, added substantially to the riffle biomass.

Other Diptera were considerably less conspicuous over this three year period. Present were: Limnophora aequifrons Stein, Bezzia setulosa (Lw.), Palpomyia tibialis (Meigen), Paradixa sp., Chelipoda sp., Hemerodromia sp., Stratomyia sp., Antocha saxicola Osten Sacken, Hexatoma sp., and Tipula sp.

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54. EFFECT OF ZINC DEFICIENCY ON THE METABOLISM OF METHIONINE IN THE PERFUSED RAT LIVER

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Zinc deficiency has been reported to adversely affect amino acid utilization and metabolism, including sulfur-containing amino acids (1). We utilized the perfusion technique to investigate methionine metabolism in zinc-deficient animals.

Long-Evans male rats (150-180g) were fed a biotin-enriched 20% sprayed egg white diet containing <1 ppm zinc and distilled deionized water for 15 days. Pair-fed and ad libitum-fed rats were fed the same diet and water containing 25 ppm zinc (as zinc acetate). Livers were removed surgically and perfused for 20 min with 100 ml of perfusate, pH 7.45, consisting of rat erythrocytes suspended in Krebs-Ringer bicarbonate buffer containing 3% bovine serum albumin, 150 mg percent glucose and oxygenated with 95% O_2 and 5% CO_2(2). Livers of zinc-deficient rats were perfused with erythrocytes from deficient rats. Following the 20 min equilibration period all the essential amino acids were added at twice plasma levels. L-Methionine (6.4 µmol) contained 100 µCi L-[methyl-^{3}H]methionine and 10 µCi of L-[carboxyl-^{14}C]-methionine. Aliquots of the perfusate (3.0 ml) and tissue biopsy samples (0.5-1.5g) were taken periodically. Specific radioactivities of S-adenosylmethionine (AdoMet), S-adenosylhomocysteine (AdoHcy), methionine, methylated DNA, tRNA, phospholipid, histone and various protein fractions were determined.

The endogenous levels of AdoMet, AdoHcy and methionine were depleted in livers from zinc-deficient and pair-fed rats as compared to normal livers. However, this effect varied depending on the severity of the zinc deficiency and the dietary intake in the pair-fed controls. The uptake of methionine by livers from zinc-deficient and ad libitum-fed rats was similar (25-35 nmol/g/min), whereas livers from pair-fed rats utilized this compound more rapidly (55 nmol/g/min). The incorporation of methionine into AdoMet was not impaired in livers from zinc-deficient rats.

Methylation of the macromolecules, i.e., histones, phospholipids or tRNA was similar in livers from zinc-deficient and ad libitum-fed rats, whereas DNA methylation was reduced 2-5-fold depending on the degree of deficiency and the stage of the feeding cycle. In contrast, methylation of all macromolecules was elevated significantly in livers from the pair-fed rats. The extent of DNA methylation probably reflects the rate of DNA synthesis, since these reactions are coupled. DNA synthesis would be impaired in zinc-deficient animals, because DNA polymerase is a zinc-dependent enzyme (3).

Protein synthesis (histones, non-histone chromosomal, cytoplasmic or mitochondrial) in the livers from zinc-deficient and ad libitum-fed rats was similar. Contrariwise, protein synthesis was elevated 2-fold in livers from pair-fed rats. This finding is consistent with reports that protein synthesis is depressed in zinc-deficient animals (1).

Increased incorporation of isotopically labeled methionine into proteins and increased methylation of macromolecules in the pair-fed animals is probably the result of dietary restriction. The endogenous levels of methionine and AdoMet are depleted in these animals. Consequently, the exogenous L-[methyl-H^3]methionine is taken up rapidly and is not diluted extensively by the endogenous pool.

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55. MECHANISM OF N-ACETYLGLUCOSAMINE INHIBITION OF GLUCOSE UPTAKE BY PERFUSED LIVERS

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Regulation of the level of blood glucose may occur at several sites, an important one being the site of glucose phosphorylation/glucose-6-phosphate (glucose-6-P) dephosphorylation. N-Acetylglucosamine is a competitive inhibitor of glucokinase (1), an enzyme of prime importance in the hepatic function of glucose phosphorylation (2). Extensive inhibition of the rate of net glucose uptake was noted when livers from fed rats were perfused in the presence of an 18-26 mM glucose load and 30 mM N-acetylglucosamine (3) (from 0.67 to -0.19 μmol/min/g, where a negative number is indicative of net production of glucose by the liver). When livers from fasted rats were perfused under similar conditions only a slight inhibition of net glucose uptake was noted (from 0.43 to 0.39 μmol/min/g liver (3). Experiments were carried out to determine the cause of the differential effect of N-acetylglucosamine with respect to glucose uptake by livers from fed and fasted animals.

Results

Glucokinase is an insulin-dependent enzyme, the activity of which decreases markedly in fasting. It is conceivable that, in addition to a decrease in enzyme activity, activity remaining in the fasted state is less sensitive to inhibition by N-acetylglucosamine. Homogenates from livers of fed and 48-h fasted rats were prepared in mercaptoethanol-containing buffer. After centrifugation at 79,500 x g for 38 min, the supernatant fraction was assayed for glucokinase and hexokinase activity with 18 and 26 mM glucose, 5 mM Mg·ATP and 0-100 mM N-acetylglucosamine. At pH 7.4 and 37°C plots of percent inhibition vs. N-acetylglucosamine concentration were similar for supernatant fractions from fed and fasted rats. Under conditions of substrate and inhibitor concentrations approaching those used in the perfusion studies, inhibitions of 85% and 81% were noted with preparations from fed and fasted rats, respectively.

The rate of net glucose uptake seen in perfused livers results from the combination of two major factors; glucose phosphorylation and glucose-6-P hydrolysis. A differential effect of N-acetylglucosamine on glucose-6-P hydrolysis (catalyzed by glucose-6-phosphatase) in fed and fasted preparations might explain the insignificant inhibition of net glucose uptake by this compound in perfused livers from fasted rats. Livers from fed and 48-hour fasted rats were homogenized in 0.25M sucrose and the microsomal fraction containing glucose-6-phosphatase was isolated. The effect of N-acetylglucosamine on glucose-6-P hydrolysis at pH 7.4 and 37°C was examined in both preparations. Apparent Km values of 5.0 ± 0.5 and 5.2 ± 1.0 mM and Vmax values of 0.59 ± 0.02 and 0.72 ± 0.10 μmol/min/mg protein were obtained in the absence and presence of 30 mM N-acetylglucosamine for a microsomal preparation from a fed rat. For the preparation from a fasted rat, apparent Km values were determined to be 3.7 ± 0.6 and 3.7 ± 0.1 mM and Vmax values 0.67 ± 0.04 and 0.67 ± 0.01 μmol/min/mg protein in the absence and presence of 30 mM N-acetylglucosamine. When microsomal preparations from these same sources were treated with 0.2% sodium deoxycholate a similar lack of variation in kinetic parameters was noted in the presence of N-acetylglucosamine.

Discussion

The above experiments suggest that the difference in the response of net glucose uptake rates by perfused livers from fed and fasted rats to N-acetylglucosamine can not be explained on the basis of an insensitivity of glucokinase from fasted livers to this compound. Neither can it be attributed to a differential effect of N-acetylglucosamine on glucose-6-phosphate hydrolysis from the two types of livers. A possible explanation yet to be explored involves the increased level of glucose utilization in the fasted state by enzyme(s) other than glucokinase which is(are) insensitive to inhibition by N-acetylglucosamine.

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56. INTERACTIONS AMONG VANADIUM, IRON, AND CYSTINE IN RATS: LIVER CONTENT OF SELECTED TRACE ELEMENTS

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Studies in our laboratory have shown a relationship between vanadium and iron, influenced by cystine, that affects hematopoiesis in the rat (1). Vanadium deprivation exacerbated the depression in hematocrit exhibited by rats fed about 16 μg iron and 4.65 mg cystine/g diet. When dietary cystine was about 10.15 mg/g, vanadium deprivation did not affect hematocrit in moderate iron-deficient rats. To gain further insight into the relationship between vanadium and iron in the rat, we decided to determine the liver levels of certain trace elements that affect hematopoiesis or iron metabolism.

Male weanling Long-Evans rats were assigned to groups of six in a fully-crossed, three-way, two-by-two-by-four design. The levels of vanadium (0 and 1 μg/g), cystine (3.0 and 8.5 mg/g) and iron (5, 15, 100, and 500 μg/g) supplemented to the basal diet (1) were the variables. The rats were fed their respective diets for six weeks, then decapitated subsequent to ether anesthesia and cardiac exsanguination with a heparin-coated syringe. The livers were removed, freeze-dried, and prepared for trace element analyses by our usual method (2). Atomic absorption spectrometry was used (2) to obtain the liver concentrations in the following table.

Treatment, μg/g			Hematocrit	Liver, μg/g dry weight			
V	Fe	Cys	%	V	Fe	Cu	Mn
0	5	3000	14.9	0.005	71	33.3	11.3
1	5	3000	14.7	0.067	69	59.4	9.8
0	15	3000	22.4	0.007	65	14.8	7.7
1	15	3000	26.1	0.044	74	12.6	8.2
0	100	3000	43.6	0.008	189	11.5	7.0
1	100	3000	44.1	0.060	197	11.6	7.4
0	500	3000	44.1	0.006	243	11.8	7.0
1	500	3000	43.7	0.080	265	12.6	7.0
0	5	8500	15.4	0.002	68	25.5	8.2
1	5	8500	17.0	0.048	77	22.5	9.6
0	15	8500	25.1	0.006	76	13.8	8.1
1	15	8500	23.8	0.052	69	14.3	8.0
0	100	8500	44.7	0.007	190	12.3	7.2
1	100	8500	44.1	0.065	208	12.1	6.6
0	500	8500	44.6	0.007	221	11.4	6.6
1	500	8500	44.7	0.065	285	11.4	6.4
			Analysis of Variance - P Values				
Vanadium effect			NS	0.0001	0.03	0.03	NS
Iron effect			0.0001	0.0007	0.0007	0.0001	0.0001
Cystine effect			NS	NS	NS	0.0001	0.01
Vanadium x iron			NS	0.001	NS	0.004	NS
Vanadium x cystine			NS	NS	NS	0.009	NS
Iron x cystine			NS	NS	NS	0.0001	0.05
Vanadium x iron x cystine			0.02	0.06	NS	0.0002	0.01

The findings suggest that dietary vanadium does not markedly affect iron absorption. Iron deficiency depressed iron, and elevated manganese and copper, levels in the liver. If the depression in hematopoiesis caused by vanadium deprivation in rats supplemented with 15 μg of iron and 3.0 mg cystine/g diet was the result of an detrimental effect on iron absorption, iron-deficiency-induced changes in liver trace element levels should also be exacerbated. This was not found. However, the findings still show a relationship between vanadium and iron which is influenced by cystine. Vanadium deprivation depressed the level of iron in liver of rats fed adequate iron; with the effect most marked when supplemental cystine was 8.5 mg/g diet. Vanadium supplementation markedly elevated the level of copper in liver of severely iron-deficient rats fed a supplemental 3.0 mg cystine/g diet. The liver trace element findings support the hypotheses that vanadium has a biological function which in some manner promotes the optimal utilization of iron after absorption.

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57. EFFECTS OF UNDERNUTRITION AND DEFICIENCIES OF ZINC, COPPER OR IRON ON HEART WEIGHT AND CARDIAC NOREPINEPHRINE (NE) IN RATS AND MICE

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Changes in heart morphology, function and elevated NE levels were reported to occur in rats fed a low protein diet (1). Infusion of subhypertensive doses of NE produced cardiac hypertrophy in dogs (2) and NE can also be destructive to the myocardium (3). Laks and Morady (4) hypothesized that NE is a hormone which initiates myocardial hypertrophy in response to an increase in ventricular wall tension. Therefore, groups of weanling male Long-Evans rats were fed a 20% egg-white diet equivalent to 30, 40, 60, 80 or 100 percent of ad libitum food intake for 12-18 days. Heart catecholamines were determined using reverse phase high performance liquid chromatography with ion-pairing and electrochemical detection (5). Data were evaluated by analysis of variance and differences between individual means assessed for significance by the Scheffe test (6). Values cited in the text are means ± SD. Heart weights correlated with food intake while cardiac NE correlated inversely with food intake. Protein-energy malnutrition is almost always associated with deficiencies of a variety of micronutrients.

Thus, in a second experiment male 30-day-old Long-Evans rats were fed a 20% egg-white diet (< 1 mg Zn/kg) for 23 days. The zinc-adequate control groups were given zinc-supplemented water (25 ppm as zinc acetate). Femur zinc concentrations for the zinc-deficient (ZD) rats (81 ± 7) were lower ($P < 0.0001$) than levels for the pair-fed (PF) (297 ± 21) or ad libitum-fed (AL) (278 ± 20 µg/g) rats. Hearts of ZD and PF rats weighed less ($P < 0.0001$) than AL rats. Heart NE levels in the ZD (1670 ± 304) and PF (1591 ± 209) rats were higher ($P < 0.0001$) than values from the AL (671 ± 152 ng/g) groups.

In a third experiment weanling male Sprague Dawley rats, fed a low copper 20% egg-white diet, had enlarged hearts ($P < 0.0001$) after 32 days. The copper-adequate control rats were given copper-supplemented water (2 ppm as cupric sulfate). The copper-deficient group displayed typical signs of copper deficiency such as hypercholesterolemia and anemia. Heart NE in the copper-deficient (324 ± 200) was less ($P < 0.0001$) than in PF (1086 ± 187) or AL (869 ± 91 ng/g) rats. This finding is consistent with a report of decreased incorporation of ^{14}C-dopamine into cardiac ^{14}C-NE in copper-deficient rats (7).

In another experiment new-born male BALB-c mice were nursed by two groups of dams fed a 27% casein diet containing 10 or 150 mg Fe/kg (as ferric chloride). The iron-deficient group had lower ($P < 0.0001$) hematocrits, liver and spleen iron than the iron-supplemented control mice. The iron-deficient group had higher ($P < 0.02$) heart weights and lower ($P < 0.01$) heart NE levels than the iron-adequate group. After weaning, the offspring were fed the diets until 32 days of age.

Thus, factors causing increased heart NE are different from those causing changes in heart weight. Zinc deficiency and undernutrition increase heart NE and decrease heart weight while iron deficiency and copper deficiency decrease heart NE but increase heart weight.

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58. PHENCYCLIDINE TOXICITY AND ITS PROTECTION BY N-ACETYLCYSTEINE IN MICE

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In recent years, abuse of phencyclidine (PCP, Angel Dust) has reached such epidemic proportions that it has now become a major drug in abuse (1). At present, there are no antidotes capable of reversing the toxic manifestations and biochemical aberrations that may result due to PCP toxicity. Although administration of diazepam, haloperidol, activated charcoal and acidification of urine is of some value (2), the management of such patients is largely symptomatic. Compounds containing sulfhydryl groups such as n-acetylcysteine (NAC, Mucomyst) are effective antidotes for acetaminophen (Tylenol) overdose (3). It also posesses good mucolytic activity. Because of these properties of NAC, its protective effects against PCP toxicity were evaluated. Groups of male mice (25-30g) were treated with 100, 103 and 105 mg/kg, po (oral) doses of PCP. Immediately following PCP, control mice were given 2 ml/kg saline by intraperitoneal (ip) injection. The experimental group received 1000 mg/kg, ip NAC. A second dose of NAC (1000 mg/kg, ip) was given to these mice 15 min later. With all three doses of PCP, NAC treatment significantly reduced the number of deaths. At 100 mg/kg oral dose of PCP, 60% of control mice died whereas 7% of the deaths occurred in NAC treated mice. Similarly, 103 mg/kg and 105 mg/kg, oral PCP caused 73 and 87% deaths in controls as compared to 20 and 28% deaths in NAC treated mice. Gross behavioral changes such as head rotation, circular movements, incoordination, muscular rigidity, tremors and violent reactions occurred within 4 to 6 min in controls. In contrast, it took 8 to 10 min if such changes ever occurred in NAC treated mice.

In another study, two groups of mice were given 40 microcuries (μCi) and 100 mg/kg, po ^{3}H-PCP. Control group and experimental mice were then given saline and NAC as described earlier. All mice were sacrificed 30 min after ^{3}H-PCP administration and tissue levels of PCP were determined in kidney, liver, salivary gland, lung, brain, fat, testis and plasma. NAC treatment produced a significant decrease in the levels of ^{3}H-PCP radioactivity in all tissues when compared to controls. These initial studies in mice suggest that NAC does have a potential for its use in PCP overdose. (Supported by UND Faculty Research Grant 1813-0409-2364).

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59. THE ACTION OF SOME CALCIUM-BLOCKING DRUGS ON THE FREE SURFACE OF BLASTODERM CELLS

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Two basic types of plasmalemma calcium channels are thought to be responsible for the response to vascular smooth muscle membrane signals. These channels are thought to reflect the processes of pharmaco-mechanical and electrical-mechanical coupling. Early work has shown that calcium blockers act selectively on the slow inward calcium current in cardiac muscles (1). The agents which cause this kind of pharmaco-mechanical block include substances from wide variety of drug classes, include procaine, sodium nitroprusside, trifluoperazine, dilantin, and indomethacin and verapamil. All of the above named agents at high concentrations exhibit other pharmacological actions such as receptor blocking, sodium channel blocking, and local anesthetic properties.

In our laboratory recent studies on the effect of procaine on the surface ultrastructure of chick blastoderm indicate increases in microappendages. Others have reported the development during cytokinesis of microvilli and microappendages along the line of division of the cell membrane in many different animals (2,3). Microappendages of the plasmalemma are observed in three major forms, microvilli, blebs, and ruffles. These structures are now recognized to be plasmalemmal extensions prevelant on the free surface of most cells. They are indicative of internal cell activity. Microvilli are small surface extensions of approximately 0.1 μm in diameter and of variable length. These structures are found on various absorptive areas such as the small intestine, the proximal tubules of kidneys as well as the free surfaces of other cells. Microtubules as internal structures aligned parallel to the longitudinal axis of a microvilli have also been reported, but not been confirmed in all areas (4).

In our study embryos treated with Hank's saline and exposed to air for 30 minutes before fixation present bulging surfaces containing yolk granules. These surfaces are covered with short microvilli, blebs and also pinocytotic pits. Procaine treatment 1 mm/L caused a large number of long microvilli while digitoxin treatment 0.1 mm/L caused even a denser network of microvilli to form. Additional substances tested in our laboratory that induced microvilli growth included dilantin, ketamine, pentobarbital, and ouabain. Acetylcholine, pilocarpine, atropine, alpha and beta blockers, and norepinephrine did not produce the same characteristic plasmalemmal changes.

Studies in other labs have reported the formation of microappendages associated directly with changes in concentration of the extra mitochondrial calcium ions in hepatocytes (5). This was postulated to be a manifestation of toxic injury to the cell membranes. No one has reported the relationship of calcium blocking agents to microappendage changes in cell membrane surface blebs.

In a separate group of experiments embryos incubated for 15 minutes at 1 bar air followed by 15 minutes at 500 meters sea water (helium + 1 bar air) or 100 meters (helium + 1 bar air) produced a reduction in the length of the microvilli and in some cases convert microvilli to blebs. Pressure studies using 100 meters of sea water air however blocked all microvilli growth and induced large pinocytotic pits on the cells. This occurred whether they were control or procaine or other calcium block treated cells. All of the embryo studies for microvilli were studied with the scanning electron microscope.

In recent studies in our laboratory embryo sections studied with transmission electron microscopy indicated the presence of microtubular protrusions within the microvilli. Microtubular presence occurred particularly in those treated with procaine.

Seeing similar characteristic plasmalemma changes under high pressure helium and exposure to calcium blockers, one may extropolate that a mechanism responsible for pressure reversal of anesthesia and also for the role of helium in high pressure nervous syndrome may be due in part to changes in the calcium transport across cell membranes.

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60. CHROMOSOME DAMAGE IN WHITE RATS INDUCED BY 2,4-D

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The hormonic herbicide 2,4-dichlorophenoxyacetic acid (2,4-D) is used extensively in the Red River Valley to control broad leaved weeds. It was also used as the potent defoliant Agent Orange (50% 2,4-D, and 50% 2,4,5-T) in the Vietnam War. However, information on the genotoxicity of 2,4-D remains fragmentary, particularly in mammalian systems. In these experiments intraperitoneal injections of 2,4-D were administered to white rats (Rattus norvegicus, White River Strain). A minimum of 2 replications with 7 treatments (50µg/Kg - 350µg/Kg) and 2 controls were conducted for 2 exposure periods (4 hrs and 24 hrs). The 4 hr exposure was used to determine the direct action of 2,4-D on chromatin and the 24 hr exposure was followed to determine the interaction of 2,4-D and its metabolities with mammalian enzymes. Mitotic indices were determined and data on chromosome damage was based on the levels of gaps breaks, and fragments. The data were taken using a Zeiss Photomicroscope III;sometimes they were reconfirmed by photographic prints. Results from ANOVA and Dunnett's tests indicate that none of the treatments resulted in significant increase in rates of chromosome abberations from the control. This indicates that during the 4 hr period, 2,4-D did not significantly alter the chromatin's morphology as detected at the light microscope level. However, a noticeable trend did develop in that the number of abberations did increase up to the 100µg/kg level and then stabilized at a lower level. This may result from some loss of severely affected cells. A third replication of the 4 hr exposure series may help clarify this tendency. The 24 hr series is currently being analyzed.

Efforts are also underway to determine in vivo and in vitro rates of sister chromatid exchanges (SCE) for various concentrations. Previous work has indicated a significant increase in SCE human lymphocytes (1). The results should help establish the levels at which 2,4-D is genotoxic. Since the compound readily biodegrades in soil or water, it is of concern only for direct exposure.

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61. PROGESTERONE SECRETORY RESPONSE TO PROLACTIN OF LUTEAL CELLS *in vitro* INCREASES WITH TIME POST-LUTEINIZATION.

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The peptide hormone secreted by the placenta of the pregnant mare and called Pregnant Mare Serum Gonadotropin (PMSG) is known to possess the right combination of gonadotropic activities: Follicle Stimulating Hormone (FSH), and Luteinizing Hormone (LH) to induce ovulation in immature rats. In addition to the induction of precocious sexual maturation, the ovulatory response to PMSG is accompanied by a surge of endogenous gonadotropin. It is not known whether or not the surge of gonadotropin which accompanies the induced ovulation of the premature rat is the same in character as that which occurs spontaneously at ovulation in the normal cycling animal.

The corpus luteum which is formed from the remains of the ovulated follicle secretes progesterone (P), the steroid hormone which is essential to the maintenance of the conceptus. P can only be produced in response to a luteotropic hormone of which there are several in the rat including: pituitary prolactin (PRL), Rat Placental Lactogen (RPL) and perhaps, pituitary LH.

In experiments using autoradiography, Oxberry and Greenwald (1) demonstrated a sharp reduction in the number of binding sites for PRL on the luteal cells freshly formed after ovulation. They found that this depletion of PRL receptors persisted for some hours after the gonodotropin surge associated with ovulation and was probably induced by this surge.

Using very different technqiues, we have found support for the concept of receptor cell depletion by demonstrating changes in the steroidogenic capability of luteal cells over time post-luteinisation. We induced ovulation in 30 day old rats by injecting 25 I.U. of PMSG subcutaneously. The rats so treated were divided into 3 groups and sacrificed on days 4,6 and 8 post treatment. The ovaries were removed and the corpora lutea dissected out, minced and treated with collagenase and hyaluronidase. After cell dispersion and filtration, the luteal cells were cultured for 24 hours in Eagle's Medium which had been treated with PRL. After 24 hours incubation, the cells were centrifuged out and the medium analyzed by radioimmunoassay for P.

One microgram of PRL induced no detectable P secretion in cultures of luteal cells taken on days 4 and 6 after PMSG treatment. Day 8 tissue responded to this dose by secreting a mean concentration of 85 nanograms P per replicate.

Ten micrograms PRL did not induce P-secretion in days 4 and 6 tissue but in day 8 tissue induced secretion of 352 nanograms per replicate, a four fold increase.

Human Chorionic Gonadotropin (HCG) treatment of the cultures produced a similar response indicating an increase in steroidogenic capacity over time. This hormone possesses luteotropic activity probably by nature of its LH-like activity but is not endogenous to the rat.

Tissue extracts containing RPL and serum from pregnant rats also produced the luteotropic response but time sequence studies on RPL have not yet been done.

The experiments described above support observations made by other techniques of a down-regulation of steroidogenic capability in newly formed luteal cells. Such down-regulation must surely be brief in mature animals with an average estrus cycle of 4.5 days. The results of the experiments reported here suggest that the duration of such a down-regulation or desensitization of luteal cells in immature animals with induced ovulation might persist for a longer period of time.

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101. SOME WOOD DECAY FUNGI FRUITING ON LIVING TREES IN NORTH DAKOTA

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Fungi which decay wood play an important part in the carbon cycle of the biosphere. When decay fungi attack living trees, however, they weaken the trees, lowering their economic value or reducing their lifespan. In wild areas this is offset by the importance of hollow and decaying trees as a habitat for wildlife. When decay-affected trees are near dwellings or in managed plantations, the consequences of extensive wood decay may be serious, causing structural hazard or reduced value or function. Often the degree of hazard or potential weakening of the tree depends on which particular decay fungus is involved. Most of the common wood-decaying fungi on living trees are Basidiomycetes, especially the orders Agaricales (the mushrooms) and Aphyllophorales (the polypores and allies) (2,3,4). Like all other fungi, decay fungi are classified by mycologists on the basis of their reproductive structures. These structures are the visible, external evidence of decay within a living tree.

In North Dakota, the last survey of wood decay fungi was made in the early 1930's (1). Since then, changes have occurred in native woodlands and there have been massive new plantings of shelterbelts and farmstead windbreaks and urban trees. Between 1976 and 1982 we observed both native and planted trees throughout North Dakota. Table 1 below lists those fungi associated with native deciduous tree species we identified during this period. The first table column lists the host trees; the second column the species of fungi. The fungi were identified and are listed according to the names used in references 2 and 4. The table column 'occurrence', at the right side means relative frequence of occurrence of trees with those fungi. For each tree on the list in table 1, there were only a few fungi which were the predominant associates. For example, on green ash, (Fraxinus pennsylvanica Marsh.) two fungal species were common--Fomes fraxinophilus Peck and Poria punctata (Fries) Karst.--accounting for perhaps 85% of all observations on trees with decay. A third fungus, Polyporus sulfureus (Fr) Bull., occurred in most of the remaining cases; the other five fungi listed in the table from this host were noted only occasionally. It is interesting to compare the results given in Table 1 to previous reports for North Dakota and to contemporary reports for the U.S. as a whole (3). In the early 1930's, Barnett (1) found Fomes fraxinophilus very common on green ash, Pleurotus species common on American elm and boxelder, and Fomes igniarius (L) Gill. common on aspen. Our results agree with his findings in these cases; however, we frequently observed two fungi which Barnett did not report at all from North Dakota--Poria punctata on green ash and Polyporus sulfureus on both green ash and bur oak. In addition we observed Volvariella bombycina Fr. rarely while Barnett reported it common (1).

Table 1.
Wood decay fungi in living trees in N.D.

Tree	Fungi	Occurrence*
Green Ash	Fomes fraxinophilus	3
Fraxinus	F. applanatus	1
pennsylvanica	F. conchatus	2
	Poria punctata	3
	Polyporus sulfureus	2
	P. dichrous	1
	P. versicolor	1
	P. tulipiferae	1
American Elm	Pleurotus sapidus	2
Ulmus	P. ulmarius	1
americana	Polyporus squamosus	1
	Volvariella bombycina	1
Boxelder	Pleurotus ulmarius	4
Acer negundo	Polyporus tulipiferae	1
	Fomes connatus	1
Cottonwood and	Fomes igniarius	3
Aspen	Polyporus squamosus	2
Populus spp.	Pleurotus ostreatus	1
Willows	Poria punctata	3
Salix spp.	Trametes trogii	1
	Polyporus squamosus	1
	Daedalia confragosa	1
Bur Oak	Fomes applanatus	1
Quercus	Polyporus sulfureus	1
macrocarpa		

*1=rare, occasional individuals, to 4=very common.

In a general discussion of heart rot fungi affecting green ash throughout the U.S., Hepting (3) lists Fomes fraxinophilus as very common, as we also found. He lists a second fungus Lentinus tigrinus Fr., almost as common on green ash. We have never observed this in North Dakota, and Barnett (1) mentions it only on railroad ties, never on living trees.

In summary, it appears that significant change in the fungi associated with decay of living trees in North Dakota has occurred in the past half-century. This is not surprising when one considers the many possible reasons for such a shift including climatic changes, differences in age and condition of trees in native woodlands and greatly increased planting of trees in many situations.

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102. OCCURRENCE OF GLOEOSPORIUM ARIDUM ON GREEN ASH AT DIFFERENT TIMES OF THE YEAR

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Anthracnose is a serious foliar disease of green ash (Fraxinus pennsylvanica Marsh.). The causal fungus, Gloeosporium aridum Ell. & Holw. causes necrotic blotches and distortion of leaflets. If infection is severe there may be complete defoliation in the lower crown (2,3). In addition, petioles, fruits, buds and twigs may be infected. The purpose of this work was to investigate the different types of symptoms seen on green ash and to confirm the association of G. aridum with these symptoms throughout the year.

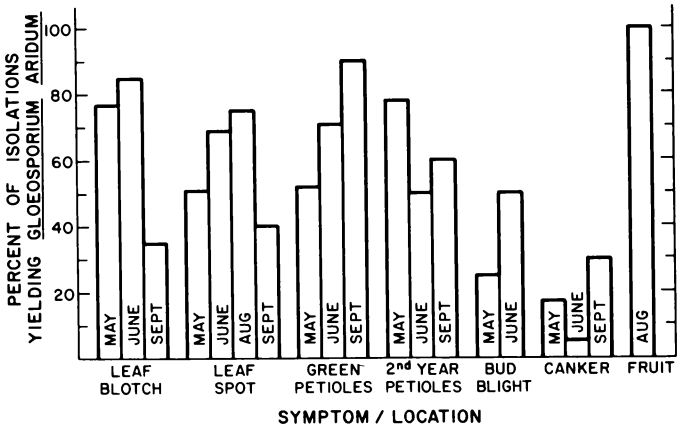
Seven types of disease symptoms were observed: 1) Leaf blotches--irregular, necrotic areas along the margin and midrib of the leaflet often causing distortion (2,3); 2) Leaf spots--much smaller necrotic areas 1 to 3 mm in diameter with a light, sunken center and a darker outer ring scattered on the leaflet surface and often coalescing (1); 3) Small spots on green petioles and petiolules--similar to leaf spots; 4) Petioles which have remained on the branches over the winter and develop fruiting bodies (acervuli) most evident in the spring; 5) Buds which die before bud break, often confused with frost damage; 6) Branch cankers--serving as overwintering structures for the fungus; 7) Fruit spots--developing in late summer, similar to the leaf spot but located on the wing of the samara. The leaf blotch symptom is the one most often reported (2,3).

Collections of plant parts showing symptoms were made in May, June, August and September, 1982 from five different sites. The sites included urban boulevards, a windbreak study planting, a multi-row shelterbelt and a single row shelterbelt. Isolations were made in the laboratory. Succulent plant material was surface sterilized in a solution of 0.25% NaOCl for 15-30 sec. and rinsed in sterile distilled water, while older, tougher parts were surface sterilized in 0.5% NaOCl for 2-4 min. After rinsing in sterile distilled water, plant material was placed between sterile paper toweling to dry. Each isolation was taken from a separate piece of tissue and placed four to a plate on potato dextrose agar (PDA). Plates were incubated for seven days at room temperature.

The year 1982 was favorable for development of anthracnose and all seven symptom types were seen. G. aridum was found associated with all symptom types and at every time of the season. It was most frequently isolated from samaras (fruits), leaves and petioles, less frequently from buds and least often from twig cankers. The times the various symptomatic tissues were collected are indicated by the legends in the bars of the figure. Not all tissues were sampled at each date.

The percentage of isolations yielding G. aridum was calculated by dividing the number yielding G. aridum by the total number of isolations from that symptom/time. Leaf blotch was the most obvious symptom in early spring and G. aridum recovery was 77% in May, 84% in June and 35% in September. The leaf spot symptom gave 51% recovery in May, 68.5% in June, 75% in August and 40% in September. G. aridum was isolated from 52% of green petioles in May, 71% in June and 90% in September. Previous year's petioles had the highest percentage of recovery in May (78%), 50% in June and 60% in September. Bud blight was only evident in May and June when 25% and 50%, respectively, yielded G. aridum. All fruits collected in August yielded G. aridum upon isolation.

Occurrence of Gloeosporium Aridum on Green Ash as Determined by Quantitative Isolations.



These results show that G. aridum is consistently associated with the several types of symptoms commonly attributed to ash anthracnose. The high proportion isolated from leaf parts in early summer indicates this fungus is a primary pathogen. Later in the season, many facultative and secondary parasites colonize senescing leaves. As these fungi increase, the proportion of G. aridum infections is relatively less of the total. The lower rate of recovery on buds is probably because many buds that do not grow in spring are not diseased but frost-killed. Many other fungi are capable of causing twig cankers on green ash. Several of these were found by these isolations, and together were more frequent from cankers than G. aridum.

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103. EFFECT OF RHIZOBIUM AND NITROGEN FERTILIZER ON NODULATION, YIELD AND RUST ON (PHASEOLUS VULGARIS L.) PINTO BEANS

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Inoculation of dry edible beans with Rhizobium strains to increase yields has been periodically recommended. We established a test to determine if application of Rhizobium increased yield. We also compared effects of Rhizobium and traditional nitrogen fertilization on yield, nodulation, and on development of bean rust.

The experiment was conducted at Carrington Branch Agricultural Experiment Station on sandy soil with low fertility. Straw was disced into the experimental area to further reduce available nitrogen. Beans had not been grown on this experimental site for at least the last 13 years.

The experimental design was a 3 X 3 factorial within a 9 X 9 Latin square. Plots consisted of four 6 m long rows spaced 0.75 m apart. Nitrogen as ammonium nitrate was broadcast at rates of 0, 56, and 112 kg/ha over designated plots, then incorporated. A granular form of Rhizobium inoculant supplied by Nitragen Company was inoculated in furrow at planting. The inoculant was applied at rates of 0, 5.6, and 11.2 kg/ha.

Plots were planted with pinto beans (Phaseolus vulgaris L. cv. U of I 114) on June 5, 1981, and approximately 6 plants were removed from 1.3 m of row in each plot on August 6, August 19, and September 9. Roots were examined for number of nodules, nodule weight, modal size, and maximum size. Rust was evaluated Sept. 9 with a rating scale spanning 0-9 logarithmic severity units.

On Sept. 26, plants in 6 linear meters from the center two rows of each plot were collected by hand in large burlap bags. The bags were oven dried at 32-38 C for 24-36 hr, then threshed in a stationary combine. Cleaned seeds were weighed to the nearest gram, and test weight (weight/unit volume) was determined.

Soil samples (4-5 cores from each plot) were collected before fertilization on 20 May and again Nov. 7. Soil from 0-15 and from 15-30 cm depths were separately analyzed by the NDSU soils testing laboratory for nitrogen content. Extant plus added nitrogen was considered available nitrogen.

Compared to the control, the number of nodules on plants taken at the first and second root harvest was significantly increased by the addition of Rhizobium. By the third root harvest, the number of nodules on inoculated plants was still greater than the control, but the difference was not significant ($p<.05$). In general, the modal size, total weight, and maximum size of the nodules was not increased by inoculation. Application of 112 kg/ha nitrogen fertilizer significantly reduced number, maximum size, total weight and modal size of nodules by the third root harvest. Inoculation of beans in a high level of nitrogen fertilizer did not overcome the effect the fertilizer had in depressing nodulation.

Plants fertilized with nitrogen had less rust than the controls and inoculated plants had more. However these differences were not significant. Both inoculation and nitrogen fertilization increased yields relative to the control, but differences were not significant. Neither inoculation nor nitrogen fertilization increased test weight of harvested seeds.

Plants inoculated with Rhizobium did not deplete available nitrogen. In fact, the mutualistic symbiotic relationship was capable of adding approximately 45 kg/ha of nitrogen by the end of the season. It is interesting that plants in nontreated plots (controls) added approximately 72 kg/ha of nitrogen. These plants were well nodulated apparently by native Rhizobium, but produced the lowest yield.

Results of this preliminary study are inconclusive. However, results obtained to date indicate that inoculation of pinto beans with Rhizobium has no significant beneficial effect on yield, test weight of seed, or resistance to rust infection. Inoculation enhanced the development of root nodules; and apparently, through nitrogen fixation, added nitrogen to the soil. Further studies are necessary to confirm these observations and to explain the interactions between native and introduced Rhizobium strains on fertilized and nonfertilized soils.

104. HEMAGGLUTINATION AND HEMAGGLUTINATION INHIBITION USING A TOXOPLASMA GONDII EXTRACT

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Toxoplasma gondii is an obligate intracellular protozoan parasite. Numerous species of mammals, birds and reptiles can be infected by this parasite (1). All research efforts, to date, have failed to produce an effective vaccine to be used against this parasite (2). In this paper we report using a toxic crude protein extract from the peritoneal exudate of T. gondii infected mice (Toxoplasma exotoxin) to immunize Swiss Webster (SW) mice against toxoplasmosis. Toxoplasma exotoxin was also used to cause spontaneous hemagglutination of rodent red blood cells. Toxoplasma exotoxin obtained from infected ovine fetal kidney (OFK) cells (OFK-antigen) had the same hemagglutinating properties as mouse-Toxoplasma exotoxin but failed to demonstrate the same levels of toxicity and immunogenicity.

Toxoplasma exotoxin was prepared from the cell-free peritoneal fluid of T. gondii-infected SW mice. Mice were infected by intraperitoneal (ip) injection of 2 X 10^5 T. gondii tachyzoites per mouse. Four days later the peritoneal exudate from these mice was collected and centrifuged at 10,000 X g for 15 min at 4°C. The supernatant was treated with ammonium sulfate (65% final concentration) to precipitate the protein. The precipitate was resuspended in saline and dialyzed against normal saline for 32h. OFK-antigen was prepared in the same manner except that spent growth medium from T. gondii-infected OFK cultures exhibiting 95% cytopathic effect (CPE) was used in place of peritoneal exudate.

There are numerous assay systems available to evaluate the immune response of an animal against T. gondii (3). We developed an assay system that utilized our immunizing agent, Toxoplasma exotoxin or OFK-antigen, as the assay antigen. Both protein preparations caused spontaneous agglutination of rodent RBC's (HA). This agglutination phenomenon may be species specific. See table 1. Hemagglutination was inhibited (HI) by anti-serum prepared against T. gondii tachyzoites. This procedure may prove to be of diagnostic value and replace the current T. gondii assay system that uses antigen-coated tanned sheep RBC's.

When mice were immunized with Toxoplasma exotoxin they successfully resisted a 10 X LD_{50} challenge of T. gondii tachyzoites. Fifty percent of the immunized mice are able to resist a 100 X LD_{50} T. gondii tachyzoite challenge. See table 2.

Electrophoretic analysis of the crude protein extracts indicate that there appears to be at least two different proteins of importance. One protein responsible for HA of mouse RBC's and one protein responsible for toxicity. It is not clear if either or both of these proteins are responsible for Toxoplasma exotoxin immunogenicity.

Table 1

Hemagglutination of RBC's by Toxoplasma Exotoxin

Cells Positive for Hemagglutination	Cells Negative for Hemagglutination
Mice - BALB/C B6C3 F1	Dog Chicken Goose
Swiss Webster C3H	Cat Calf Rabbit
C57BL/6 CFW	Goat Sheep Horse
	Guinea Pig
Rat - Albino X Cream Hooded	
	Human types, A+, A^-, B^-, O+ and O^-

Table 2

Immunogenicity of Toxoplasma Exotoxin

No. of Mice	Immunized with Toxoplasma Exotoxin	Challenge Dose	Percent Survival
20	Yes	10 X LD_{50}	100%
20	No	10 X LD_{50}	0
8	Yes	100 X LD_{50}	50%
20	No	100 X LD_{50}	0

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105. VISUALIZATION OF FLAGELLA

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Bacterial flagella are long, thin, whip-like appendages that provide bacteria with a means of locomotion. Flagella widths are measured in nanometers and are below the resolving power of the compound light microscope. Special staining techniques, usually employing a dye and tannic acid or other precipitating reagents, often are used to artificially enlarge the structures so they can be visualized. Six staining and/or smear preparation procedures were chosen from the literature and each evaluated for effectiveness and reliability in demonstrating flagellated bacteria.

Four important variables involved in the procedure were studied and controlled: growth of properly flagellated organisms, smear preparation, staining, and reagent stability. Various authors differed in their approach to each of these variables.

Leifson pointed out that log phase cells grown in carbohydrate free medium at temperatures below optimum flagellate well. Clark (1) showed that bacterial growth from blood agar provided well flagellated cells. Kodaka (3) described a delicate smear preparation procedure in which a colony was picked with an inoculating needle and lightly touched to two drops of water on a new, pre-cleaned slide. These procedures circumvented more tedious and time consuming steps used by other authors.

A large number of slides were prepared from a twenty-four hour growth of Proteus vulgaris on blood agar plates using the methods of Clark and Kodaka. Areas 2½ cm by 4½ cm were enclosed with wax pencil. Smears then were stained using one milliliter portions of the dye-mordant reagents of Clark, Forbes, Leifson, Ryu, and West (1,2,4,5,6). The staining time prescribed by the respective authors was followed. The five point rating system of West was used to evaluate the quality of each stain.

Initial evaluation of each method showed good staining using freshly prepared reagents. However, the quality of the staining of all except West's silver stain, decreased in ratings after two weeks. Stability of the staining reagents reported by the various authors ranged from several days, to weeks, to indefinite periods of time. The stability over time of these reagents appears to be much shorter than claimed. Kodaka (3) reported that the combined Ryu stain used in his procedure was stable indefinitely, but our results showed significant loss of activity within two weeks. The effective staining time required for the frozen and thawed Clark stain was found to be longer than the 5-15 minutes staining time, and the quality ratings from these reagents were poor.

Instability of the tannic acid mordant in alcohol was reported in 1951 by Leifson (4), therefore such deterioration should be expected. Compartmentalization of the dye and mordant solutions in separate containers has been used widely since. West's (6) procedure combines the dye and mordant at the time of staining which explains the consistent ratings. Recent attempts to shorten and simplify the flagella staining procedure have emphasized stabilization of the combined dye mordant mixtures.

The procedure recommended here is a combination of several different procedures from the various methods studied. Of all the procedures tried, it is the easiest to use, least troublesome and most reliable. It is amenable for classroom use with few or no problems and a high degree of success.

Growth of the organism according to Leifson (4) and Clark (1), and smear preparation advocated by Kodaka are recommended. Enclosure of the smear in areas of constant size as used by Leifson, Clark, and Forbes and use of a known, constant amount of stain give consistent precipitation reactions. Use of stain freshly made by combination of dye and mordant just before or at the time of staining is most reliable and is worth the small amount extra time to obtain effective, reproducible staining. Any of the five reagents combinations are adequate if used fresh; however, the Ryu (5) stain is the simplest and most rapid to perform in the laboratory.

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106. STRUVITE FORMATION IN COLONIES OF A *BACILLUS*

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During an investigation of the bacteria associated with the sclerotia of *Sclerotinia sclerotiorum*, a plant pathogenic Ascomycete, crystals were observed in colonies of a bacterium growing on Difco nutrient agar. The crystals were collected, washed in water, analyzed with X-ray powder diffractometry and unequivocally identified as the mineral struvite (magnesium ammonium phosphate hexahydrate, $MgNH_4PO_4 \cdot 6H_2O$) using the Powder Diffraction File. The bacterium was rod-shaped, gram +, catalase +, motile, strictly aerobic and formed endospores, characteristics which identified it as a *Bacillus* sp.

The struvite crystals formed only in colonies of the *Bacillus* indicating the bacterium was directly associated with crystal formation. Occasionaly, crystals formed and projected from the colony into the solid medium, but they never formed entirely outside of colonies. Crytals were first observed in 8-20 days following initiation of bacterial growth and increased in size during a 30-60 day incubation at 20-30° C. Crystals ranged from .3-.5 mm in diameter to .3-3 mm in length, were occasionally formed in aggregates and were colorless.

Examination of struvite crystals with X-ray flourescence spectrometry and energy dispersive X-ray analysis on individual crystals in an SEM revealed the presence of Mg and P supporting the identification made with X-ray powder diffractometry. Calcium was also detected, but its role in crystal composition was unclear. Calcium is a component of the endospore wall of *Bacillus* spp. and must be present for sporulation. Thus, calcium may have been present in colonies and deposited on the crystal surfaces during formation, or it may be substituting in part for Mg in the crystal structure.

Experiments were conducted to determine if factors other than bacterial growth were involved in crystal formation. Results indicated that growth of the *Bacillus* on nutrient agar was the cause of crystal formation. Crystals never formed in or on nutrient agar without the bacterium. Light and the instrument used to transfer and streak the bacteria were not involved in crystal formation.

In nature, struvite is found in association with decomposing organic matter such as cow dung, bat guano, peat and other organic sediments (8). Struvite has also been found in canned seafood (1,3,7) and is a component of urinary stones in mammals (4). The occurrence of struvite in association with decomposing organic matter suggests it is a biogenic mineral in nature (see review by Lowenstam). Indeed, there is evidence that microorganisms are involved in struvite formation. Struvite was observed in colonies of *Brucella abortus*, *B. melitensis* and other bacteria (unidentified) growing in vitro (5,10,11), and was also reported in colonies of actinomycetes (2,12). Struvite urinary stones in mammals are formed following bacterial infections with gram- bacteria (4).

The process of struvite formation in colonies of or in association with bacteria is unclear. Lowenstam (6) states that bacterial mineral precipitates form as a result of the interaction between biogenically formed gases and metal ions present in the external medium. Several researchers postulated that crystals formed because of an increase in local alkalinity resulting from the decomposition of protein by micobial enzymes (2,5). Robinson (10) reported that crystal formation was probably due to ammonia produced by bacteria which combined with magnesium phosphate from the medium. Formation of struvite in urine of mammals is a consequence of the hydrolysis of urea by bacterial urease. Ureolysis increases pH and levels of ammonia and carbonate in urine, which promotes supersaturation of struvite resulting in crystal formation (4). Apparently there are several processes of biogenic struvite formation, however, definitive studies elucidating such processes are lacking.

This is the first report that *Bacillus* can biogenically form struvite. The only other mineral known to be biogenically formed by *Bacillus* is calcite (9). *Bacillus* spp. are ubiquitous microorganisms, common in soil and organic matter where struvite has been found. *Bacillus*, therefore, may play a major role in the natural occurrence of this mineral. The discovery of struvite in canned seafood could be explained by the presence of *Bacillus* endospores which were not killed during the pasteurization process and thus initiated bacterial growth on the organic substrate resulting in struvite formation.

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107. THERMONUCLEASE PRODUCTION BY STAPHYLOCOCCUS AUREUS OBTAINED FROM NURSING HOMES

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The presence of Staphylococcus aureus thermonuclease (TDNase) exoenzyme in clinical specimens can serve both as an indication of S. aureus growth and the possible presence of staphylococcal enterotoxin (1,2,3). TDNase is tolerant to prolonged heating, storage at room temperature and bacterial contamination (2,3), so TDNase could be used to detect S. aureus presence regardless of viability. Most observations on TDNase production by S. aureus are based on organisms isolated from disease. TDNase production by S. aureus from normal, healthy people has not been studied. The object of this investigation was to a) detect TDNase production in, and b) compare the incidence of TDNase production by S. aureus isolates obtained from healthy individuals in nursing homes.

The employees and residents of several nursing homes within a 95 miles radius of Grand Forks were cultured for S. aureus in 1977 and 1980. All the cultures were taken from external nares. TDNase and deoxyribonuclease (DNase) production was detected using Toluidine Blue O (TBO)-DNA agar plates (3). 24 h Brain heart infusion broth (nonheated & heated to 100 C for 15m) was used to inoculate TBO-DNA agar plates. Positive reactions were seen (within 2h) as bright pink zones.

The incidence of TDNase and DNase producing S. aureus within four groups varied from 95.4 to 100% (Table I) which represents no significant difference. The overall incidence of TDNase & DNase producing S. aureus was 97.2% (448 out of 461 isolates). The average diameter of pink zones was 1 cm in 2 h. A 100% correlation was observed between TDNase & DNase (Table I).

Table I. Incidence of thermonuclease production by S. aureus isolates

Source	Number of Strains	Number of Thermonuclease Positive (%)	Number of Deoxyribonuclease Positive (%)
1977 Control	31	31 (100.0)	31 (100.0)
1977 Employees	186	181 (97.3)	181 (97.3)
1980 Employees	135	132 (97.8)	132 (97.8)
1980 Residents	109	104 (95.4)	104 (95.4)
TOTAL	461	448 (97.2)	448 (97.2)

The variation in incidence of TDNase & DNase production among nursing homes was more variable in 1980 (84-100%) than in 1977 (91.7-100%) (Table II). Except for nursing home IX, the incidence in employees and residents from the same homes (1980) showed no marked difference (Table II).

Table II. Percent of thermonuclease and deoxyribonuclease positive S. aureus from nursing homes

Group		I	II	III	IV	V	VI	VII	VIII	IX	X	XI
1977	a	(95.8)	(100.0)	(95.2)	(100)	(100)	(100)	(100)	(91.7)	(93.8)	(100)	(100)
Emp	b	23/24	25/25	20/21	16/16	18/18	6/6	9/9	22/24	15/16	19/19	8/8
1980	a	(100.0)	(100.0)	(100.0)	(100)	(87.5)	---	---	(95.5)	(100)	(100)	---
Emp	b	22/27	19/19	13/13	6/6	14/16			21/22	7/7	25/25	
1980	a	(100.0)	(100.0)	---	---	(84)	---	(100)	---	(85.7)	(100.0)	---
Res	b	23/23	25/25			21/25		14/14		6/7	15/15	

[a]95.8 = % of TDNase positve: also represents DNase positive S. aureus: same relationship in all other nursing homes.
[b]Number of isolates positive/total number of isolates.

TDNase and DNase have been found to be produced by most S. aureus isolates (97.2%) obtained from healthy residents and employees in nursing homes. The incidence of TDNase production in healthy populations was found to be similar to that observed in specimens from diseased persons (1,2,3). Waller and Almquist (4) found 83% of S. aureus isolated from nursing home personnel produced DNase. This could be attributed to a difference in technique since it seems that the TBO-DNA method is more sensitive that either the DNA-HCl or Methyl Green methods for detecting DNase activity.

Based on earlier observations (1,2,3), the high incidence of TDNase observed in our study could reflect a high incidence of enterotoxin production by S. aureus isolates. However, Greek and Waller (5) found only 24.1% of isolates obtained from healthy individuals produced enterotoxin. It can be concluded from our study that not all TDNase positive S. aureus isolates produce enterotoxin.

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108. BACTERIAL FLORA OF THE INNER CAVITY

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The normal flora of the nasopharynx includes alpha/ and beta/ hemolytic streptococci, Staphylococcus aureus, Staphylococcus epidermidis, and Neisseria species while S. epidermidis and S. aureus commonly are found in the external nares. Preliminary observations in this laboratory suggested that few bacteria could be recovered from the nasal cavity.

The purpose of this research was to determine the bacterial flora of the inner nasal cavity.

In November, 1982, samples were obtained from forty-three individuals. Samples were taken transnasally by passing a thin, calcium alginate tipped, aluminum swab through the external nares into the inferior nasal meatus until only 4.0 cm of the swab's handle remained visable. The nasal mucosa was swabbed at that point and the swab withdrawn.

Chocolate agar plates were inoculated with each swab and incubated at 37°C for 48 hours in increased CO_2 and anaerobic environments. No obligate anaerobes were isolated.

Table 1 shows the amount of bacterial colonization found from each sample. These numbers are adjusted to eliminate the presence of probable contaminants from the external nares. Any growth under 20 colonies was not considered indicative of inner nasal colonization. Nineteen samples showed lack of colonization and nineteen showed growth (>50 colonies per sample) indicating colonization of the inner nasal cavity. Five samples grew 20-29 colonies per sample, which indicates low grade or lack of colonization.

Table 1: Recovery of Organisms From the Inner Nasal Cavity

	Number of Colonies Per Sample				
	0-19	20-29	30-39	40-49	>50*
Number of Samples	19	5	0	0	19
Percentage of Samples	44.2%	11.6%	0.0%	0.0%	44.2%

*>50 contains 3 samples with 50 to 200 colonies and 16 samples with too many colonies to count.

Eleven different colony types were recovered from the plates. Each colony type was identified using the identification schemes in MacFaddin's Biochemical Tests for Identification of Medical Bacteria[1].

S. epidermidis types 1 and 4 were the most prominent organisms found in the inner nasal cavity (Table 2). One or two isolates each of Corynebacterium pseudodiphtheriticum, S. aureus, Streptococcus viridans, Citrobacter diversus, and Proteus mirabilis also were obtained. These results indicate that the bacterial flora of the inner nasal cavity, when present, is similar to that found in the external nares. The inner nasal cavity is relatively free from bacterial colonization with only the non-pathogenic S. epidermidis being harbored in any significant number of people. This study also demonstrates the importance of taking a proper nasopharyngeal swab culture as the flora of the inner nasal cavity is not representative of the nasopharynx.

Table 2: Bacterial Flora Isolated From the Inner Nasal Cavity

Organism	Average number of colonies/sample	Number of samples	Carrier Rate[a]
S. epidermidis biotype 1	TNTC[b]	18	41.9%
S. epidermidis biotype 4	TNTC	16	37.2%
C. pseudodiphtheriticum	29	2	4.7%
S. aureus	20	1	2.3%
S. viridans	TNTC	1	2.3%
C. diversus	Spreader	1	2.3%
P. mirabilis	Spreader	1	2.3%
No colonization	c	19	44.2%

[a]The percentage of samples colonized with a particular organism.
[b]TNTC - The average number of colonies per sample ranged from 50 to too many colonies to count.
[c]Samples with less than 20 colonies were not considered indicative of colonization.

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62. ELECTROCHEMICAL QUANTITATION OF METAL COMPLEXES SEPARATED BY SIZE-EXCLUSION CHROMATOGRAPHY

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The chemical speciation of trace metals in aquatic environments plays a key role in their transport, chemical reactions, and biological availability. With the increase of organic pollutants with potential complexing ability, metal complexes formed in these waters are very important. We have been interested in developing a methodology for the quantitation of metal complexes using copper as the metal probe and analysis at natural water pH's.

Our approach has been to use chromatographic techniques coupled with metal analysis to separate and quantitate ligands. Size-exclusion columns to which a constant metal addition is made (1) are used to separate labile and inert complexes which are subsequently detected using a flow-through electrochemical cell. A reverse pulse amperometric (rpa) excitation signal, which has been shown to decrease the interference of oxygen (2), is used to quantitate the metal complex in the flow system.

A series of polyaminocarboxylic acids, amino acids, and other organic acids was used in developing the methodology. A partial list of the ligands tested along with their respective k' values (k'=elution volume/void volume) are shown in Table 1. The void volume was determined using blue dextran. A value of $\Delta k' = 0.2$ is necessary for ligands to be completely separated on the column.

Table 1. Chromatographic Data for a Series of Copper Complexes on Sephadex G-25

Ligand	k'
DTPA	1.44
EDTA	1.65
NTA	1.79
leucine	2.08
aspartic acid	1.92
glutamic acid	1.90
lysine	1.99
histidine	2.15
citric acid	1.56

A statistical detection limit for the analysis of EDTA, which has been separated as the copper complex and detected electrochemically using rpa was calculated from the slope (m) and standard deviations (s) over the range of 0.025 to 0.2 μmoles. A detection limit = ts/m was calculated using a t test at the 95% confidence level. A value of 0.0060 μmoles or 2 μg of EDTA was obtained as the detection limit with the above technique.

In an attempt to test this methodology relative to natural water samples, fulvic acid (3) samples were used. Soil fulvic acid (SFA) and water fulvic acid (WFA) samples were used. The samples appear different chromatographically, (i.e., different k' values), which was apparently due to the sample sources. The WFA was isolated from a Grand Forks, ND waterway and the SFA was obtained by isolation techniques from New Hampshire soil. A statistical detection limit for the analysis of WFA was calculated from a calibration curve over the range of 0.1 to 0.3 mg. A value of 5.5 μg was obtained as the detection limit by the calculation method described above.

The described method is potentially useful in the quantitation of metal complexes. The technique not only provides a measurable "peak", but in addition a metal depletion band is noted in the eluent. The depletion band therefore can be utilized in measurements of overall binding or complexation capacity of an aqueous sample. This can be particularly important for metal complexes which either can not be resolved on a column or if the metal complex(es) is irreversibly adsorbed onto the column packing. Acknowledgements: The authors gratefully acknowledge the support of matching grant B-057-NDAK from the Office of Water Research and Technology and the North Dakota Water Resources Institute. The soil fulvic acid sample was generously provided by Professor J.H. Weber of the University of New Hampshire.

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63. # FE^{2+} AND DITHIOTHREITOL AUTOXIDATION IN ASSAYS FOR IRON-ACTIVATION OF PHOSPHOENOLPYRUVATE CARBOXYKINASE

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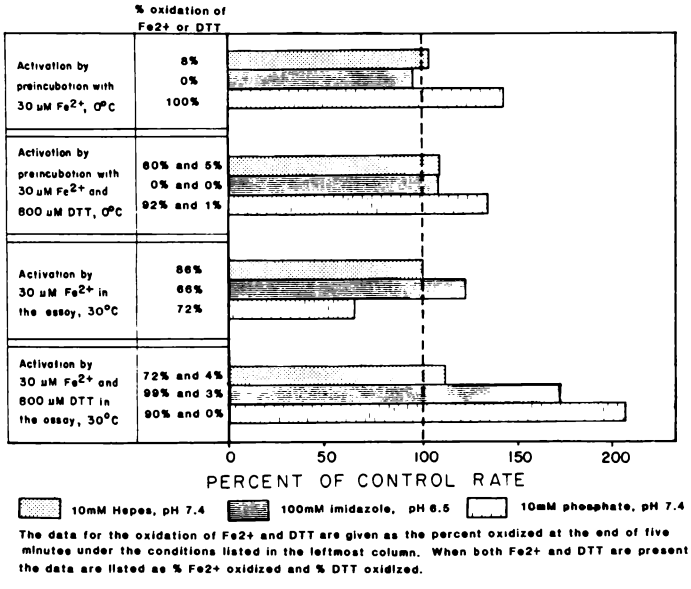
The activation of phosphoenolpyruvate carboxykinase (PEPCK) by 30 μM Fe^{2+} is reported to depend on the purity of the enzyme preparation, the identity of anions in the assay, and the concentration thiols (1). The purpose of our research was to determine if the variability of iron-activation is correlated with the inherent instability of Fe^{2+} and thiols in assay solutions. We investigated the rates of autoxidation of 30 μM Fe^{2+} and 800 μM dithiothreitol (DTT) (a thiol used as an enzyme sulfhydryl protectant) under conditions simulating PEPCK assays. Three different buffers with differing affinities for iron were used. Three components for the assay of PEPCK were included: 2.0 mM inosine triphosphate, 1.5 mM oxalacetate, and 10 mM sodium fluoride.

The rate of autoxidation of Fe^{2+} was followed with time by assaying aliquots for Fe^{2+} using 1,10-phenanthroline (2). The concentration of DTT remaining in the reduced state was measured at timed intervals with 0.1 mM 5,5'-dithiobis (2-nitrobenzoic acid) reagent. PEPCK was assayed by the method of Seubert and Huth (3) as modified by Bentle and Lardy (1). The enzyme assays were terminated after five minutes. The activities of PEPCK presented are the average of duplicate measurements.

The iron-activation of PEPCK can be accomplished by either preincubation of enzyme at 0°C with Fe^{2+} in the absence of assay components, or by the addition of Fe^{2+} directly to the enzyme assay solution. Therefore, the three buffers were tested for their influence on Fe^{2+} and DTT stability under both preincubation and assay conditions. The results are summarized in the second column of Figure 1. Hepes has very little affinity for metal, imidazole is a nitrogen-containing Fe^{2+} ligand which stabilizes Fe^{2+}, and phosphate is an Fe^{3+} ligand which promotes the autoxidation of Fe^{2+} (2). Substrates of PEPCK also promote the rapid autoxidation of Fe^{2+} while DTT remains relatively stable.

Figure 1. The Iron-activation of PEPCK in Three Buffers



The data for the oxidation of Fe2+ and DTT are given as the percent oxidized at the end of five minutes under the conditions listed in the leftmost column. When both Fe2+ and DTT are present the data are listed as % Fe2+ oxidized and % DTT oxidized.

PEPCK from unpurified rat liver cytosolic preparations was equilibrated with each of the three buffers by passage over a Sephadex G-25 column containing the buffer of interest. The enzyme was then iron-activated either by preincubation with Fe^{2+} or addition of Fe^{2+} to the assay. As shown in Figure 1, preincubation with 30 μM Fe^{2+} resulted in little activation, while 30 μM Fe^{2+} added to the assay demonstrated good activation if 800 μM DTT was present with 10 mM phosphate, pH 7.4 or 100 mM imidazole, pH 6.5. Although our results demonstrate striking differences in the degree of PEPCK activation by Fe^{2+} depending on the buffer present, the absence or presence of thiol, and whether iron is added before or after the enzyme assay is initiated, there does not appear to be a simple correlation between the stability of Fe^{2+} and the degree of activation seen.

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64. AERIAL PHOTO CENSUSING OF SANDHILL CRANES: DISTRIBUTIONAL EFFECTS OF INTERSTATE 80

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Sandhill cranes along the central flyway, utilize the Platte River Valley of Nebraska as the major staging area for their northward migration. In the spring of each year, upwards of eighty percent of all lesser sandhill cranes and a large number of other crane subspecies habituate the rivers, meadows, and agricultural lands in this valley (1). Three staging areas (see Figure 1) have been identified by the United States Fish and Wildlife Service. There, feeding and resting, cranes build energy reserves needed for continuing their migration to summer breeding grounds in the arctic. Construction of six major dams on the Platte River System, between 1909 and 1957, reduced annual river flows by seventy-five percent (2). Loss of spring high water and its scouring effects, has permitted the encroachment of woody vegetation, and a loss of usable river habitat for cranes (3). Another cultural feature that may be affecting use of staging areas by cranes is the presence of Interstate 80, which traverses or is adjacent to these staging areas. There has been an obvious loss of critical crane habitats to highway construction. In addition, land use within habitats have been altered by highway access and accessibility. This study analyzes the effects Interstate 80 has on the cranes' use of adjacent preferred habitats.

Aerial photo techniques were used to census sandhill crane distributions within the staging areas and with respect to Interstate 80. Cranes were sampled by airborne photo acquisition flights made on March 14 and March 24. Each flight provided data for sixteen percent of the 320 square miles of staging areas.

Statistical techniques were used to analyze data for crane and habitat distributions with respect to the location of Interstate 80. Results of variance analysis revealed that the apparent non-random distributions of cranes were statistically significant. This analysis also showed that spacial distributions were consistent for data gathered from each flight. Pearson analysis (see Table 1) indicated a strong correlation existed between distance from the interstate highway and increase in the number of cranes.

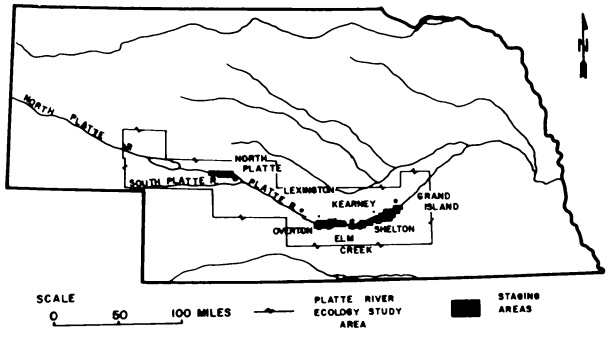

Figure 1. Geography of the Platte River Valley

Source : modified from Krapu, 1981.

TABLE 1

Pearson Correlation Coefficients N=10

	CULTIV	GRASS	ALFALFA	BIRDS	DISTANCE
CULTIV	1.00000	0.68606	0.10569	0.71064	0.93330
	0.0000	0.0285	0.7714	0.0213	0.0001
GRASS	0.68606	1.00000	-0.35988	0.72448	0.69199
	0.0285	0.0000	0.3070	0.0178	0.0266
ALFALFA	0.10569	-0.35988	1.00000	0.07047	0.33577
	0.7714	0.3070	0.0000	0.8466	0.3429
BIRDS	0.71064	0.72448	0.07047	1.00000	0.76882
	0.0213	0.0178	0.8466	0.0000	0.0094
DISTANCE	0.93330	0.69199	0.33577	0.76882	1.00000
	0.0001	0.0266	0.3429	0.0094	0.0000

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65. ASSESSMENT OF PROTEIN-CARBOXYL METHYLTRANSFERASE AND PROTEIN METHYLESTERASE ACTIVITY IN VARIOUS RAT TISSUES DURING DEVELOPMENT AND AGING

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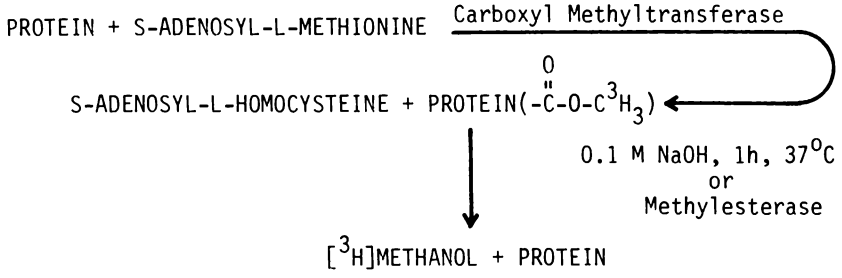
Specific proteins, particularily hormones from the anterior pituitary gland, have been found to function as methyl acceptors in the presence of S-Adenosyl-L-Methionine resulting in the formation of alkaline labile protein methyl esters (PME). The hydrolysis of PME has also been found to be catalyzed by protein methylesterase. The purpose of this investigation was to determine the levels



of protein-carboxyl methyltransferase and protein methylesterase in different fractions from various organs during development and aging. Protein-carboxyl methyltransferase was detected by incubating various cell fractions in the presence of S-Adenosyl-L-[methyl-^{3}H]methionine and ACTH. Protein as precipitated with 10% trichloroacetic acid and washed three times. After hydrolysis of methyl esters in NaOH, [^{3}H]methanol was extracted with organic solvents and radioactivity determined in a liquid scintillation spectrometer.

Measurable levels of protein-carboxyl methyltransferase were observed in the cytoplasm of all organs tested with the highest activity in the brain and thymus. Enzyme activity decreased with age in all organs, except the brain which increased. The nucleoplasmic fraction also contained significant amounts of protein-carboxyl methyltransferase. In young animals (0-30 days) activity in the nucleoplasm was equal to or greater than the cytoplasm.

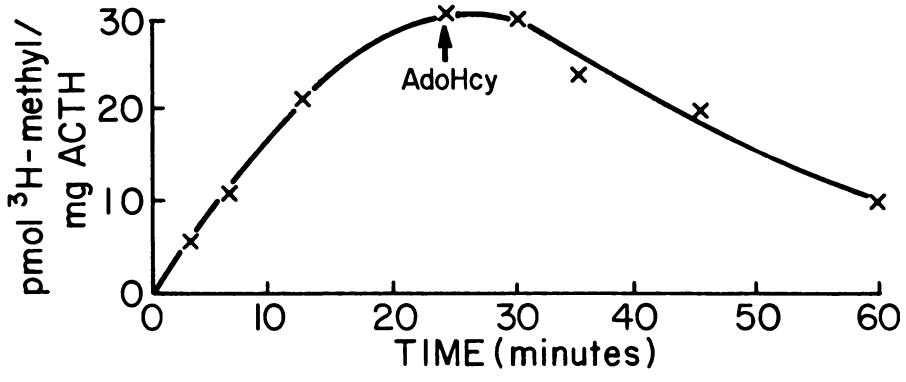


Fig. 1 Methylation-Demethylation of ACTH

When ACTH was incubated with brain cytosol the substrate appeared to be saturated in 20 minutes. At saturation 0.15 mmol of alkaline labile methyl groups had been incorporated per mole of ACTH. This represented less than one methyl residue per 6600 molecules of ACTH. Failure to reach stoichiometric levels of methylation was probably due to the presence of a protein methylesterase. Demethylation was observed when S-Adenosylhomocysteine (AdoHcy) was used to block methylation (Fig. 1). Protein methylesterase activity was also manifest by the amount of [^{3}H]methanol formed during the course of the reaction. The rate of methanol formation at saturation was found to be equivalent to the initial rate of methylation. The methylation-demethylation system presents a possible mechanism of regulation during cellular development.

66. ACETYLENE REDUCTION BY RHIZOSPHERE BACTERIA ISOLATED FROM NORTH DAKOTA MINING RECLAMATION SITES

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Heterotrophic nitrogen-fixing bacteria associated with the rhizosphere of grasses are considered by many to be an important source of nitrogen in temperate grasslands (1). These organisms may therefore be an important factor in the revegetation of mined areas in North Dakota. In our investigation, samples were collected from sites designed and maintained by the Agricultural Research Service at the Glenharold coal mine near Center, N.D. The test plots consisted of two treatments, one with 30 cm of topsoil, and one with no topsoil. They had been seeded with Nordan crested wheatgrass (Agropyron desertorum) (Fish.) (Shult.) and had received no fertilization. Two samples were taken during the growing season (late June, 1982 and early August, 1982) and two samples were taken during non-growing season (October, 1981 and 1982).

Two hundred thirty-two nitrogen-fixing microorganisms were isolated for identification and characterization, and methods for identifying heterotrophic nitrogen-fixing bacteria were improved. Most of the species previously reported in the literature were found, but Bacillus spp. predominated (2).

Standard plate counts for total bacterial populations, and most-probable-numbers (MPN) of nitrogen-fixing bacteria, (as determined by acetylene reduction) were made of washed samples of plant roots (Table 1). There was no seasonal variation in the total bacterial counts. The ratio between the MPN of nitrogen-fixing bacteria and the total bacterial numbers was consistently narrower in topsoil sites as compared to no topsoil sites (Table 2).

Table 1

Enumeration of Bacteria

	Total Bacterial Plate Counts	MPN Nitrogen-fixing Bacteria
	Topsoil	
Fall, 1981	383×10^6	70×10^3
Fall, 1982	183×10^6	43×10^3
Summer (1), 1982	236×10^6	7×10^3
Summer (2), 1982	322×10^6	46×10^3
	No Topsoil	
Fall, 1981	1030×10^6	2.1×10^3
Fall, 1982	613×10^6	1.2×10^3
Summer (1), 1982	870×10^6	7×10^3
Summer (2), 1982	620×10^6	70×10^3

Table 2

The Ratio on MPN of Nitrogen-fixing Bacteria to the Total Bacterial Count

	Topsoil	No Topsoil
Fall, 1981	1: 5500	1:490000
Fall, 1982	1: 4300	1:510000
Summer (1), 1982	1:34000	1:120000
Summer (2), 1982	1: 7000	1: 8900

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67. PROPERTIES OF THE CARBONIC ANHYDRASE FROM RHODOSPIRILLUM RUBRUM

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Carbonic Anhydrase (CA) catalyzes the reaction $CO_2 + H_2O \rightleftharpoons HCO_3^- + H^+$ and is typically found in organisms and situations where there is an established requirement for CO_2 utilization or transport. The CA of *Rhodospirillum rubrum* has previously been identified as a soluble, cytoplasmic enzyme and has been partially purified and characterized. We now report a new purification procedure involving $(NH_4)_2SO_4$ precipitation of the crude extract, passage through Sephacryl S-200, isoelectric focusing at pH 3.5 to 10 and chromatofocusing at pH 7 to 5. Crude enzyme was stable, but Zn^{+2} was required for stability during purification. The zinc requirement was further established by EDTA inhibition of purified CA (60% at 2mM) and reversal of the inhibition with Zn^{+2} (4mM). CA was inhibited by sodium azide and 5,5'-dithiobis-(2-nitrobenzoic acid) with a Ki of 1.2×10^{-5}M and 9.96×10^{-7}M respectively. Table 1 shows several inhibitors and the percent inhibition of CA activity. Rose Bengal dye, a modifier and inhibitor of active site histidines in bovine CA, also inhibited *R. rubrum* CA 50% at 0.074mM. Pyridoxal-5'-phosphate, a modifier of lysine amino groups, inhibited CA 57% at 0.13mM. Phenyl Glyoxal, a modifier of arginine groups, inhibited CA 14% at 0.1mM. CA is stable when stored in 50% glycerol at -70°C. Incubation of CA at temperatures ranging from 23.5°C to 60°C resulted in an activity loss of 31% to 70%. The ultraviolet absorption spectrum of CA showed no peak at 280nm which suggests the absence of tyrosine residues. *R. rubrum* CA does exhibit esterase activity.

Table 1

Inhibitor	Concentration (mM)	Percent Inhibition
Acetazolamide	0.5	100%
Sulfonamide	0.5	100%
Potassium Cyanate	0.5	100%
Sodium Azide	0.5	79%
5,5'-dithiobis-(2-nitrobenzoic acid)	0.5	78%
Iodoacetate	0.5	44%
O-Iodobenzoate	0.5	42%
Imidazde	0.5	40%
Phenylmethyl sulfonyl fluoride	0.5	20%

68. REFLEX INFERIOR VENA CAVA SEGMENT RESPONSE TO PEEP AND CAROTID OCCLUSION IN THE RABBIT

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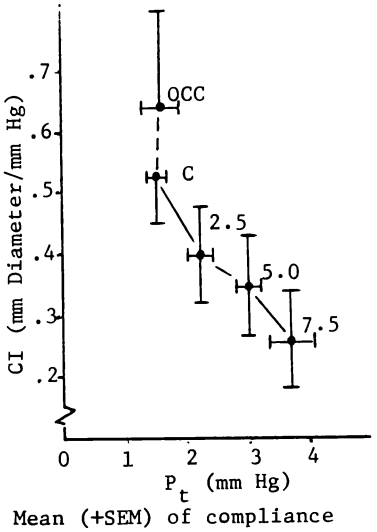
This study examines the hypothesis that vagally mediated cardiopulmonary mechanoreceptors reflexly influence the tone of a segment of the inferior vena cava. Most evidence for reflex influences attributed to these receptors, stimulated by lung hyperinflation, has dealt with the responses of the heart and arterial system (1,2,3). However, in a prior study (4) we found that right atrial (transmural) filling pressure was proportionately increased during positive end expiratory pressure (PEEP) lung hyperinflation in the rabbit and following vagotomy right atrial filling pressure decreased as PEEP was increased. In the present study we selected the rabbit's inferior vena cava segment between the renal inlets and the liver based on the results of Shigei et al. (5). They demonstrated this vein segment to have a relatively thick portion of vascular smooth muscle rich in adrenergic alpha (α) and beta (β) receptors. Our measurements included quantification of the diameter (D), rate of change in diameter (dD/dt), transmural pressure [(P_t) = internal - external] and its rate of change dP_t/dt, using induction angiometry (Medical Testing Systems Inc.) and appropriate pressure catheters and transducers. To quantify changes in segment vascular tone we calculated an index of segment compliance (CI) as CI = $(dD/dt)/dP_t/dt$. Each of nine anesthetized aortic denervated rabbits were instrumentated and placed on positive pressure ventilation. Measurements were made before and during two or more levels of PEEP and following use of alpha and/or beta smooth muscle receptor blockers or vagotomy. Results for all animals included mean segment diameter (D) of 7.01 ± 0.26 mm (SEM) at a mean segment transmural pressure (P_t) of 1.52 ± 0.14 mm Hg at control conditions. For all animals the CI was calculated and averaged and Fig. 1 is a plot of mean CI vs P_t. This figure indicates that during successive increases in PEEP, CI decreased as P_t increased, respectively. Linear regression analysis of control and PEEP responses revealed a decrease of 0.12 mm diameter for every 1 mm Hg increase in P_t (r = 0.9790). Bilateral carotid occlusion (OCC) resulted in a nonsignificant increase in CI while P_t remained unchanged as compared to control values. In four animals, CI responses to PEEP were significantly attenuated when results following α + β smooth muscle receptor blockade were compared to preblockade responses. From control, 2.5 to 5.0 cm H_2O PEEP, P_t values were 1.74 ± 0.06, 2.25 ± 0.10, and 2.86 ± 0.10 mm Hg while respective CI values were 0.32 ± 0.07, 0.28 ± 0.08, and 0.27 ± 0.07 mm/mm Hg. These results, of a relatively unchanged CI as P_t increased, indicated that a large portion of active change in vessel tone can be attributed to α + β adrenergic efferent receptors of the segment. To estimate the individual influence of α or β receptors on CI and P_t responses we compared results before and after use of each blocker on separate groups of animals. Alpha blockade in three animals did not alter CI values, however, P_t values we significantly reduced for control and PEEP conditions. Beta blockade alone in four animals resulted in a significant decrease in CI values while P_t values were significantly increased for control and PEEP conditions. Lastly, to estimate the reflex influence of vagally mediated cardiopulmonary mechanoreceptor afferents we compared responses before and after cervical vagotomy in three rabbits. Vagotomy resulted in a significant decrease in P_t values at all PEEP levels while CI values were slightly decreased. The decrease in P_t values following vagotomy is consistant with our earlier observations of a decrease in right atrial filling pressure (4). In conclusion, these experiments support our hypothesis and indicate that activation of vagal mediated cardiopulmonary mechanoreceptors results in an increase in inferior vena cava segment tone (decrease in CI) during lung hyperinflation. These results further indicate that both α and β smooth muscle receptors are involved in the reflex. These experiments do not, however, preclude the reflex involvement of nonvagal mediated cardiopulmonary mechanoreceptors.



Mean (+SEM) of compliance index (CI) vs. transmural pressure (P_t) for 9 rabbit inferior vena cava segments. OCC, bilateral carotid occlusion; C, control; 2.5, 5.0, and 7.5 cm H_2O PEEP lung hyperinflation.

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69. THE EFFECT OF MATING AT SHORT INTERVALS ON CORTISOL SECRETION IN THE PIG

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Mating at 15 minute intervals in the pig has been reported to produce endocrine changes favoring greater ovulation rates and higher fertility. The effect of mating regimen on cortisol release and fertility was examined in the current experiment. Nineteen virgin gilts (weighing approximately 110 kg) were cannulated via the cephalic vein five days prior to estrus. Gilts were checked for breeding activity twice daily (0700 and 1900 hr). The control group was mated twice by fertile males at 12 hour intervals. The control group was mated first by a fertile male at 12 hour intervals; then 15 minutes after each fertile mating, treatment gilts were exposed to a vasectomized male for a subsequent sterile mating. Blood samples were collected 4 times daily beginning three days before expected estrus and continuing until the onset of lordosis. Blood samples (5ml) were then collected hourly until one hour before mating. Sampling frequency was increased to once every 15 minutes for 7 consecutive hours at this time. Blood samples were immediately centrifuged after collection at 1250 x g (4° C). Plasma was removed and stored at -20C until analyzed for cortisol by radioimmunoassay procedures.

Results suggest an association between mating and plasma cortisol concentration in the gilt. No significant difference was observed in mean cortisol concentrations between the treated and control group. Mating at fifteen minute intervals did not result in altered cortisol concentrations in plasma. Short interval matings did not increase ovulation rate or embryo survival, nor did the stress of additional mating activity appear to depress ovarian activity. Conception rates were higher in the treated group.

Mean (±S.E) Concentrations of Cortisol and Fertility in Gilts Exposed to Two Mating Regimen

	Treatment	Control
	$\bar{X}$ ± SEM	$\bar{X}$ ± SEM
Corticoid Values (mg/ml)		
Number of Gilts	10.	9.
Before Mating	24.1 ± 3.4	29.4 ± 5.8
At Mating	67.0 ± 6.6	72.8 ± 9.1
Post Mating	15.8 ± 3.0	18.8 ± 4.4
Fertility Data		
Ovulation Rate	14.1 ± 1.8(17)	14.4 ± 2.3(16)
Total Embryos	11.1 ± 3.5(17)	11.7 ± 2.9(16)
Conception Rate (%)	100	75

Numbers in parentheses represented total number evaluated.

70. EFFECT OF DIFFERING LEVELS OF BARLEY STRIPE MOSAIC VIRUS INFECTED SEED AND RATE OF FIELD SPREAD ON YIELD LOSS IN BARLEY

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Barley stripe mosaic virus (BSMV) is one of the few seed-borne viruses of gramineous plants (1). Seed infection is epidemiologically important because (i) it insures that the virus will be associated with the planted crop, (ii) infected seed is randomly dispersed in the field, and (iii) the infected seedlings (as a result of seed infection) serve as sources of inoculum to initiate secondary spread since the virus is also transmitted from plant to plant when leaves rub together in the field (2,4). Artificial inoculations of barley field plots with BSMV have provided information as to the relative yield losses incurred when all plants in a plot are infected at one specific growth stage. The greatest reduction in yield occurs when plants are inoculated in the late tillering stage (3). However, under natural field conditions 100% BSMV infection is not possible at one point in time. Furthermore, there may be some yield compensation by healthy plants that are adjacent to infected plants or by plants that are infected very late in the growing season. Loss in yield will be a function of the initial proportion of infected seed (X_o) and the rate of secondary spread with respect to time. The present study utilized known BSMV seed infection levels to more precisely determine the effect of BSMV on reduction in yield and 500-seed weight in 'Dickson' barley.

Seed infected with BSMV was blended with healthy seed to produce initial seed infection levels of 0, 0.01, 1.0, 5.0, 15.0, 30.0, and 60.0%. Seed infection levels (treatments) were replicated in 6' by 20' plots arranged in a randomized complete block design. The experiments were conducted in 1981 and 1982 in Fargo, N.D. The proportion of BSMV infected plants (X) was determined for each replicate plot at approximately 2 week intervals throughout each growing season. Four 25-plant cluster samples were assessed visually and averaged to obtain the disease proportion (X) for each replicate plot. The logit transformation, log(X/1-X), was made on the disease proportion measurements and apparent infection rates were calculated by regressing logits on time (t). Following harvest, the seed was dried and cleaned and the yield per plot and 500-seed weight was determined.

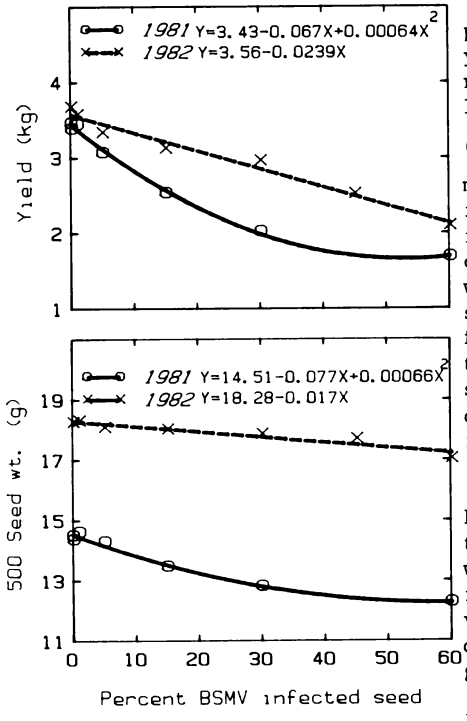

Figure 1. Effect of different seed infection levels planted in 1981 and 1982 on yield and 500 seed weight.

Barley yield per plot and 500-seed weight decreased as the proportion of BSMV infected seed planted was increased in both years (Figure 1). Reduction in yield and seed weight (Y) in response to seed infection levels was best described by a linear model ($Y = b_o - b_1X_o$) in 1982 but by a quadratic model ($Y = b_o - b_1X_o + b_2X_o^2$) in 1981. Environmental conditions were more conducive for plant to plant spread in 1981. The apparent infection rate was 0.06 units/day in 1981 whereas the apparent infection rate in 1982 was 0.02 units per day. In 1981 adequate moisture was available for the development of tillers whereas in 1982 moisture was a limiting factor early in the season which resulted in reduced tillering. Thus, if little field spread occurs, yield reduction is nearly linear in response to increasing levels of BSMV seed infection; but as the rate of secondary field spread increases, greater yield reduction occurs and the response (to increasing seed infection levels) is more closely represented by a quadratic model.

This experiment indicates that both the initial level of BSMV seed infection and the rate of field spread as affected by the environment determines the reduction in yield and 500-seed weight. The use of known seed infection levels may be useful in making comparisons of different strains of BSMV in a single variety or to study the effect of a single BSMV strain in different barley varieties for purposes of finding barley genotypes which reduce field spread.

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71. ANHYDROUS AMMONIA AND PROPIONIC ACID FOR THE PREVENTION OF DICOUMAROL FORMATION IN SWEETCLOVER HAY

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Sweetclover [Melilotus officinalis (L.) Lam. and M. alba Desr.] is a biennial legume grown in North Dakota primarily as a forage and green manure crop. Sweetclover hay is difficult to dry in the field due to its coarse stem and high moisture content. Baling sweetclover hay before it is sufficiently cured can result in molding and heating in storage which results in the formation of dicoumarol, the blood anticoagulant responsible for causing "sweetclover bleeding disease" in livestock. Dicoumarol at 20 to 30 mg/kg and above can result in animal death due to internal and/or external bleeding.

Propionic acid (PA) and anhydrous ammonia (NH_3) have been used as high moisture hay preservatives (1). Our objective was to investigate if PA or NH_3 could prevent dicoumarol formation in high moisture sweetclover hay and preserve the forage quality.

Preliminary experiments with PA and NH_3 on 7-kg samples of 55 and 65% moisture hay indicated that NH_3 at 1% of the wet hay weight prevented molding and dicoumarol formation while PA at 1 and 2% did not. Laboratory experiments with 400 g of hay rewetted to 40% moisture and treated with various levels of PA showed that PA at 0.3% was effective in preventing molding and dicoumarol formation.

Large round bales of sweetclover at 20, 27, and 37% moisture were treated with NH_3 or PA at 10 g/kg of wet (20 and 27% moisture hay) and at 20 g/kg on 37% moisture hay. Propionic acid was applied to the windrow immediately prior to baling with a CO_2 pressurized sprayer and NH_3 was applied as Cold-flo® to bales sealed in 6-mil plastic. The bales were sampled after a six-week storage period and all samples analyzed for dicoumarol, crude protein, in vitro dry matter disappearance (IVDMD), acid detergent fiber (ADF), neutral detergent fiber (NDF), and acid detergent fiber protein (ADF-P). Hemicellulose was calculated as NDF-ADF.

Anhydrous ammonia prevented extensive dicoumarol formation and increased forage quality of sweetclover hay in large round bales (Table 1). Bales at 20 and 37% moisture treated with NH_3 had only 3.5 and 5.6 mg/kg dicoumarol while NH_3 at 10 g/kg on 27% moisture bales was an inadequate rate and resulted in 29 mg/kg dicoumarol. Propionic acid did not prevent dicoumarol formation possibly because of nonuniform application. The surface 5 to 8 cm of the bales was lower in dicoumarol, crude protein, and IVDMD and higher in ADF and NDF than the inside of the bales (Table 2). This was as expected as the surface layer dries quickly and is more subject to leaf loss and leaching of nutrients by rain. Forage quality was highest in the 40 cm (outer core) between the surface layer and the inner core 40 cm.

Table 1. Dicoumarol content, crude protein content, and IVDMD of sweetclover large round bales treated with propionic acid, anhydrous ammonia, or untreated, averaged over three moisture levels.

Treatment	Dicoumarol	Crude protein	IVDMD
	mg/kg	%	
Untreated	43.3	19.1	61.4
Propionic acid	36.4	19.3	64.0
Anhydrous ammonia	12.7	25.0	66.7
L.S.D. (0.05)	15.9	0.94	2.4

Table 2. Dicoumarol concentration and forage quality of sweetclover hay as influenced by position in large round bales, averaged over three moisture levels and treatments.

Position	Dicoumarol	Crude protein	IVDMD	ADF	NDF	ADF-P	Hemicellulose
	mg/kg	%					
Surface	17.0	18.2	59.1	49.4	60.3	1.8	10.9
Outer core	38.4	23.8	68.0	37.0	47.3	1.9	10.4
Inner core	37.0	21.4	65.0	39.7	53.8	1.9	14.0
L.S.D. (0.05)	11.2	0.8	1.4	1.1	1.7	ns	1.2

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72. ANALYSIS OF OXYGEN FUNCTIONALITIES IN COAL DERIVED LIQUIDS

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In addition to distillable products a sizeable portion coal liquefaction products fall into non-distillable higher molecular weight fractions. These fractions contain 80-85% weight of carbon, of which 70% is aromatic. The molecular weight distribution of these tars range from 300 to 2000 g/mole. The fractions contain mono- or polyfunctional oxygen and nitrogen groups depending on the molecular weight. Knowledge of the structure of these fractions is important in coal liquefaction processes because their formation is responsible for the high viscosities of coal liquids leading processing and operational problems.

Two studies are underway to measure the amount of ether and carbonyl oxygen in the coal derived higher molecular weight fractions. Reductive ether cleavage techniques utilizing sodium in hexamethylphosphoric triamide are being examined for the formation of phenolate which can be quantitated by subsequent derivatization by alkyl halide or acetic anhydride. Carbonyl oxygen functionalities are determined by reaction of the coal matter with hydroxylamine to form oximes. The moles of carbonyl present are equal to the moles of nitrogen added to the sample. Completeness of the carbonyl reaction presents a problem. Early coal work indicated that hindered carbonyl or quinone compounds were unable to quantitatively form oximes with hydroxylamine. Examples of such compounds are 1,4- or 1,8-dihydroxyanthraquinone and benz(a)anthracene-7,12-dione. Our work has shown that derivatization of the adjacent hydroxyl groups allows quantitative oxime analysis of model compounds. The technique is to be employed with the heavy coal liquids.

Table 1 reports the amount of oxygen present in six of the Grand Forks Energy Technology Center (GFETC) high molecular weight liquids. The total oxygen content was determined by difference using the hydrogen, carbon, nitrogen and sulfur elemental analyses. The hydroxyl group concentration was measured by acetylation using ^{14}C labeled acetic anhydride, purification, and counting techniques. The carbonyl oxygen reported is that measured by hydroxylamine reaction without prior derivatization of the sample.

Several reductive cleavage analyses of the coal samples were performed without formation of additional hydroxyl groups. Cleavage of an ether results in the formation of hydroxyl groups in addition to those originally present in the sample. The lack of total accountability of the oxygen can be explained by unreactivity of ethers because of the presence of numerous hydroxyl groups which interfere in the cleavage mechanism. Modifications to the ether analysis procedure are under active investigation. Another explanation of the lack of accountability could be the presence of hindered carbonyl groups which give low oxime values. Infrared analysis of 32-A prior to oximation showed the sample contained no carbonyl adsorption peak. Only the 1600 cm^{-1} peak that occurs in all coal liquids was observed. Methylation of 32-A gives a new peak at 1675 cm^{-1}. A carbonyl group which is hydrogen bonded to a hydroxyl group shows such behavior. Speight and Moschopedis observed similar results for Athabasca tar sand asphaltenes(1).

Modification of the carbonyl analytical scheme to include prior methylation of all hydroxyl groups effects completion of oximation reaction. Both 1,4- and 1,8-dimethyoxyanthraquinone yield two moles of oxime per mole compared to one mole of oxime per mole for the dihydroxyl moities. Nmr analysis of the monoxime of 1,8-dihydroxylanthraquinone shows that the hindered hydroxyl position has not reacted. Work has begun on the analysis of coal matter samples using the above treatment.

Table 1. Oxygen Functionability in Six GFETC Samples[a]

	Oxygen, mmol/g			
Sample	Total	Carbonyl	Hydroxyl	%, accounted for
32 A	4.64	0.94	2.57	76
43 A	4.98	0.79	2.50	70
32 FA	5.19	1.39	3.11	86
34 PA	5.07	1.07	2.82	77
41 PA	3.88	0.76	1.79	65
44 PA	3.42	0.74	1.54	67

a. Samples prepared at 460°C, 2000-4000 psig H_2 or Co:H_2(1:1) at Grand Forks Energy Technology Center

1. Moschopedis, S. and Speight, J. (1976) Fuel, 55, 334-338.

73. ELECTROCHEMICAL STUDY OF ARYL-ARYL ETHERS

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The ether linkage, particularly that of diaryl ethers, is one of the most inert bonds in organic molecules. For example, thermal studies on diphenyl ether at 700°C indicated less than 5% pyrolysis.[1] These types of carbon-oxygen bonds are known to occur in natural products, including coal. Their natural abundance makes it desirable to study and understand the mechanistic and kinetic aspects of the ether linkage cleavage. Reductive cleavage of ether with alkali metals has shown promise; therefore, electrochemical studies on the reductive electron transfer chemistry of ethers should be productive.

Cyclic voltammetry on diphenyl ether in N,N-dimethylformamide at low temperatures was used with ferrocene as internal electrochemical standard. The effect of concentration, temperature, and scan rate on the reduction peak potential was measured. A ten-fold concentration change was done at each temperature chosen and peak potentials were measured. The reduction potential of diphenyl ether exhibited no dependence on concentration (Table 1). Lack of concentration dependence for the disappearance of the radical anion indicated a first order process.

The rate constant for the disappearance of the radical anion can be obtained by use of the ratio of anodic to cathodic peak current, i_{pa}/i_{pc}. This ratio is a measure of the stability of the radical anion. Cyclic voltammetric data measured at various temperatures with different scan rates was used to determine the rate constant for the cleavage of the radical anion.

Table 1. Cyclic Voltammetric Data on Diphenyl Ether.[a]

Scan rate V/s	Temperature	Epc^b	Epc^c	$i_{pa}/i_{pc}{}^c$	Epc^d	$i_{pa}/i_{pc}{}^d$
.020	-26°C	-2.72	-2.72		-2.73	
.030	-26°C	-2.73	-2.72		-2.74	
.050	-26°C	-2.73	-2.73		-2.76	.454
.066	-26°C	-2.74	-2.75	.536	-2.76	.473
.10	-26°C	-2.74	-2.76	.555	-2.76	.483
.020	0°C	-2.69	-2.69*		-2.69	
.030	0°C	-2.70	-2.69*		-2.70	
.50	0°C	-2.71	-2.70*		-2.71	
.066	0°C	-2.72	-2.71*		-2.71	
.10	0°C	-2.73	-2.73*		-2.72	

[a]Solvent was N,N-dimethylformamide with .2F tetrabutylammonium perchlorate as supporting electrolyte. Working electrode was a planar platinum electrode, 19.6mm^2 volts vs NHE.

[b].502mM. [c]1.89mM. [d]4.96mM.

*measured at 2.75mM.

The model used for this determination of the rate constant was the E_rC_i scheme.[2] A comparison of the experimental data (Table 1) to a working curve for this model resulted in $k = 1.55\ s^{-1}$ at -26°C. A mechanism, which is consistent with these data for the reductive cleavage of diphenyl ether is:

$$PhOPh + e^- \rightleftarrows [PhOPh]^{\cdot -} \xrightarrow{k} PhO^- + Ph^{\cdot}$$

$$Ph^{\cdot} + e^- \rightleftarrows Ph^- \xrightarrow{H^+} PhH$$

Controlled potential electrolysis of diphenyl ether has confirmed the expected products of benzene and phenol. The mass and oxygen recoveries of these products was quantitative. These data do not, however, provide insight into the overall stoichiometry of the electron transfer at the electrode surface because of the poor current efficiency.

Electrolyses of higher order diaryl ethers, including 1-phenoxynaphthalene and 9-phenoxyanthracene have also been carried out. Carbon-oxygen cleavage occurs alpha(α) to the larger aryl moiety with quantitative formation of phenol. Reduction of the resultant hydrocarbon may also occur. These reactions and related kinetic studies on the phenoxynaphthalene radical anion will be discussed.

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74. NARROW-BAND ULTRA-VIOLET WINDOWS AT 2181Å AND 2385Å IN WELDERS' LENSES USED AS EYE-PROTECTION FILTERS IN TOTAL SOLAR ECLIPSE AND SUN-SPOT OBSERVATIONS

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INTRODUCTION

In a preliminary report at the 1979 meeting of the Academy we reported that the Welders' Lenses that we and many others had used as eye-protection filters for observing the total eclipse of the sun across the northern United States and Canada on February 26, 1979, as recommended by various authorities (1) for use by amateur astronomers, did indeed strongly absorb most of the ultraviolet radiation, except that they did have three narrow, almost completely transparent, windows at 2181Å, 2385Å, and 3042Å. A thorough search of the available literature as well as inquiries directed to competent authorities (2) (3) indicate that these windows had not been observed, or at least not reported, previously.

PROCEDURE AND RESULTS

The procedure used for our studies was described previously (4)(5)(6). Acme and other welders' lenses were tested for their absorption of the light emitted by an ultraviolet lamp.

The total spectrum of the lamp is shown in Fig. 1, with strong ultraviolet down to as far as 2000Å, as well as considerable radiation in the visible region, and a small hump in the infrared. Fig. 2 shows the shorter wave-length ultraviolet with special emphasis on the relatively strong peaks of radiation around 2181Å and 2385Å, Figs. 3 and 4 show the effects of the welders' lens filters on the transmission of this radiation. From these graphs (not shown here) as well as from Table I, we see that all of the welders' lenses exhibit an essentially complete window-effect at both 2181Å and at 2385Å. Fig. 3 shows the effect of a combination of two welders' lenses. As had already been observed by crude naked-eye comparisons, the optical density of a combination of two lenses gives the effect of a number one less than the sum of the two numbers: $Fn + Fm = Fn + Fm - 1 = F_{n + m - 1}$

TABLE I

ACME LENS	4	5	6	8	10	12	13
INTENSITY OF 2181Å	4.0	4.0	3.8	4.1	4.0	3.5	4.0
INTENSITY OF 2385Å	2.0	2.0	1.9	2.1	2.0	1.7	2.0

This formula holds exactly for the combination of lenses H-8 and H-5 equivalent to H-12, and almost exactly for H-9 + H-5 equivalent to H-13.

While solar radiation contains considerable ultraviolet and infrared components, as shown by Fig. 4, the ultraviolet below 2900Å is essentially completely absorbed by the ozone in the upper layers of the atmosphere, so that the ordinary amateur astronomer has nothing to fear from the welders' lens windows at 2181Å. Whether the same can be said for welders using all types of arc flames is not so certain. In any event welders' lenses should be used with a large amount of caution whenever ultraviolet light sources are being used. These remarks apply also to the window at 2385Å.

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75. BIOLOGICAL SEED ACCLIMATION FOR ACTIVATED SLUDGE TREATMENT OF COAL GASIFICATION WASTEWATER

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The primary objective of this study was to develop an acclimated seed for activated sludge treatment of coal gasification wastewater. To achieve this objective, two basic criteria were required: 1. Biological growth in a semi-toxic environment, 2. biological removal of phenol, fatty acids, and ammonia.

Initial acclimation procedure began with biological seed obtained from the Amoco Oil Refinery aerated lagoon near Mandan, North Dakota. Experimental apparatus included four aerated reactor units each containing 4.0 liters of the seed. Two units were fed continuously and two on a daily batch routine. One continuous and one batch reactor were operated at 20°C while the remaining two were operated at 29.4°C. Wasting from all reactors was conducted daily by removing a volume equal to the daily feed volume.

The wastewater feed was produced by the slagging, fixed-bed gasifier at the Grand Forks Energy Technology Center using the North Dakota lignite. The wastewater was subsequently solvent extracted and steam stripped to reduce phenolic levels to 150 mg/ℓ and ammonia to 500 mg/ℓ. This level of phenolics and ammonia when combined with thiocyanate concentration of 100 mg/ℓ rendered the wastewater relatively toxic for treatment by the activated sludge process. Therefore, the acclimation process was conducted using a mixture of the gasifier wastewater and synthetic feed consisting of glutamic acid and glucose. The ratio of gasifier wastewater to synthetic feed was gradually increased over time until the feed was 100 percent wastewater.

Biological growth was evidenced by increased total suspended solids as shown in Figure 1. Settleability of batch and continuous reactors at 20°C varied from an average value of 1.7 ml/ℓ to 25.6 ml/ℓ, respectively. At the maximum wastewater feed rate of 460 mg BOD_5/Day, complete removal of phenol and cresol occurred with a minimum ammonia reduction of 41.2 percent as shown in Figure 2.

During the test, all reactors produced a dispersed biological growth. Initially, the continuous feed reactors exhibited poor settling characteristics, while the batch feed reactors exhibited better biological flocculation and subsequent higher settleability. At the feed rates used, no significant difference in substrate removal was detected between the 20°C and 29.4°C reactors. An effective biological seed was sucessfully developed through the batch and continuous feed acclimation procedures.

Figure 1

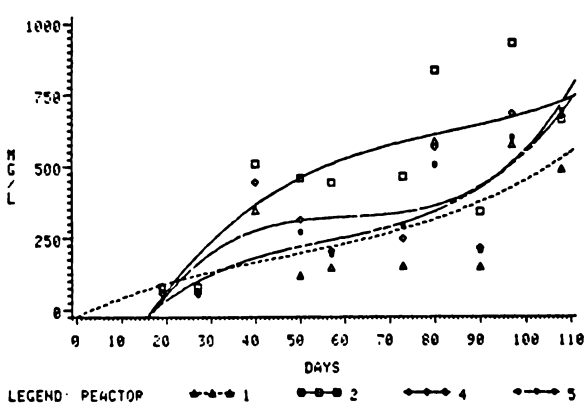

FIGURE 2

REACTOR INFLUENT/EFFLUENT CHARACTERISTICS

	Influent (Wastewater)			Effluent		
Reactor	NH_3	Phenol	o, m, p-cresol	NH_3	Phenol*	o, m, p-cresol
1	500	120	30	300	0	0
2	500	120	30	290	0	0
4	500	120	30	260	0	0
5	500	120	30	260	0	0

* Less than detectable limit of 10 mg/ℓ

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76. SOIL EROSION IN MCKINLEY TOWNSHIP

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The purpose of this paper was to determine the annual predicted soil erosion for McKinley Township, Ward County, North Dakota, for 1982. This area was selected because of its wide variety of soils and easy accessibility.

In 1977, the Soil Conservation Service conducted a state-wide soil erosion survey for North Dakota. It was determined that the annual predicted soil erosion for the state was 3.6 tons per acre on cropland (4). I was led to wonder how close this estimate was to the actual soil loss in McKinley Township by the observation of rill and sheet erosion present in this area and also by the number of farmers concerned about soil erosion in this area. The study which was conducted by the SCS in 1977 (4) revealed some alarmingly high rates of water and wind erosion in other states which made me wonder if these high rates of erosion could occur in McKinley Township, so I decided to do this study.

With the use of the universal soil loss equation (3) and numerous field studies of this area, it was possible to predict the soil erosion in McKinley Township for 1982. In order to use this equation, it was necessary to determine what land was being cropped. This was accomplished by the use of soils maps and aerial photographs of the study area.

A field study was conducted. The amount of residue, the unsheltered distance, the soil type, the cropping rotation, the length of slope and the gradient of slope in each section was determined. These results were then averaged and placed in the soil loss equation and the predicted soil loss was determined.

The study revealed that approximately 18,050 acres of land in this study area was being cropped and that between 2.92 and 3.36 tons of topsoil was being lost per acre and that a total of between 52,752 and 60,694 tons of topsoil would be lost in this township in 1982. The soil loss tolerance for the soils in this study area is five tons per acre. Thus, the study area was well below the tolerance level, but this is misleading because severe erosion has occurred on some land which has been averaged with low erosion losses on protected land. For instance, approximately 2,250 acres of this cropland lost more than the five ton tolerance. Thus, approximately 13 percent of the cropland lost enough topsoil so that nature cannot replace it in a given year.

McKinley's Township's predicted soil erosion of between 2.92 and 3.36 tons per acre was very similar to the 1977 estimate of 3.6 tons per acre (4) for North Dakota. The average topsoil depth in North Dakota, as well as McKinley Township, is approximately five inches (5) while that in other states is considerably more. For example, Iowa's topsoil depth is approximately 16 inches. Iowa loses an average of ten tons of topsoil per acre per year (4). North Dakota's and McKinley Township's erosion is as severe as Iowa's, since they have one-third as much topsoil to lose and one-third as much erosion occurring.

The study also revealed that if climatic conditions and farming practices remain the same, 13 percent of the cropland in this township will be destroyed in 91 years. But if a severe drought of several years should occur, this 13 percent of the land could be destroyed in only a few years. As topsoil is lost, subsoil becomes part of the tillage layer, reducing the soil's organic matter, nutrient content, water retention capacity, aeration, and other structural characteristics that make it ideal for plant growth (1).

In Ward County, between 1978 and 1979, the acreage of sunflowers has increased from 24,000 acres to 77,500 acres (2). This has helped to increase the erosion problem because sunflowers provide less protective cover on critically eroding cropland.

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77. FORAMINIFERA ECOLOGY OF THE GALVESTON ISLAND AREA

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Sediments, foraminifer and shell fauna were studied from Pelican Island and Galveston Island to determine possible correlations between ecological parameters and faunal type. Galveston Island and Pelican Island alluvial sediments were generally composed of fine to mediun grained, well sorted sand. Quartz was the dominant component, however, glauconite, chert, limestone fragments and shell fragments were also found.

The sample collected from the north shore of Pelican Island (sample # 1) was coarse, poorly sorted sand composed mostly of quartz, glauconite and a high percentage of shell fragments with approximately 73% of the sample having a mean diameter of 500 or more. The sample collected from the southeast, oceanward shore of Galveston Island (sample # 2) was fine, well sorted sand composed of quartz, glauconite and a low percentage of shell fragments. Current energy and depth of water control grain size distribution and the sorting of sediments(1). The high velocity of the water may have acted on the Pelican Island sample resulting in the poorly sorted nature of the sand. On the beach of Galveston Island the tidal and wind action resulted in sand size sediments that were better sorted.

Forty-eight foraminifera specimens were collected from sample # 1 and 40 foraminifera specimens from sample # 2. Foraminiferal specimens were of the suborder Rotaliina and superfamilies Rotaliacae and Noionacea. All specimens were planktonic in habit, no benthonic forms were observed. The 88 specimens were very similar to each other in that all exhibited planispiral or trochospiral chamber architecture. Test color ranged from orange to a milky white appearance to grey; porcellaneous and hyaline forms were found, only. Sample # 2 produced smaller foraminifera tests than sample # 1, however they were similar in type indicating possible juvenile forms of the same genera found in sample # 1; tidal action may wash juveniles ashore more readily than the larger adult forms. Also, percentages of arenaceous, porcellaneous, and hyaline species are representative of the sediments were established in Nantucket Bay, this relationship could also apply to the Galveston Bay area(2). There was also a higher concentration of foraminifers found in sample # 1 indicating a possible zone of high organic material and a potential site of a reducing environment, causing a high foraminifera mortality rate. Sample # 1 was composed almost entirely of shells and shell fragments. The incidence of a pelecypod population would increase the total organic matter contributing to a possible reducing environment upon death of the organism. There were also broken and abnormal tests observed in both samples. They are indicative of extreme seasonal changes in climatic condition such as a large temperature fluctuation within a short period of time(3).

The Galveston Island and Pelican Island locals are typical of most shoreline spit environments, composed of alluvial beach sand ranging from poorly sorted to well sorted. The fauna of the area is similar to that of such environments. The conclusion that no benthonic foraminifera were found in samples #1 and #2 was significant, however, this is not indicative that no benthonic species are located in the Galveston area as only samples of beach sand were taken.

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78. Mass Spectrometry of Trimethylsilyl Substituted Dihydroxy and Amino Hydroxy Arenes

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The mass spectra of several trimethylsilyl (TMS) derivatized catechols were found to contain a loss of 88 atomic mass units (AMU's) from the molecular ion ($M^{+\cdot}$) and from M-methyl. (1,2) Further investigation was done to determine the generality of this loss in TMS derivatives of ortho substituted hydroxy arenes.

The TMS derivatives of o-, m-, and p-aminophenol, o-, m-, p-hydroxyphenol, alizarin, 2-amino-4-nitrophenol, ethyl-3,4-dihydroxybenzoate, 3,4-dihydroxybenzonitrile, 3,4-dihydroxycinnamic acid, 2,3-dihydroxy-4-methoxybenzaldehyde, o-hydroxynaphthol, and pyrogallol were produced by reaction with bis-(trimethylsilyl)trifluoroacetamide at 70 degrees C for two hours. After derivatization, the compounds were purified through gas chromatography. They were then subsequently trapped and analyzed by electron impact mass spectrometry. In all of the ortho derivatives, an 88 AMU loss was found although, in two of the compounds, alizarin and 2-amino-4nitrophenol,the relative intensity of the peak corresponding to the loss was small. The 88 AMU loss usually occurred from $M^{+\cdot}$ or from M-methyl.

The pathway of this phenomenon was investigated through the use of deuterium-labeled BSTFA with pyrogallol and o-aminophenol. Two possible pathways were originally considered. One was the loss of C_3H_8OSi which corresponds to a 96 AMU loss in the deuterated compounds. The other possibility was the loss of a silicon and four methyl groups, 100 AMU in the deuterated compounds.

The mass spectral analysis of the pyrogallol derivative contained a large 100 AMU loss from M-methyl. Likewise, the o-aminophenol derivative contained a 100 AMU loss from $M^{+\cdot}$ and from M-methyl. Therefore, the 88 AMU loss from the TMS derivatives is clearly due to the loss of a silicon and four methyl groups.

1. J.F. Green, J.V. Evans, J.L. Neumeyer and Paul Vouros (1979) Biomed. Mass Spectrom., 6, 282-286
2. Helge Buset and Ronald R. Scheline (1979) Biomed. Mass Spectrom., 6, 212-220

FIFTY PLUS TWENTY FIVE EQUALS SEVENTY FIVE

by

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A History of the North Dakota Academy
of Science 1958-1983
upon the occasion of its
75th Anniversary

FIFTY PLUS TWENTY FIVE EQUALS SEVENTY FIVE

Introduction

Yes, the North Dakota Academy of Science is now seventy five years old. "The First Fifty Years" is the title of a neatly bound booklet that no other than GEORGE A. ABBOTT, Professor of Chemistry at the University of North Dakota, presented to the 1958 meeting of the Academy. Here a cofounder who never missed a yearly meeting vividly describes the joys and woes of a fledgling organization, gives credit to those pioneer members who toiled so hard to apply scientific know-how to the agricultural and budding industrial problems of a frontier state, geographically far removed from the older, recognized centers of learning. Abbott himself assisted in the recognition of the Academy when he wrote in 1958:

> "In the light of its half-century of brilliant performance and the enormous contributions of its members to the wealth and prestige of this commonwealth, it seems time that the State confer upon the Academy its recognition and legal status as the official North Dakota Academy of Science. Such recognition long has been given to the State Historical Society and it would seem that creative science upon which our very lives and the future of the State depend should be deemed equally worthy of official recognition."

The 1959 session of the North Dakota Legislature recognized the organization as the official North Dakota Academy of Science. George Abbott did not forget that the prime goal of history must always be its lessons for the future. He wrote:

> "If free nations are to survive, their citizens no longer can remain indifferent to science. It is not enough to train more technicians or even to educate more scientists and engineers. We must make science an integral part of our modern culture. We must develop an intelligent, thinking citizenry, not easily stampeded by a few sputniks or flying saucers - citizens able to apply the orderly methods of science to their individual and social thinking and acting - for science will continue to impose upon society its most baffling problems."

These are courageous and prophetic words, indeed, and we should keep them in mind as we proceed now to examine the Academy's doings in the twenty five years that followed.

Scientists, as a group, are people who have gone through a long educational process. Some of it they enjoyed, and some of it they suffered through; but they all know that without education they could not be scientists. So, when they band together in a professional organization, one of their important aims is to maintain, to update, and improve scientific education at all levels. Therefore it should not surprise anybody that the North Dakota Academy of Science in its third quarter century of existence has made great efforts to stimulate and support science education. The approaches have been many and so full of different ideas that reviewing them - which we will start doing in a moment - should not be a dull job by any means.

This active interest and participation in science education certainly is the number-one way in which Academy members can and do serve the community, but it is not the only one. In recent years, North Dakota has started a fundamental transformation from a purely agricultural state to one with a mixed agricultural and industrial economy. We will, therefore, consider how the Academy is involved and wishes to get even more involved in the many scientific problems brought about by these momentous changes.

Any organization must by necessity be somewhat number-conscious and try to at least maintain, better even increase its membership numbers. We will see how the Academy fared in this respect in these recent years.

Also - like it or not - you must have money to achieve anything. The North Dakota Academy of Science has had varied experiences in fund-raising, and we will briefly review them.

The Academy is a democratic institution and has to have rules to live by. The constitution and the bylaws of the organization have now and then been adapted to changing times, as we will briefly examine.

Promoting science means publication among other things. We will briefly look into some significant changes that the Academy made in the way it publishes its annual Proceedings.

If an organization is successful, you will always find a few people in it who go beyond the call of duty in their enthusiastic work for the group. This is very true for this Academy. We wish to honor the devoted work of these outstanding members.

Science and Engineering Fairs

It is the aim of the historian to study the records and bring back to life what he learned. But if good luck provides him with original accounts of those who themselves made part of that history, he gladly lets them tell what nobody else could produce that credibly.

HARALD N. BLISS, Grafton and Mayville, ND, gives the following vivid account of the modest origins and steady development of science fairs in North Dakota:

> "Encouraging young scientists: During the years 1942 to 1950 Harald N. Bliss, then a young science teacher in Grafton, ND, needed materials and equipment for student laboratory use and lecture demonstrations. Finances were meager. On learning of the need, the business community and others responded with used equipment to be dismantled for parts. The school laboratory was opened for evening and Saturday use. The City Park became a fall and spring student research laboratory. Out of the teacher, student and community desire for a strong science department, annual "Science Shows" and project displays were begun in 1943. The Science Club, a member of the Science Clubs of America, provided student leadership for these annual events. This activity led to the formation and growth of the North Dakota Science Fair Program.
>
> In 1950 science leaders in the Philadelphia area established the first National Science Fair. Information about this fair was broadcast through the National Science Service. Regions across the United States could sign a contract with the newly formed fair association to exhibit at subsequent national fairs. JULIAN ROLZINSKI, science instructor at Devils Lake, ND, signed such a contract. With that The North Dakota State Science Fair was born. At the outset the entire state was a single region and as such was eligible to send two exhibitors to the National Science Fair.
>
> In 1954 Harald N. Bliss contracted for a regional fair at Grafton and named it The Northeast North Dakota District Science Fair. Within a few years North Dakota had seven regional science fairs, and fourteen winners going to the National Science Fair each year.
>
> Also in 1954 The North Dakota Science Fair Association was formed. HARRY MASON, Professor of Physics at Jamestown College, served as Executive Secretary for the first eight years. Harry Mason and Harald Bliss wrote the first constitution for the State Science Fair Association. From 1963 until his retirement in 1982 EARL KRUSCHWITZ of Valley City, ND, served as Executive Secretary. It was Earl's leadership over these twenty years that provided stability for the North Dakota Science Fair Association and for its continued growth.
>
> In the early sixties OSCAR MANZ of the University of North Dakota Civil Engineering Department started the JETS program (Junior Engineering Technical Society) which added another dimension to the North Dakota Science Fair. Two JETS finalists were added to the fourteen State Fair finalists attending the National Fair each year.
>
> Over the past 32 years more than 425 North Dakota students and an equal or greater number of teachers and chaperones attended the National Science Fairs. A tribute is due to the dedicated science teachers throughout our state. Their enthusiasm and continuing efforts plus the support of their communities played a vital role in encouraging these young scientists."

DONALD SCOBY of the North Dakota State University Botany Department contributed much to the recent development of science fairs in North Dakota. He calls attention to the International Science and Engineering Fair taking place in May each year. Calling it "the World Series of Science Fairs," he recommends participation in it as a further goal for local winners. In 1982 sixteen finalists with their teachers and parents did attend the International Science and Engineering Fair at St. Louis, MO. Fourteen awards were earned by these students. The North Dakota delegation was the largest of all, when considered in proportion to home state population.

The North Dakota Academy of Science continues its intimate involvement with the Science Fair movement by providing many of the judges and different kinds of recognition for the winners. This ranges from prize money to encouraging the winners to present a paper describing their project at the annual Academy meeting. In 1971, under Scoby's leadership, the North Dakota Junior Academy of Science was founded. That gave this relation between Science Fair and Science Academy a new form that seems to be much enjoyed by all concerned and will be described further in a later section.

State Science Talent Search Program

In 1960 the same HARALD BLISS, who did so much for the Science Fair movement in North Dakota, became a full-time Science and Mathematics Consultant with the North Dakota State Department of Public Instruction. Much of his work there was directed towards the establishment of in-service training programs and workshops for elementary science teachers.

When the National Science Talent Search Committee asked the Consultant who would be a suitable person to start a State Science Talent Search Program, Bliss recommended FRED SANDS of the College of Chemistry at North Dakota State University. Sands accepted the responsibility and established the North Dakota Science Talent Search in 1961. He conducted it for twelve years, and then DON SCOBY of the Botany Department of NDSU took over.

The interest in the program has had its ups and downs, but it is still functioning at present. In 1982 Scoby reports increased participation, also that LORI MAAS from Jamestown was recognized for National Honors that year.

The Science Talent Search Program is conducted by the National Science Clubs of America, administered by Science Services and financed by the Westinghouse Educational Foundation.

In 1972 OSCAR MANZ writes about the program: "Science research projects are performed by high school students throughout the nation and are judged by a national committee. The committee selects the top 300 for National Honors from which 40 are chosen as winners for a trip to Washington, DC, and a share in the $67500 scholarships and awards."

More often than not, the entries come from science fair participants who see another chance for recognition in the Science Talent Search Program.

Science Education Committee

Science Fair and Science Talent Search programs were already in place in 1962. But in that post-sputnik era so many proposals cropped up to improve science and mathematics teaching in one way or another, that the Academy formed a Science Education Committee to sift these ideas and bring the best of them to fruition.

The prime mover of these efforts seems to have been J. DONALD HENDERSON of the UND Physics Department, who in 1963 critically reviewed what had been done and recommended that the committee be continued if, but only if definite responsibilities and duties be assigned to it. This

obviously was done, and, to this day, the Science Education Committee is one of the most active parts of the Academy. Once that committee was in existence, all the different educationally oriented projects of the Academy being reported in this historic review came under its jurisdiction.

It cannot escape the reader of the yearly reports that some very dedicated people were and are at work here. The committee always meets several times a year; in one year I counted seven meetings, and they were not telephone conferences! Whoever is familiar with North Dakota travelling distances and weather will appreciate such performance.

The Academy members who had or have a major part in the work of the Science Education Committee, are the following:

Harald Bliss, Mayville State College,
Jerry Knoblich, Jamestown State College,
Eric Clausen, Minot State College,
Fred Sands, North Dakota State University,
Don Scoby, North Dakota State University,
Don Henderson, University of North Dakota,
Oscar Manz, University of North Dakota,
Wilbur Weisser, University of North Dakota,
Clarence Thompson, Grand Forks Central High School,
Robert Pederson, Fargo North High School,
George Fors, ND State Department of Public Instruction.

Outstanding Science Teacher Awards

In the early sixties, when the North Dakota Science Talent Search was started, the Academy also recognized that high achievements by science students can only be expected if they are taught by capable and devoted science teachers. In 1962 PAUL KANNOWSKI of the UND Biology Department started the Outstanding Biology Teacher Award as an Academy program.

In 1974 the Science Education Committee decided to expand this program by selecting a state outstanding teacher not only for biology but also for earth science and for physical science. To implement this selection, the State was divided into four regions, formed roughly by state highways 3 and 200. One of the four regional winners in each science area was then selected for the State Outstanding Teacher Award. In 1976 regions III and IV were combined as region III.

In 1982 the program is still in place for biological and for physical science. The prizes are usually donated by industrial firms and presented at the Awards Luncheon of the Academy's annual meeting. Some examples are research microscopes, field glasses, calculators, a compass, a geologic atlas, occasionally supplemented by the Academy out of its own funds with scientific magazine subscriptions, etc.

The Education Committee decided to suspend the program for the year 1983 for two reasons: 1) the National Association of Biology Teachers dropped its support for one year in order to assess the program, and 2) nominations for the award in North Dakota have drastically decreased in number.

High School Science Visitation Program

The post-sputnik rush to improve science education prompted the National Science Foundation (NSF) to finance a program of high school visitations by academic scientists. In North Dakota the program was organized under the supervision of the Academy's Science Education Committee, and it was directed by FRED H. SANDS of North Dakota State University's College of Chemistry. DON SCOBY of NDSU's Botany Department shared the work for this program.

Reports about the visits all went to the North Dakota Department of Public Instruction, both from the visiting professors and from the high schools they visited. For the school years 1964/65,

1965/66 and 1966/67 the NSF grant took care of the cost. Then the North Dakota Department of Public Instruction financed it for another two years, which shows that it appreciated the results. The participating colleges paid for another year of visitations, and with that the program ended for the time being.

One pleasant consequence of all these contacts between high school science teachers and Academy members has been the increasing cooperation between the North Dakota Science Teachers Association and the Academy. This should bear fruit now in the early eighties when the public mood has turned again to the question of how we can educate enough good scientists to hold our own in the ever keener international competition. The main ideas tried so far are synchronized meetings of the two organizations, also the welcoming of science teachers into the ranks of the Academy and its Science Education Committee.

North Dakota Junior Academy of Science

In the sixties, as we have just seen, the North Dakota Academy of Science tried out many different ways to stimulate and support scientific interest and activities of North Dakota high school students. The seventies were more years of critical choice and consolidation of those programs found most useful.

The one project that appeared most promising to the people guiding the Academy activities around 1971 was the Junior Academy. By its title and by its structure, it conveyed the impression - and justifyingly so - that the seniors were willing to treat the juniors on an even keel, if they rose to a reasonable level of scientific activity and scientific communication.

The North Dakota Junior Academy of Science program was worked out in close cooperation between the Academy's Science Education Committee and the North Dakota Science Teachers Association. It was made to dovetail nicely with the well established Science Fair program, forming, one might say, the crowning feature of a successful Science Fair project that contained some element of research-oriented thinking or of actual research.

The prestige of the Junior Academy was enhanced by printing proceedings for it with unedited abstracts of the papers to be presented by the students, and by scheduling the meeting to coincide with that of the Senior Academy.

The recognition of the contest winners presumes that they are college-bound. First and second place winners receive $200 and $100, respectively, in form of a George A. Abbott Scholarship, paid to a North Dakota college of the student's choice. Added to that is for first place a $75 cash Dunbar Award, and for second place a $50 cash Henderson Award. These are today's figures. But there were years when funds were short and members of the Science Education Committee pitched in with their own money to keep the rewards at a respectable level.

Limited advance financial help to do the planned research is available in form of "Mini-Grants" (about $10 to $80) financed by a yearly grant of the American Association for the Advancement of Science to the Education Committee of the Academy.

The Abbott scholarships as well as the Dunbar and Henderson awards are now endowed by the Academy.

The cooperation that developed in recent years between the Science Academies of Minnesota and North Dakota has led to an offer by Minnesota to let up to three participants in our Junior Academy compete also in their contest. Of those who followed the invitation, some made a pretty good showing.

Much work by many Academy members has gone into the development of this fine program.

Three names, especially, are recurring through the years: HARALD N. BLISS of Mayville State College, DONALD SCOBY of NDSU, and OSCAR MANZ of UND.

North Dakota Science and Mathematics Newsletter

When HARALD BLISS of Mayville State College was appointed Science and Mathematics Consultant with the North Dakota State Department of Public Instruction, he started the North Dakota Science and Mathematics Newsletter. It had state-wide circulation and was much appreciated by the teachers. GEORGE FORS continued as its editor when he followed Harald Bliss as Science Consultant.

When George Fors, in turn, retired, PATRICIA HERBEL, Coordinator of Library Services, was asked to take over as Science Advisor, but the Newsletter ceased to appear.

A. Rodger Denison Student Research Competition

The Academy programs we looked into so far are all directed at the high school students and high school teachers. But back in 1953, Mr. A. RODGER DENISON, Vice-President of the Amerada Petroleum Corporation, decided that college students need some encouragement not only to do some worthwhile research but also to present the results clearly, precisely and concisely in written as well as in spoken form. For many years, Denison gave the Academy funds for a first and a second prize each in an undergraduate and in a graduate competition. From 1967 to 1980 the Academy continued giving the $50 first prizes and $25 second prizes out of general fund money. In 1981 an endowment in the amount of $3000 was invested, and the prizes were raised to $100 and $50 respectively.

The Denison Awards Committee, appointed by the Academy President, has five members with staggered five-year terms. The contestants must be pursuing a degree in a North Dakota college or university. They turn in a written paper and report also on their work orally at the annual Academy Meeting. They are guests at the annual Academy Banquet at which occasion the winners are announced.

In 1975, at the MINNDAK Academies meeting, both North Dakota and Minnesota students could participate in the Denison contest.

The Academy and Environmental Education

A timely and quite successful public service was given by the Academy in the early seventies. DONALD SCOBY of the NDSU Botany Department, whose name appears so often in this account, was the one who spearheaded the drive to improve the high school teaching of ecology and environment. When he was Chairman of the Academy's Science Education Committee in 1969/70, he had high school instructors sit in on the meetings and offer suggestions on activities that would be worthwhile to include in an environmental education curriculum.

Three Environmental Education Conferences were held in Fargo in 1970 and 1971. At the third of them about 120 elementary and secondary teachers attended. How-to-do workshops followed. A series of Environmental Convocations were given at Napoleon, Linton, Wishek, LaMoure, Forman and Hankinson. The program included population, life style, and resulting pollution problems. Arrangements were made through GEORGE FORS and the State Department of Public Instruction.

Much more followed than this brief account can recite, and today Don Scoby can state with pride that much of this environmental material is now incorporated in existing school courses.

The Academy and North Dakota's Industrial Revolution

In these last twenty five years North Dakota has discovered that there is oil in them thar hills, and - for better or worse - it has become an oil-producing state. Detection, pumping and refining of petroleum today occupy many North Dakotans.

The presence of huge beds of lignite in this state, an estimated 350 billion tons, has long been known; but some disadvantages connected with its direct use as a fuel have kept down its utilization until recently. Not only has combustion engineering overcome some of these drawbacks, but chemists and chemical engineers in this State are tackling the problems of coal gasification and liquefaction. The Nation's first gasification plant is under construction near Beulah, ND.

As strip-mining of lignite took on larger dimensions, the difficult question came up how to restore the stripmined land to previous or to new usefulness. The problem occupies a number of specialists in geology, forestry, agriculture, husbandry and ecology.

An entirely new technology, remote sensing, has been developed and is much used in recent years in North Dakota in its applications to agriculture and to mineral exploration.

Inevitably, such new industrial developments in areas considered valuable for recreation and tourism are raising problems how to control air and water pollution. Another group of scientists has its work staked out for it.

Climatic extremes cause the ever-present problems of drought, floods, soil erosion and others. It is to be hoped that competent scientists will have more of a voice in their treatment than they have had so far.

The increasingly preventive trend in modern medicine has led to intense interest in nutrition, and North Dakota scientists have become much involved in this work.

The oil and coal developments we briefly mentioned are providing employment for many Academy members, and they have somewhat shifted the center of gravity of our State. The call of "Go west, young man!" has been heard by the Academy of Science. Of its last 25 annual meetings, three were held in Minot, two in Dickinson, and one each in Valley City and Bismarck. The field trips and the symposia, both innovations at the Bismarck meeting of 1982, were to a large extent directed at these new developments and their consequences.

Academy Contacts with the State Government

A few times during the last twenty five years, the Academy has probed cautiously for chances to establish some cooperation with North Dakota government agencies. Except for the very fruitful cooperation with the State Department of Public Instruction, these attempts of the Academy did not get very far.

In the early seventies the Academy had a State Science Advisory Committee. Its 1974 report to the membership contained the philosophical sentences: "The Committee cannot force its activities on state officials who may be suspicious of its motives. It should, however, make itself and the Academy more visible in the public eye."

The new industrial developments in North Dakota and the Academy's positive reactions to them give us hope that in the eighties this advice will be followed consistently and eventually be successful.

Proceedings of the North Dakota Academy of Science

Editorship can be a difficult and thankless job, and some members of this Academy could sing quite a litany about that. But the story has a happy ending.

The Proceedings were first published in 1948. From then until 1967, they appeared as a single yearly issue, including both Abstracts and Full Papers. Authors were not always in a hurry to hand in their papers and the yearly volume occasionally became available only after the meeting.

Beginning in 1968, the Proceedings were published in two parts. Part 1, published before the annual meeting, contained an abstract of each paper to be presented. Part 2, published later, contained full papers by some of the authors. Availability of the Abstracts at the meeting was an advantage; but getting Part 2 out was still the same headache as before the change. Also, publication costs were escalating.

In 1977 and '78, the Editor A. WILLIAM JOHNSON of UND together with the three members of the Editorial Advisory Committee, JEROME PEKAS of USDA, HAROLD GOETZ of NDSU, and MOHAN WALI of UND, worked out a timely new solution for these publication problems. For the first time in 1979, the Proceedings took on the larger format 8½x11", and they are now produced from copy handed in camera-ready by the authors. They are issued in a single volume prior to the annual meeting. The book consists of full-page "Communications" which are more than an abstract, but less than a full paper. Room permitting, illustrations and graphs can be included; and all is in the hands of the members right at the meeting.

This innovation is another case of very dedicated, hard work by a small group of Academy members.

The 1980 Proceedings carried on the cover for the first time the new seal of the Academy, designed by FRANCIS JACOBS of the UND Biochemistry Department.

Academy Membership

Membership figures in the range of 200 to 300 were reported for the earlier years. By 1973 a standardized way to account for Academy membership figures was in place. The figures from that year on to the present are shown graphically in figure 1, together with the number of registrants at the annual meetings and the number of papers presented at these meetings.

At first glance, it seems astonishing that the membership figures vary that much from year to year. But they reflect not only the general mobility of Americans but also the special conditions of academic people in a region with limited and variable employment opportunities. Here is an illustration: in the calendar year 1978, 30 members were lost and 98 new ones gained, for a net gain of 68. Only two years later, in the calendar year 1980, the Academy lost 78 members and gained 48 new ones, for a net loss of 30.

In 1975 the bylaws of the Academy were changed to permit prompt cancellation of membership when dues are not paid. The corresponding decline in the membership curve is shown as a dotted line.

The 1976 meeting and the 1979 meeting were combined meetings with the Minnesota and the South Dakota Academies, respectively. The attendance figure for '76 shows attendance by North Dakotans only, and so does the '79 figure for the Aberdeen, SD, meeting. The number of papers presented at these combined meetings were left out of the figure.

North Dakota Foundation for Engineering and Science Scholarships

Dr. Abbott reports in "The First Fifty Years" that this foundation was established through the cooperation of the Academy with the North Dakota Society of Professional Engineers in order to establish scholarships. It began its activity in 1956, providing scholarships for North Dakota college freshmen students who wished to study engineering or science in the State of North Dakota and had

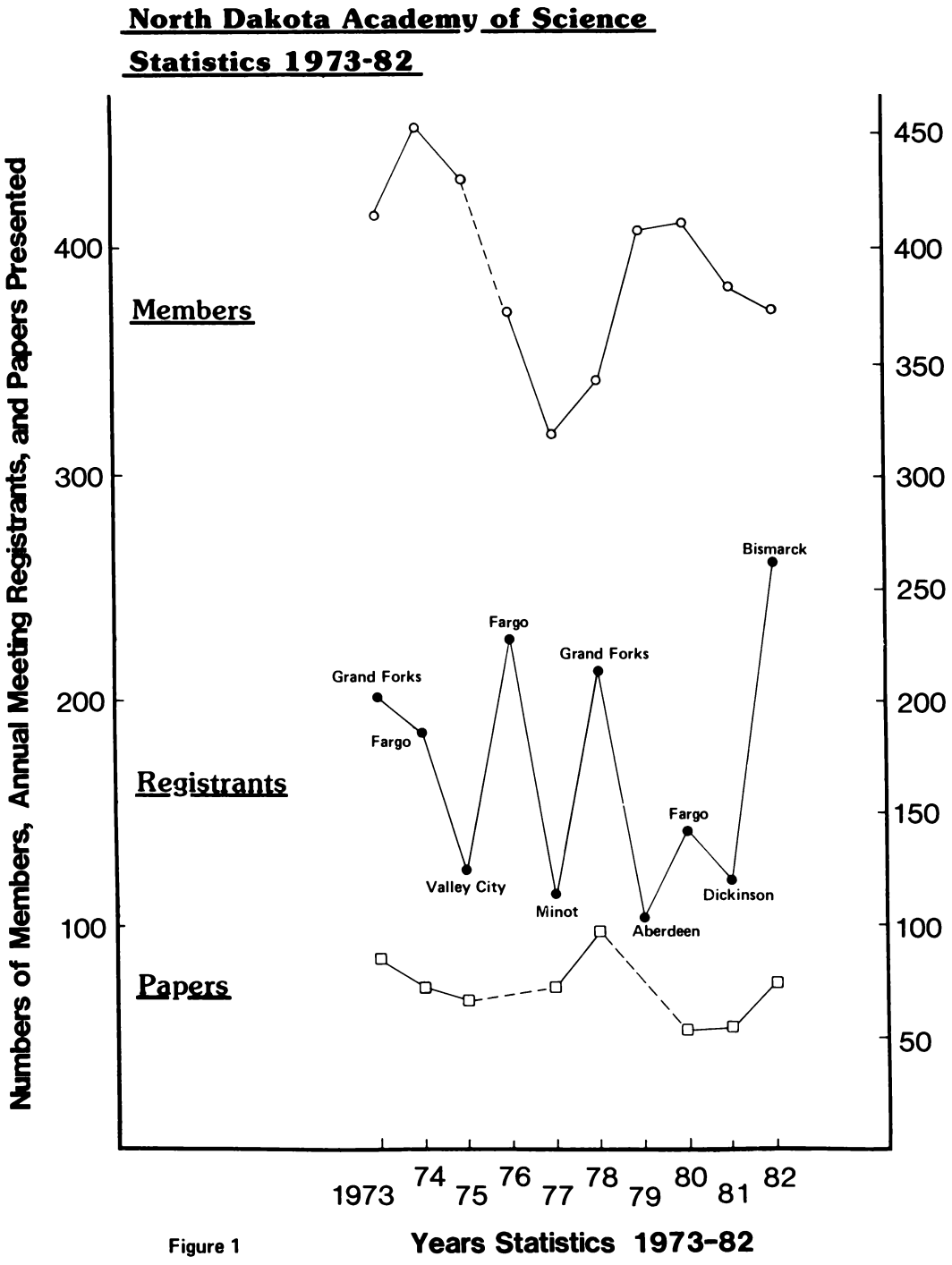
North Dakota Academy of Science
Statistics 1973-82
Numbers of Members, Annual Meeting Registrants, and Papers Presented
Members
Registrants
Papers
Grand Forks
Fargo
Valley City
Fargo
Minot
Grand Forks
Aberdeen
Fargo
Dickinson
Bismarck
100
200
300
400
450
350
250
150
50
1973
74
75
76
77
78
79
80
81
82
Years Statistics 1973-82

Figure 1

done well on the ACT-test.

In 1960 the North Dakota Chapter of the Associated General Contractors joined the Foundation and soon became major contributors of funds. About $3000 to $4000 per year were received and disbursed by the Foundation around that time.

Academy members active for a number of years in the Foundation work are HAROLD KLOSTERMAN of NDSU and EDWARD J. O'REILLY of UND.

In 1970 the Contractors transferred their support to a strictly engineering program, and in 1971 the Scholarship Foundation ceased to exist. Residual funds were transferred to the J. Donald Henderson Memorial Fund which now provides for the Dunbar and Henderson awards to Junior Academy winners.

AAAS Research Grants

As we have seen, the North Dakota Academy of Science has a long history of promoting participation of high school students in research projects by arranging competitions and rewarding the winners. But in a state like North Dakota where many small high schools do not have adequate science equipment, students often need initial help for purchase of equipment and supplies required for their research projects.

That's where the Academy's "Mini-Grant" program fits in. The American Association for the Advancement of Science grants funds for just that kind of use. The problem for the Academy is the right timing of all phases of the program. The AAAS office wants rather detailed accountability, and student requests for mini-grants tend to come in late. In time, all participants learn to observe deadlines, and then the program works well in providing some seed money just when and where it is needed.

DONALD SCOBY at NDSU and A. WILLIAM JOHNSON at UND, the Secretary-Treasurer of the Academy for the last decade, had to hold many conferences and write many letters to achieve that difficult streamlining of the process.

Academy Finances

The North Dakota Academy of Science used to draw its operational funds from the membership dues, subsidized by institutional contributions. In the early seventies these subsidies declined and the cost of producing the Proceedings escalated. This dilemma was solved by the Executive Committee in a very constructive way. The membership dues were doubled in order to produce income somewhat exceeding expenses. Any surplus is being promptly invested, and the interest used from then on to pay for the different prizes given each year.

As of January 1, 1983, the J. Donald Henderson Memorial Fund is endowed with $2331, the A. Rodger Denison Fund with $3139, and the George A. Abbott Fund with $3659. At present these funds totalling $9129 are bringing 12% interest per year.

This idea to replace annually recurring fund raising ventures with interest income from a once established endowment is being further extended by the Academy this year.

North Dakota Science Research Foundation

VIRGIL STENBERG of the UND Chemistry Department, the 1982/83 President of the Academy, proposed to the 1982 Academy meeting to create a North Dakota Science Research Foundation, as an operating arm of the Academy. His move carried, and the necessary legal steps were soon taken. In November 1982 Secretary of State BEN MEIER issued a license to solicit contributions in North

Dakota to the new foundation.

A descriptive folder tells where the funds will go, as follows: "North Dakota Science Research Foundation will fund the research needed for the State's resource development, to launch the careers of new scientists and initiate new ideas. Grants may be made in any field of science. The funded research will help in the development of new industries for the State and provide jobs."

In other words: the aim is seed money. The comparison made in this expression "seed money" between the matter-of-fact provision of a certain number of dollars and the ever fresh miracle of a seed bursting into new life applies so truly to the support of new and fragile ideas in scientific research. All the risk and all the promise of venture-capital investment is right there, appealing to the friendly imagination of the would-be donor.

As a special "diversification" measure, the Academy decided to use one half of the funds received each year directly in the form of grants to scientists, and to place the other half of the money into an endowment with only the interest spent for research.

Constitution and Bylaws

In adaptation to changing times, the constitution and the bylaws of the North Dakota Academy of Science have occasionally been revised.

In 1980/81 the following constitutional changes were made: It was more precisely expressed that the President-Elect, chosen by ballot at the annual meeting, will hold this office for one year and then assume the office of President for one year; The Secretary-Treasurer is now appointed rather than elected for a three-year term; The Executive Committee now has three members-at-large with staggered three-year terms, instead of the previous two members-at-large; In 1981 an article was inserted in the Academy constitution designed to help the Academy qualify as a tax-exempt organization.

There have been a number of changes made in the Academy's bylaws. The more important ones seem to me to be the following items. The Executive Committee used to appoint an Academy Representative to the yearly meetings of the American Association for the Advancement of Science (AAAS) for an indefinite time. Starting with a 1979 bylaw revision, the same Representative is appointed annually to both the AAAS and the National Association of Academies of Science (NAAS).

In 1980 the committee structure of the Academy was spelled out in much greater detail than it used to be: number of members and their terms are given; also the duties of each committee are outlined. For the very important Education Committee, seven members are now specified, two of whom shall be high school teachers. The members will serve staggered five-year terms.

The Academy President appoints the members and chairpersons for all committees, except the Executive Committee and the Nominating Committee.

Five categories of membership were spelled out in a 1973 revision. The designation Emeritus Member was newly adopted for any member in good standing upon formal retirement. The title Honorary Member was at the same time reserved for special recognition of outstanding scientists.

The appointment and service of Ad-hoc Committees is laid down.

An Editor for the Proceedings is to be appointed for a three-year term at a salary set by the Executive Committee. A page fee for publication of full papers in the Proceedings was set. The fiscal year was formalized as Jan. 1 to Dec. 31.

The Academy's Relationship with AAAS and with NAAS

As the tabulation on page 136 shows, one Academy member, FRANZ RATHMANN of the NDSU

College of Chemistry, served as the Academy's delegate to the American Association for the Advancement of Science for all of the first eighteen years in the time span we are considering. I have read Rathmann's detailed yearly reports about his attendance at the giant weeklong meetings, and I sensed the keen, multifaceted interest that made him take part to such an extent.

The National Association of Academies of Science (NAAS) synchronizes its meetings with those of AAAS, and Rathmann represented our Academy there too. He served for a time as the President of this association, and in this capacity attained a prestigious position in the AAAS Council meetings. Franz Rathmann wrote himself the following words about representing us at these meetings:

> "The North Dakota Academy of Science is a corporate member of the American Association for the Advancement of Science, and as such regularly sent a delegate to the same 500-member Council of the AAAS at its annual meetings. When the Council of the AAAS was reduced to some seventy members, the individual Academies lost their direct representation, but for several years the North Dakota delegate to the Association of Academies of Science was chosen as one of its two delegates to the Council of the AAAS.
>
> Although funds were very short (no federal funds were available for research or travel; state funds were very meager), the Academy did send its delegates to the national meetings despite inconveniences and hardships. Thus, Dr. Ralph Dunbar, and later for some time Dr. Rathmann also, travelled by Greyhound Bus to Washington, New York, Chicago, etc., and stayed overnight at the YMCA or a cheap hotel (at $3 per night at the old pre-Civil War Astor in Washington, DC!) so as to attend both the NAAS and the AAAS Council Meetings as well as the AAAS scientific and cultural sessions. Using bus or rail travel required time; one did not rush to go such distances unless prepared to take full advantage of the program offered. In the early sixties, however, air travel came to be accepted as standard."

After a 1979 bylaw revision, the Academy appointed its representative to AAAS and NAAS for only one year. It then became the custom to ask the President-Elect to serve in this capacity, so that he may learn from others and be able to apply that to the year as President.

Relations with Other Academies of Science

Two recent-year Academy meetings have been joint meetings with neighboring State Academies of Science. FRANZ RATHMANN of NDSU had a hand in bringing this about, and he reports about it as follows:

> "When in May 1968 the North Dakota Academy was meeting in Fargo, while the neighboring Minnesota Academy of Science was meeting on the very same days in Moorhead, it was noted that some members might well wish to hear papers on opposite sides of the Red River, and in particular, to hear both of the very excellent national speakers.
>
> It was then proposed that from time to time we arrange for joint meetings of the North Dakota Academy of Science with the Academies of our neighboring states. F. H. Rathmann, then the delegate to the NAAS and AAAS, was instructed to write letters to the Academies of Science of Minnesota, South Dakota, Montana and Manitoba, suggesting such joint meetings. As a result a joint meeting was held with the Minnesota Academy of Science in Fargo-Moorhead in 1976 with some sessions held at North Dakota State University, some at Moorhead State University, and some at Concordia College, along with a joint dinner session and after-dinner speaker.
>
> Three years later, a joint meeting was held with the South Dakota Academy of Science at Northern State College, Aberdeen, SD, just south of the ND-SD border."

For over 25 years, the Red River Valley Section of the American Chemical Society and local chapters of the Society of the Sigma-Xi have been supporting societies of the Academy. They were more recently joined by the Association of North Dakota Geographers and the North Dakota Geological

Society. These scientific groups share in meeting expenses and sometimes help find Academy lecturers and keynote speakers.

Where Do We Go From Here?

If we reread once more George Abbott's words about the lessons for the future, words that I quoted in the introduction to this paper, we must admit that we have a long way to go to measure up to these goals. Sorry to say, we have not succeeded "making science an integral part of our modern culture." I am tempted to ask: have we really tried? Well, a handful of highly dedicated people in this Academy of ours certainly have worked very hard towards this goal, as I have tried to show in this brief historical review. But the rest of us - myself included - could do a lot more. Please bear with me for a few more minutes, while I report what the Academy has designated as goals for the future, and let me add a few ideas of my own.

At the 1982 meeting in Bismarck, the Academy made some significant changes. The choice of location was one of them. It was the first time that the Academy assembled at the seat of the North Dakota Government instead of leaning on the presence of one of the colleges and its faculty. That presented some logistical challenges; but it certainly also improved the image of the Academy for people who barely knew so far that such a group existed.

Four field trips were offered which introduced participants in a tangible way to modern developments in science and technology important to the future of the State. Seven symposia were organized, each around a subject of more than specialist interest.(1) As far as the speakers followed the advice given to them to avoid scientific lingo where possible, and explain indispensable scientific terms where needed, these symposia functioned as the right kind of popularized science: addressing educated people in general, not only the specialist.

These changes of meeting format that were started in Bismarck are one of the goals for the future. The Executive Committee decided upon them after surveying the membership's views early in 1981 and following up with a "goals workshop" later that year. Other points of that program are: more workshops, more invited papers, some sessions focusing on educating scientists to new concepts, rather than just concentrating on research results. It was also decided that our programs to involve youth in science should be further expanded, and that activities should be organized to promote public interest in science. If many members take part, these worthwhile goals should soon be reached. There is a dire need, I believe, for all scientists of good will to recognize how urgently their insights are needed by the community at large and to find a way to repay that community for the privilege of having been educated as scientists. There are many such ways, and everyone of us has to find the one that suits him best.

But we all have to speak up; that is a sure thing, because many other voices are being heard, some of them utterly opposed to scientific thinking. The alarming fact is that the "creation scientists", the "right-to-lifers," the racist hatemongers and other spreaders of rigid dogma have the ear of millions of people in America. Those who know better cannot afford to be silent. We should have learned that essential fact of political life from another highly educated and scientifically productive nation, where, about forty years ago, a Nobel-laureate physicist wrote a textbook that he called "German Physics" with the sole aim to ignore Einstein's theory of relativity. -- And those who knew better kept their mouths shut!

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(1)The first symposium held at a North Dakota Academy of Science meeting was organized in 1973 by MOHAN WALI of UND on the subject of "Environmental Impact of Strip Mining in North Dakota."

Good will and the courage to speak up are the prime requirements, but they alone are not enough to effectively promote scientific views. In order to be not only heard but also understood, we scientists must speak in clear and precise but simple terms. This is where our Academy has a marvelous chance. Not only will the Senior Academicians keep their own presentations free of specialist gobbledygook, but they will also impress upon the many Juniors whose papers they judge, that throwing around learned-sounding words does not by itself make a good scientist.

In this context, I follow with great delight George Abbott's example, who loved to quote extensively from Goethe's Faust - in German language. Here are just four lines, still as fresh as ever after two hundred years. Doctor Faust is speaking to his graduate assistant Wagner.

Such' er den redlichen Gewinn!
Sei er kein schellenlauter Tor!
Es traegt Verstand und rechter Sinn
Mit wenig Kunst sich selber vor.

Seek thou the honest recompense!
Beware a tinkling fool to be!
With little art, clear wit and sense
Suggest their own delivery.

Another, but probably related trend of the day in our country is a weird preference for complicated and therefore expensive technology, coupled with actual disdain for simpler solutions of the very same problem. E. F. Schumacher who wrote "Small Is Beautiful," said this about it: "Any third-rate engineer or researcher can increase complexity; but it takes a certain flair of real insight to make things simple again." Whoever follows the development of solar energy these days, knows how true this is.

Let's not lose sight of this when we consult with science teachers and when we judge the achievements of their students. When the sputnik scare was upon us, a whole new science curriculum was worked out, and some of it was very good. But, we also should admit that such oversophisticated programs as the Chemical Bond Approach were eaten up by about five percent of the high school students taking them. The other ninety five percent could not follow; they were disgusted and permanently lost for any scientific endeavor. Later, even the top students had trouble, when college freshman courses seemed a boring rehash of what they knew already.

Today, the strong temptation is to instrumentalize and computerize everything, starting in elementary school. If we yield to it, we repeat the sputnik-era mistake of teaching calculus in kindergarten, so to speak. Our youngsters, then, will play around with a lot of black boxes, displaying a phony expertise with no idea what it really means.

At the Centennial Symposium of the University of North Dakota, Rollo May proclaimed that every child has creativity that should be stimulated and developed by "playful tinkering with ideas" and Mortimer Adler told us that "we need specialists - but everyone should be a generalist first, and a specialist second."

Allow me to translate that into a guideline how to introduce youngsters to science. The teacher who realizes that attitude has to come before knowledge, will scrutinize earlier scientific discoveries to find some where the mental discovery jump is within reach of his or her students, and the expense within reach of the school budget. The students who are gently guided to make that mental jump once more, will be so excited that "they think they are scientists," as a wonderful high school teacher told me years ago. That can be done with simple means, and when the gadgetry inevitably comes at the college level, it will neither hit an unprepared mind, nor appear to be a rehash of

previous teaching.

Well, here you have the history of the North Dakota Academy of Science for its last twenty five years - as I see it - and some conclusions for the future - also as I see them. I will feel that my effort was worthwhile if it will lead to plenty of lively discussion. That's after all what an Academy meeting is all about.

26 February 1983 RICHARD E. FRANK

NORTH DAKOTA ACADEMY OF SCIENCE RECORDS

Calendar Year	Academy Year	Meeting Place	President	Secretary -Treasurer	Delegate to AAAS
1959	51	Minot	Art W. Koth	Ben G. Gustafson	Franz H. Rathmann
1960	52	NDAC	H. J. Klosterman		
1961	53	UND	Vera Facey		
1962	54	NDSU	J. F. Cassel		
1963	55	UND	C. Art Wardner		
1964	56	NDSU	Fred H. Sands		
1964	57	UND	Paul B. Kannowski		
1966	58	NDSU	Paul C. Sandal		
1967	59	UND	F. D. Holland, Jr.		
1968	60	NDSU	W. E. Dinusson		
1969	61	Minot	Paul D. Leiby		
1970	62	UND	Roland G. Severson		
1971	63	NDSU	Robert L. Burgess		
1972	64	Dickinson	John C. Thompson		
1973	65	UND	John R. Reid	A. Wm. Johnson	
1974	66	NDSU	Richard L. Kiesling		
1975	67	Valley City	Art W. DaFoe		
1976	68	NDSU	Donald R. Scoby		
1977	69	Minot	Om P. Madhok		J. A. Stewart
1978	70	UND	James A. Stewart		J. A. Stewart
1979	71	Aberdeen SD	Jerome M. Knoblich		D. O. Erickson
1980	72	NDSU	Duane O. Erickson		Robert G. Todd
1981	73	Dickinson	Robert G. Todd		Eric Clausen
1982	74	Bismarck	Eric N. Clausen		V. I. Stenberg
1983	75	UND	Virgil I. Stenberg		Gary Clambey

OBITUARIES (1982-83)

Bernhard G. Gustafson (1903-1982)

Ben Gustafson died November 9, 1982 at his home in Grand Forks.

Gustafson was born September 8, 1903 in Foxholm, North Dakota and graduated from Turtle Lake High School. He received his B.S. degree from Jamestown College and his M.S. degree in Chemistry from UND in 1946. After working in the public schools up to the level of superintendent he joined the UND faculty in 1940 as an Associate Professor of Chemistry. In 1957 he became Director of the UND Extension Division and in 1964 Dean of Continuing Education. He was instrumental in operations of the UND centers in Williston and Ellendale. Gustafson retired in 1974. He won a special election to the State Senate in 1971 and served in the North Dakota House of Representatives from 1975-1977.

Gustafson joined the Academy in 1939 and served as Secretary-Treasurer from 1957 to 1972.

His wife Ruth, children Bernard and Lorna, sister Josephine, and five grandchildren survive.

ADOMAITIS, VYTAUTAS	1000 - 11TH AVE. NE, #6		JAMESTOWN	ND	58401	A	1966
AKERS, THOMAS K.	PHYSIOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1966
ALBRECHT, STEVEN		JAMESTOWN COLLEGE	JAMESTOWN	ND	58401	A	1979
ALESSI, JOSEPH	NORTHERN GREAT PLAINS	RESEARCH CENTER	MANDAN	ND	58554	A	1962
ALSOP, TED J.	GEOGRAPHY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1981
ALTENBURG, LOIS IVER		1146 FIFTH STREET, N	FARGO	ND	58102	A	1982
ANDERSON, EDWIN M.		213 - 20TH AVENUE, N	FARGO	ND	58102	C	1962
ANDERSON, ORDEAN S.		RURAL ROUTE 1	NEW PRAGUE	MN	56071	A	1972
ANGELO, ROBERT T.	707 NORTH 19TH STREET		BISMARCK	ND	58501	A	1982
ANTES, JAMES R.		3524 SEVENTH AVENUE, N	GRAND FORKS	ND	58201	A	1979
ARDILA, MYRIAM	312 HANCOCK HALL	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58201	B	1982
ASCHBACHER, PETER W.	METABOLISM AND RADIATION LAB	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1958
ASHWORTH, ALLAN C.	GEOLOGY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105	A	1974
AUYONG, THEODORE	PHARMACOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1963
BALTISBERGER, RICHAR	CHEMISTRY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1969
BANASIK, ORVILLE J.	CEREAL TECHNOLOGY	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1947
BARES, RICHARD	PROJECT RECLAMATION	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1977
BARNEY, WILLIAM G.	MECHANICAL ENGINEERING DEPT.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1957
BARNHART, MARY DIX	5011 SOUTH 73RD STREET		LINCOLN	NE	68516	A	1975
BARRON, GEORGE		JAMESTOWN HIGH SCHOOL	JAMESTOWN	ND	58401	A	1972
BARRY, DAVID G.		445 TENTH STREET, E	DICKINSON	ND	58601	A	1980
BARTAK, DUANE E.	CHEMISTRY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1977
BEHM, MARLA	MARY COLLEGE	APPLE CREEK ROAD	BISMARCK	ND	58501	A	1980
BEHRINGER, MARJORIE		1613 CRIPPLE DRIVE	AUSTIN	TX	78758	C	1969
BELINSKEY, CAROL R.		MINOT STATE COLLEGE	MINOT	ND	58701	A	1958
BELKNAP, JOHN K.	PHARMACOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1979
BENSON, STEVEN A.	ENERGY TECHNOLOGY CENTER	BOX 8213	GRAND FORKS	ND	58202	A	1979
BENZ, LEO C.		1407 NORTH 23RD STREET	BISMARCK	ND	58501	A	1962
BERGSTROM, DONALD E.	CHEMISTRY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1982
BERKEY, GORDON B.	SCIENCE DIVISION	MINOT STATE COLLEGE	MINOT	ND	58701	A	1970
BERRYHILL, DAVID L.	BACTERIOLOGY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1973
BITZAN, EDWARD F.	U.S. BUREAU OF MINES	EXPERIMENT STATION	GRAND FORKS	ND	58202	A	1952
BLEIER, WILLIAM J.	ZOOLOGY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105	A	1982
BLISS, HAROLD N.		MAYVILLE STATE COLLEGE	MAYVILLE	ND	58257	C	1951
BLUEMLE, JOHN P.	ND GEOLOGICAL SURVEY	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1963
BOLEY, CHARLES		500 VANCE STREET, #47	LAKEWOOD	CO	80226	C	1967
BOLIN, F. M.		1505 SIXTH STREET, S.	FARGO	ND	58102	C	1948
BOLONCHUK, WILLIAM W	HPER DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1981
BOUDJOUK, PHILIP	CHEMISTRY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1978
BRADDOCK, NORMA	1402 SPAULDING AVENUE		BISMARCK	ND	58501	A	1981
BRAINARD, JAMES A.	RURAL ROUTE 5	BOX 78	LANGDON	ND	58249	A	1982
BRAMMER, J. D.	ZOOLOGY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1978
BRAND, MICHAEL		1116 SOUTH THIRD STREET, #2	BISMARCK	ND	58501	A	1976
BREKKE, DAVID	N.D. GEOLOGICAL SURVEY	UNIVERSITY STATION	GRAND FORKS	ND	58202	A	1979
BROMEL, MARY C.	BACTERIOLOGY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1969
BROPHY, JOHN A.	GEOLOGY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	C	1960
BRORBY, KIMBERLY K.	122 PROSPECTOR PARK		GOLDEN	CO	80401	B	1982
BROSCHAT, MYRON D.		203 EAST CHANNING AVENUE	FERGUS FALLS	MN	56537	A	1976
BROWN, RALPH C.	GEOGRAPHY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1972
BRUMLEVE, STANLEY	PHYSIOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1958
BUER, MARJORIE	306 PIONEER HALL	MINOT STATE COLLEGE	MINOT	ND	58701	B	1982
BUKOWIEC, TRUDY		MINOT STATE COLLEGE	MINOT	ND	58701	B	1982
BUTLER, JACK L.	BOTANY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105	B	1982
CALLENBACH, JOHN A.	ENTOMOLOGY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	C	1954
CAMARA, MICHAEL		11723 CLEARGLEN AVENUE	WHITTIER	CA	90604	A	1977
CARLSON, EDWARD C.	ANATOMY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1982
CARMICHAEL, VIRGIL W		1013 NORTH ANDERSON STREET	BISMARCK	ND	58501	A	1979
CARTER, JACK F.	AGRONOMY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1950
CASSEL, J. FRANK	ZOOLOGY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	C	1950
CHRISTOFERSON, LEE A		700 FIRST AVENUE, S.	FARGO	ND	58102	A	1952
CLAFLIN, JOE	BOX 24	JAMESTOWN COLLEGE	JAMESTOWN	ND	58401	A	1974
CLAMBEY, GARY K.	BOTANY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1975
CLAUSEN, ERIC N.	SCIENCE DIVISION	MINOT STATE COLLEGE	MINOT	ND	58701	A	1968
COCKRUM, FRANCES E.		10 FIRST STREET, SW., #10	MINOT	ND	58701	B	1982
COLLINS, CHARLES C.	ELECTRICAL ENGINEERING DEPT.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1962
COMITA, GABRIEL W.		89 NORTH 21ST AVENUE	FARGO	ND	58102	C	1954
CONNELL, MARVIN D.		2006 FIFTH AVENUE, N.	GRAND FORKS	ND	58201	A	1972

COOK, DEBORAH A.	BOTANY DEPARTMENT, BOX 30	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105	B	1982
CORNATZER, WILLIAM E	BIOCHEMISTRY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1952
COWARDIN, LEWIS M.		310 - 16TH AVENUE, NE.	JAMESTOWN	ND	58401	A	1967
CROOKE, PATSY J.	ND PARKS AND RECREATION	BOX 700	BISMARCK	ND	58502	A	1982
CVANCARA, ALAN M.	GEOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1963
D'APPOLONIA, BERT L.	CEREAL TECHNOLOGY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1968
DAFOE, ARTHUR W.		551 THIRD STREET, NE.	VALLEY CITY	ND	58072	C	1963
DANDO, WILLIAM A.	GEOGRAPHY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1975
DAVIS, DAVID G.	METABOLISM AND RADIATION LAB	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105	A	1973
DAVY, JOEL A.		MINOT STATE COLLEGE	MINOT	ND	58701	A	1981
DEBOER, BENJAMIN		312 ALPHA	GRAND FORKS	ND	58201	C	1952
DEITZ, MICHAEL C.		530 TULANE DRIVE, #207	GRAND FORKS	ND	58201	B	1982
DINGA, GUSTAV P.		CONCORDIA COLLEGE	MOORHEAD	MN	56560	A	1961
DINUSSON, WILLIAM E.	ANIMAL SCIENCE DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1950
DISRUD, DENNIS T.		413 HILLCREST DRIVE	MINOT	ND	58701	A	1963
DOERING, EUGENE J.		2206 LAFOREST AVENUE	BISMARCK	ND	58501	A	1966
DOGGER, JAMES R.	ROOM 313	BUILDING 003, BARC W	BELTSVILLE	MD	20705	A	1958
DOUBLY, JOHN A.		306 - 23RD AVENUE, N.	FARGO	ND	58102	C	1950
DOYLE, DARYL J.		RURAL ROUTE 2	VALLEY CITY	ND	58072	A	1978
DUERRE, JOHN A.	MICROBIOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1965
DUYSEN, MURRAY E.	BOTANY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1966
EBERTZ, CHRIS J.		604 EAST CENTRAL	MINOT	ND	58701	B	1982
EDERSTROM, HELGE E.		903 NORTH 26TH STREET	GRAND FORKS	ND	58201	C	1953
EDGERLY, CHARLES G.M	DAIRY SCIENCE DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1955
EGINTON, CHARLES T.		VETERANS ADMINISTRATION CNTR	FARGO	ND	58102	A	1979
ERICKSON, DUANE	ANIMAL SCIENCE DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1961
ERICKSON, J. MARK		ST. LAWRENCE UNIVERSITY	CANTON	NY	13617	A	1966
EVANS, HAROLD W.		2624 OLSON DRIVE	GRAND FORKS	ND	58201	A	1961
FACEY, VERA		801 BOYD DRIVE	GRAND FORKS	ND	58201	C	1948
FARNUM, BRUCE	ENERGY TECHNOLOGY CENTER	BOX 8213	GRAND FORKS	ND	58202	A	1965
FARNUM, SYLVIA	ENERGY TECHNOLOGY CENTER	BOX 8213	GRAND FORKS	ND	58202	A	1966
FEDORKA, PAULA J.	BACTERIOLOGY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105	B	1981
FEGLEY, MELVIN M.		1402 GRAFTON STREET	LARAMIE	WY	82070	A	1951
FEIL, VERNON J.	METABOLISM AND RADIATION LAB	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1964
FILLIPI, GORDON M.		1005 SOUTH 20TH STREET	GRAND FORKS	ND	58201	A	1972
FISCHER, ALLAN G.	BIOCHEMISTRY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1971
FISH, HAROLD F.		BOX 338	WATFORD CITY	ND	58854	A	1975
FISK, ALLEN L.		1122 AVENUE B WEST	BISMARCK	ND	58501	A	1982
FIVIZZANI, ALBERT J.	BIOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1979
FLEETWOOD, CHARLES W	CHEMISTRY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	C	1948
FLETCHER, ALAN G.	SCHOOL OF ENGR. AND MINES	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1970
FOLLAND, JOHN		TOLLEY HIGH SCHOOL	TOLLEY	ND	58787	A	1982
FOSSUM, GUILFORD O.	CIVIL ENGINEERING DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1957
FOWKES, WALTER W.		422 WEST FARMER	INDEPENDENCE	MO	64050	C	1957
FRAASE, RONALD G.		P.O. BOX 223	BISMARCK	ND	58501	A	1973
FRANCKOWIAK, JEROME	AGRONOMY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105	A	1979
FRANK, ANTHONY M.		716 FIFTH AVENUE, SE.	JAMESTOWN	ND	58401	A	1982
FRANK, RICHARD E.		1020 BOYD DRIVE	GRAND FORKS	ND	58201	C	1949
FULTON, GARY W.	BOTANY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105	B	1978
FUNKE, B. R.	BACTERIOLOGY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1966
GABRIELSON, DAVID	BACTERIOLOGY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105	A	1979
GALITZ, DONALD S.	BOTANY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1974
GANO, DAVID		MINOT STATE COLLEGE	MINOT	ND	58701	A	1968
GARDNER, RUSSELL JR.		700 FIRST AVENUE, S.	FARGO	ND	58102	A	1975
GARVEY, ROY	CHEMISTRY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105	A	1967
GASSNER, GEORGE	MRR LAB UNIVERSITY STATION	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1977
GILBRAITH, DAVID M.	4401 SAN JUAN DRIVE		FARGO	ND	58103	A	1982
GILJE, SANDRA		BOX 335	ROLETTE	ND	58366	B	1981
GILLIS, DAVID O.		BOX 49	WHITE EARTH	ND	58794	B	1982
GLASS, THOMAS L.	DEPARTMENT OF BACTERIOLOGY	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105	A	1983
GLASSER, JAMES C.		BOX 65	REGENT	ND	58650	A	1973
GOETTLER, HANS J.	MECHANICAL ENGINEERING DEPT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105	A	1979
GOETZ, HAROLD	BOTANY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1968
GREGORYK, JON F.	RURAL ROUTE 1	BOX 210	WILTON	ND	58579	B	1982
GRIM, PAUL		P.O. BOX 570	BELCOURT	ND	58316	A	1982
GROENEWOLD, GERALD	ND GEOLOGICAL SURVEY	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1970
GRONHOVD, GORDON H.	3004 BELMONT ROAD		GRAND FORKS	ND	58201	A	1957

GUSE, PAUL A.	SCHOOL OF PHARMACY	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105	A	1979
HALVORSON, GARY A.		BOX 459	MANDAN	ND	58554	A	1982
HANSON, DAVID D.		RURAL ROUTE 1, BOX 31	TURTLE LAKE	ND	58575	A	1982
HANSON, STEVEN A.		1817 TENTH STREET, SW.	MINOT	ND	58701	B	1982
HANSON, TOM		506 MIDWEST FEDERAL BUILDING	MINOT	ND	58701	A	1982
HARRISON, STEPHEN		11006 KIRKLAND WAY, 201	KIRKLAND	WA	98033	A	1979
HASSETT, DAVID J.		20 FENTON AVENUE	GRAND FORKS	ND	58201	A	1979
HAUNZ, EDGAR A.		1029 LINCOLN DRIVE	GRAND FORKS	ND	58201	C	1951
HAUSERMAN, WILLIAM B	126 SLEEPY HOLLOW		GRAND FORKS	ND	58201	A	1982
HEIDEL, BONNIE	PARKS AND RECREATION	BOX 700	BISMARCK	ND	58502	A	1982
HEIDT, JEFFRY		130 THIRD AVENUE, SE.	DICKINSON	ND	58601	B	1980
HELENBOLT, KENNETH S		3563 LONGFELLOW ROAD	FARGO	ND	58102	A	1964
HENDERSON, WILLIAM		3014 NORTH ELM STREET	FARGO	ND	58102	A	1979
HERTSGAARD, DORIS	DEPARTMENT OF MATH SCIENCE	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105	A	1982
HICKOK, FLOYD	GEOGRAPHY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1981
HIGHUM, ALAN W.		812 TENTH STREET, NW.	MINOT	ND	58701	B	1982
HNOJEWYJ, WASYL S.	COLLEGE OF CHEMISTRY	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105	C	1964
HODEK, DONALD		LONG LAKE WILDLIFE REFUGE	MOFFIT	ND	58560	B	1979
HOEPPNER, JEROME J.		2518 NINTH AVENUE, N.	GRAND FORKS	ND	58201	C	1949
HOFFMAN, CHARLES A.		MINOT STATE COLLEGE	MINOT	ND	58701	C	1958
HOFMANN, LENAT		317 SATURN DRIVE	BISMARCK	ND	58501	A	1981
HOGANSON, JOHN W.	GEOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1978
HOLLAND, F.D., JR.	GEOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1961
HOLLOWAY, HARRY JR.	BIOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1973
HOPKINS, RICK B.	1221 TENTH AVENUE NORTH		FARGO	ND	58102	A	1983
HOSTETTER, TERRY L.		2261 HUDSON STREET	DENVER	CO	80207	A	1980
HOUGHTON, ROBERT L.	U.S. GEOLOGICAL SURVEY	821 EAST INTERSTATE AVENUE	BISMARCK	ND	58501	A	1983
HOWARD, DALE B.	ONE IRMA COURT		MINOT	ND	58701	A	1981
HOWELL, FRANCIS L.	PHYSICS DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1970
HUIZENGA, ARCHIE		RURAL ROUTE 1	GLENBURN	ND	58740	B	1981
HUNG, YUNG-TSE	27906 LINCOLN ROAD		BAY VILLAGE	OH	44140	A	1975
HUSAIN, SYED	PHARMACOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1977
IVERSON, LOUIS	IL NATURAL HISTORY SURVEY	607 EAST PEABODY DRIVE	CHAMPAIGN	IL	61820	A	1978
JACOBS, FRANCIS A.	BIOCHEMISTRY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1955
JALAL, SYED M.	BIOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1965
JENKINS, DENNIS R.		493 MCMULLIN DRIVE	GRAND JUNCTION	CO	81504	A	1975
JENSEN, GORDON	BOX 366	111 MEDORA AVENUE	MANDAN	ND	58554	A	1980
JOHANSEN, ROBERT H.	HORTICULTURE DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1955
JOHNSON, A. WILLIAM		416 TERRACE DRIVE	GRAND FORKS	ND	58201	A	1961
JOHNSON, ARNOLD R.		MINOT STATE COLLEGE	MINOT	ND	58701	A	1966
JOHNSON, DOUGLAS H.		BOX 1747	JAMESTOWN	ND	58401	A	1973
JOHNSON, LESTER E.			BOTTINEAU	ND	58318	A	1969
JOHNSON, PHYLLIS E.	HUMAN NUTRITION LAB	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1978
JONES, MARTIN B.	CHEMISTRY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1982
JONES, MICHAEL L.	ENERGY TECHNOLOGY CENTER	BOX 8213	GRAND FORKS	ND	58202	A	1981
JORDAN, DAN R.		207 STATE STREET, #108	GRAND FORKS	ND	58201	B	1982
JORDE, DENNIS	240 NUTTING HALL	UNIVERSITY OF MAINE	ORONO	ME	04469	B	1979
KANNOWSKI, PAUL B.	BIOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1960
KANTRUD, HAROLD A.		ROUTE 7	JAMESTOWN	ND	58401	A	1980
KARNER, FRANK R.	GEOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1963
KEHEW, ALAN E.	315 LEONARD HALL	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1979
KELLEHER, JAMES J.	MICROBIOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1972
KELLER, LEE		305 - 25TH STREET, NW	MINOT	ND	58701	B	1982
KEMP, JUDY B.		748 VIKING DRIVE	VALLEY CITY	ND	58072	A	1978
KIESLING, RICHARD	PLANT PATHOLOGY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1961
KIRBY, DON	BOTANY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105	A	1980
KLEVAY, LESLIE M.		223 - 27TH AVENUE, S.	GRAND FORKS	ND	58201	A	1973
KNOBLICH, JEROME		BOX 63	ELDRIDGE	ND	58435	A	1958
KNUDSON, CURTIS L.	DOE ENGR RESEARCH, BOX 20	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1978
KOENKER, WM. E.		6403 GARRET ROAD	DURHAM	NC	27707	C	1958
KOHANOWSKI, N.	GEOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	C	1949
KOLSTOE, RALPH H.	PSYCHOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1962
KOOB, MICHAEL		1219 FOURTH AVENUE, S.	MOORHEAD	MN	56560	B	1982
KOPONEN, MARK A.	CHATEAU 304	815 DUKE DRIVE	GRAND FORKS	ND	58201	B	1975
KORDONOWY, RHODA	HARRIS HALL	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105	B	1981
KRAFT, DONALD J.	BEMIDJI STATE UNIVERSITY		BEMIDJI	MN	56601	A	1970
KRESS, WARREN D.	GEOGRAPHY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1958

KRUGER, ROBERT M.	DEPARTMENT OF ENTOMOLOGY	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105	B	1982
KRUPINSKY, JOSEPH M.	USDA-ARS	BOX 459	MANDAN	ND	58554	A	1982
KRUSCHWITZ, EARL H.		431 SIXTH STREET, SW	VALLEY CITY	ND	58072	C	1947
KUBE, WAYNE R.	CHEMICAL ENGINEERING	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1949
KUCERA, HENRY L.	AGRICULTURAL ENGINEERING	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1966
KUKLA, JEFF L.	273 JOHNSON HALL	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105	B	1982
LAIRD, WILSON M.		101 SPANISH OAK LANE	KERRVILLE	TX	78028	C	1941
LAMBETH, DAVID		1909 - 20TH AVENUE, S.	GRAND FORKS	ND	58201	A	1979
LARSON, MARK J.	PROSPECTOR PARK #122		GOLDEN	CO	80401	B	1982
LARSON, OMER R.	BIOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1964
LEAGUE, LARRY		DICKINSON STATE COLLEGE	DICKINSON	ND	58601	A	1981
LECHNER, TERESA		715 NORTH 40TH, #204I	GRAND FORKS	ND	58201	A	1982
LEFEVER, JULIE	ND GEOLOGICAL SURVEY	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1982
LEFEVER, RICHARD D.	GEOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1980
LEGLER, JULIE M.	DEPARTMENT OF MATH SCIENCE	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105	A	1982
LEHR, EUGENE R.			LINTON	ND	58552	A	1982
LEITE, DAVID	ROUTE 2, BOX 161		MINOT	ND	58701	B	1982
LI KAM, W.	MECHANICAL ENGINEERING DEPT.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1968
LIPP, GARY		BOX 1229	DICKINSON	ND	58601	A	1982
LIPP, WILLIAM V.		3024 NORTH 10TH STREET, #19	FARGO	ND	58102	A	1972
LOBDELL, FREDERICK	GEOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	B	1980
LOCKER, HOWARD J.		P. O. BOX 209	DRAKE	ND	58736	B	1982
LOENDORF, LAWRENCE L	ANTHROPOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1973
LORENZ, RUSSELL J.	NORTHERN GREAT PLAINS	RESEARCH CENTER	MANDAN	ND	58554	A	1962
LOW, FRANK N.		2511 ST. CHARLES AVENUE	NEW ORLEANS	LA	70301	C	1964
LOWE, STEPHEN	DIVISION OF SCIENCE AND MATH	MINOT STATE COLLEGE	MINOT	ND	58701	A	1981
LUNN, ERIC R.		503 SPINDRIFT LANE	COLUMBIA	SC	29209	B	1981
LURA, CHARLES L.		1014 - 15TH STREET, N.	FARGO	ND	58102	B	1981
MACCARTHY, RONALD F.		1116 - 19TH AVENUE, S..#18	GRAND FORKS	ND	58201	A	1968
MADHOK, OM P.		MINOT STATE COLLEGE	MINOT	ND	58701	A	1967
MAGNUSSON, ADELYNN M		1703 SOUTH 20TH STREET	GRAND FORKS	ND	58201	C	1951
MAIANU, ALEXANDRU	SOIL SCIENCE DEPT., BOX 5575	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105	A	1982
MANZ, OSCAR	CIVIL ENGINEERING DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1970
MARKELL, CLARK		MINOT STATE COLLEGE	MINOT	ND	58701	A	1972
MARTIN, DEWAYNE C.H.		2104 SEVENTH AVENUE, NW	MINOT	ND	58701	A	1962
MARTIN, GWEN		BOX 122	WILLISTON	ND	58801	B	1981
MARWIN, RICHARD M.	MICROBIOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1949
MASON, HARRY		P.O. BOX 1116	JAMESTOWN	ND	58401	A	1951
MASTEL, JEROME A.	DEPARTMENT OF RANGE SCIENCE	COLORADO STATE UNIVERSITY	FORT COLLINS	CO	80523	B	1980
MATHSEN, DON	MECHANICAL ENGINEERING DEPT.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1970
MATTHIES, DONALD L.	ANATOMY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1973
MAYER, JANET F.		1602 NORTH 10TH STREET	FARGO	ND	58102	A	1982
MCCARTHY, G. J.	DEPTS OF CHEMISTRY & GEOLOGY	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1982
MCDONALD, CLARENCE E	CEREAL TECHNOLOGY	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1965
MCDONNELL, TIMOTHY	ANATOMY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	B	1978
MCKENNA, MICHAEL G.		1601 SOUTH COLUMBIA	BISMARCK	ND	58501	A	1976
MCMAHON, KENNETH J.	BACTERIOLOGY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1970
MEDHAUG, CARRIE L.	1802 1/2 FIFTH AVENUE SOUTH		MOORHEAD	MN	56560	B	1982
MELDRUM, ALAN		512 COLUMBIA ROAD	GRAND FORKS	ND	58201	C	1957
MERCER, STEPHAN		509 - 10TH STREET, NE	MINOT	ND	58701	B	1982
MERRILL, STEPHEN D.	NORTHERN GREAT PLAINS	RESEARCH CENTER, BOX 459	MANDAN	ND	58554	A	1982
MESSENGER, THEO	PHILOSOPHY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1976
MEYER, DWAIN W.	AGRONOMY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1970
MILLER, DAVID	ENERGY RESEARCH CENTER	BOX 8213	GRAND FORKS	ND	58202	A	1979
MILLER, JAMES E.		3807 MICHAEL LANE	GLENVIEW	IL	60025	A	1964
MITCHELL, E. N.	220 GLENHILL LANE		CHAPEL HILL	NC	27514	A	1960
MITCHELL, MARTHA J.	ENERGY TECHNOLOGY CENTER	BOX 8011, UNIVERSITY STATION	GRAND FORKS	ND	58202	A	1982
MOLLAND, GIBBS		1205 NORTH 22ND STREET	BISMARCK	ND	58501	A	1979
MONTGOMERY, GEORGE G		BOX 76	MANVEL	ND	58256	A	1979
MOORE, MARGARET M.	COLLEGE OF FORESTRY	1530 CLEVELAND AVENUE NORTH	ST. PAUL	MN	55104	B	1981
MORLOCK, BRADLEY J.		1530 NORTH 9TH STREET	FARGO	ND	58102	B	1982
MOWER, ROLAND D.	GEOGRAPHY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1983
MOWERY, GARRY B.		334 FOREST AVENUE, N.	FARGO	ND	58102	A	1979
MUNSKI, DOUGLAS	GEOGRAPHY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1981
MURPHY, KATHLEEN A.	MICROBIOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	B	1979
NALEWAJA, JOHN D.	AGRONOMY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1963
NEEL, JOE K.	BIOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	C	1969

NELSON, BERLIN D.	PLANT PATHOLOGY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105	A	1983
NELSON, C. N.	BOTTINEAU BRANCH	NORTH DAKOTA STATE UNIVERSITY	BOTTINEAU	ND	58318	C	1972
NELSON, DENNIS R.	METABOLISM AND RADIATION LAB	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1964
NELSON, HARVEY K.		10515 KELL AVENUE, S.	BLOOMINGTON	MN	55437	A	1967
NELSON, WALLACE T.	ROUTE 1, BOX 167		PARSHALL	ND	58770	A	1981
NIELSEN, FORREST H.	USDA HUMAN NUTRITION LAB	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1974
NIESAR, SHERRY L.		12-1/2 9TH AVENUE, NW, APT B	MINOT	ND	58701	B	1982
NORDLIE, ROBERT C.	BIOCHEMISTRY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1962
NORTHROP, RICHARD		835 - 17TH AVENUE, NW	MINOT	ND	58701	B	1982
NUTTER, FORREST W.	PLANT PATHOLOGY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105	B	1982
NYREN, PAUL	DICKINSON ENGINEERING	STATION, BOX 1117	DICKINSON	ND	58601	A	1980
O'CONNELL, JAMES W.		535 - 8TH AVENUE, SW	VALLEY CITY	ND	58072	A	1973
O'MALLEY, RANDY		718 NINTH STREET, NW	MINOT	ND	58701	B	1982
OKLAND, LINDA E.		2702 MCKENZIE DRIVE	ANCHORAGE	AK	99503	A	1982
OLSON, NORMAN		301 - 33TH AVENUE, N., #201	FARGO	ND	58102	B	1979
ORING, LEWIS W.	BIOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1971
ORR, PAUL H.		1010 RIVER DRIVE, SE	EAST GRAND FORKS	MN	56721	A	1982
ORTH, JAMES A.		C.P. 1076 SCHEFFERVILLE	QUEBEC, CANADA		G0G2T0	A	1970
OWEN, ALICE K.	BIOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1966
OWEN, JOHN B.	BIOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1966
OWEN, SHUBEL D.		8000 PANORAMA ROAD	PANORA	IA	59216	C	1959
OWENS, THOMAS C.	CHEMICAL ENGINEERING DEPT.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1970
PARK, CHUNG S.	DEPARTMENT OF ANIMAL SCIENCE	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105	A	1979
PARMAR, SURENDRA	PHYSIOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1977
PARRILL, CLARK C.	BOX 19	NORTHLAND TRAILER COURT	BOTTINEAU	ND	58318	A	1977
PATTERSON, DONALD D.	DEPARTMENT OF SOIL SCIENCE	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105	A	1982
PAULSON, QUENTIN F.		821 EAST INTERSTATE AVENUE	BISMARCK	ND	58501	A	1982
PAULSON, RICK L.	422 SOUTH 5TH STREET, APT. 2		GRAND FORKS	ND	58201	B	1983
PAULSON, THOMAS L.	902 - 7TH STREET EAST		DICKINSON	ND	58601	A	1983
PEDERSON, A. ROBERT		414 - 20TH AVENUE, N.	FARGO	ND	58102	A	1972
PEDERSON, VERNYL D.	PLANT PATHOLOGY	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1968
PETERKA, JOHN J.	ZOOLOGY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1968
PFISTER, PHILIP C.		30 MEADOWLARK LANE	FARGO	ND	58102	A	1968
PRATT, GEORGE L.	AGRICULTURAL ENGINEERING	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1961
PRESZLER, DALE A.		1717 EAST INTERSTATE AVENUE	BISMARCK	ND	58501	A	1978
PRUNTY, LYLE		318 - 23RD AVENUE, N.	FARGO	ND	58102	A	1981
RALSTON, ROBERT		MAYVILLE STATE COLLEGE	MAYVILLE	ND	58257	A	1961
RAND, ROGER W.		542 FIFTH AVENUE, SW	VALLEY CITY	ND	58072	A	1975
RATHMANN, FRANZ H.	CHEMISTRY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	C	1955
RAWAT, BANMALI	ELECTRICAL ENGINEERING DEPT.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1992
RAY, PAUL D.	BIOCHEMISTRY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1968
REICHMAN, GEORGE A.		306 SIXTH AVENUE, NW	MANDAN	ND	58554	A	1962
REID, JOHN R.	GEOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1962
RICHARDSON, J. L.		1245 NORTH 9TH STREET	FARGO	ND	58102	A	1978
RIES, RONALD E.		908 SECOND AVENUE, NW	MANDAN	ND	58554	A	1979
RINDT, DIANE	ENERGY TECHNOLOGY CENTER	BOX 8213	GRAND FORKS	ND	58202	A	1979
RINDT, JOHN R.	2115 SECOND AVENUE WEST		GRAND FORKS	ND	58201	A	1983
ROGERS, DAVID A.	ELECTRICAL ENGINEERING DEPT.	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105	A	1983
ROGLER, GEORGE A.		BOX 459	MANDAN	ND	58554	C	1962
ROHDE-FULTON, MONICA	BOTANY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105	B	1980
ROTHENBERGER, STEVE		MIDLAND LUTHERAN COLLEGE	FREMONT	NE	68025	A	1976
RUDESILL, JAMES T.	CHEMISTRY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1958
SANDAL, PAUL	AGRONOMY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105	C	1955
SANDS, F. H.	CHEMISTRY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	C	1946
SARGEANT, ALAN B.	NORTHERN PRAIRIE WILDLIFE	RESEARCH CENTER	JAMESTOWN	ND	58401	A	1972
SAUMUR, JEAN H.	PATHOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1975
SCHAFER, JOHN E.		140 - 11TH AVENUE, W., #1	DICKINSON	ND	58601	A	1979
SCHEIBE, PAUL		3 SHIRLEY LANE	WOODSIDE	CA	94062	A	1960
SCHIMMELPFENNIG, DIA		BOX 1227	HETTINGER	ND	58639	A	1978
SCHMID, THOMAS		1125 - 2ND AVENUE, SW	JAMESTOWN	ND	58401	A	1982
SCHMIDT, CLAUDE H.	P.O. BOX 5674	STATE UNIVERSITY STATION	FARGO	ND	58105	A	1980
SCHMIDT, LAWRENCE A.	ROUTE 5, BOX 407C		MINOT	ND	58701	B	1982
SCHNEIDER, FREDERICK	ANTHROPOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1973
SCHOBERT, HAROLD	ENERGY TECHNOLOGY CENTER	BOX 8213	GRAND FORKS	ND	58202	A	1978
SCHULZ, JOHN T.	ENTOMOLOGY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105	A	1960
SCHWERT, DONALD P.	GEOLOGY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1981
SCHWINDEN, CINDY		52 - 16-1/2 AVENUE, N.	FARGO	ND	58102	B	1982

SCOBY, DONALD R.	BOTANY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1968
SEABLOOM, ROBERT W.	BIOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1962
SEARS, SHEILA	MRR LABORATORY	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	B	1977
SEIDEL, JIMMY LEE	CHEMISTRY DEPARTMENT, BOX 72	UNIVERSITY OF UTAH	SALT LAKE CITY	UT	84112	B	1981
SEVERSON, ARTHUR L.	ENGR. EXPERIMENT STATION	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1970
SEVERSON, D. E.	CHEMICAL ENGINEERING DEPT.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1949
SEVERSON, ROLAND G.	CHEMISTRY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1958
SHAW, BRENDA K.		TOLLEY HIGH SCHOOL	TOLLEY	ND	58787	A	1982
SHELTON, DAVID R.	CEREAL CHEMISTRY & TECHNOLOGY	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	B	1978
SHELVER, WILLIAM	COLLEGE OF PHARMACY	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105	A	1979
SHUBERT, L. ELLIOT	BIOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1974
SILVERMAN, LOUIS B.		2524 OLSON DRIVE	GRAND FORKS	ND	58201	A	1957
SIMONS, PAUL B.	GREAT PLAINS GASIFICATION	PROJECT	BEULAH	ND	58523	A	1982
SIMS, RODGER L.		718 - 25TH STREET, N.	GRAND FORKS	ND	58201	A	1979
SKAR, GERALD	APT. 311	439 W. CENTURY AVENUE	BISMARCK	ND	58501	A	1982
SLEEPER, BAYARD P.	BACTERIOLOGY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1952
SMITH, GLENN S.		1115 NORTH 14TH STREET	FARGO	ND	58102	C	1930
SNOOK, THEODORE		343 SHERIDAN ROAD	RACINE	WI	53403	C	1954
SOINE, PAMELA	ND PARKS AND RECREATION	BOX 700	BISMARCK	ND	58502	A	1982
SOUBY, ARMAND M.	CHEMICAL ENGINEERING DEPT.	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	C	1973
STACK, ROBERT W.	PLANT PATHOLOGY	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105	A	1980
STANISLAO, JOSEPH	ENGINEERING AND ARCHITECTURE	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1979
STARCHER, GEORGE W.		3605 JAFFA DRIVE	SARASOTA	FL	33579	C	1954
STATLER, GLEN D.	PLANT PATHOLOGY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1970
STAUBER, JULIE E.	224 HANCOCK HALL	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58201	B	1982
STENBERG, VIRGIL I.	CHEMISTRY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1961
STEWART, JAMES A.	CHEMISTRY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1960
STINNETT, HENRY O.	PHYSIOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1978
STOAKS, RALPH D.		6300 RANCHO MISSION, #174	SAN DIEGO	CA	92108	A	1982
STOY, W. MICHAEL		1826 NORTH BELL STREET	BISMARCK	ND	58501	A	1980
SUGIHARA, JAMES M.	GRADUATE SCHOOL	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1965
SUKALSKI, WILLIAM M.	813 NORTHWESTERN DRIVE		GRAND FORKS	ND	58201	A	1983
SUMMERS, LAWRENCE	CHEMISTRY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	C	1951
SWANSON, GEORGE A.		1727 - 4TH AVENUE, NE	JAMESTOWN	ND	58401	A	1967
SWANSON, RICHARD J.		567 - 3RD STREET COURT	WEST FARGO	ND	58078	A	1972
TAYLOR, RAYMOND	PLANT PATHOLOGY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105	B	1980
THOMPSON, CLARENCE E		1526 COTTONWOOD STREET	GRAND FORKS	ND	58201	A	1975
THOMPSON, MICHAEL B.		2208 CRESCENT DRIVE	MINOT	ND	58701	A	1970
THRASHER, LAWRENCE C	GEOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	B	1983
TILTON, JAMES E.	ANIMAL SCIENCE DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1966
TIMIAN, ROLAND G.	PLANT PATHOLOGY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1954
TIMPE, RONALD C.		MAYVILLE STATE COLLEGE	MAYVILLE	ND	58257	A	1973
TODD, ROBERT G.		DICKINSON STATE COLLEGE	DICKINSON	ND	58601	A	1962
TURNER, CHARLES D.	CIVIL ENGINEERING DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1983
VADHEIM, KIRSTEN	1108 - 4TH AVENUE SOUTH		FARGO	ND	58103	B	1982
VAN DEUSEN, JAMES L.		USFS SHELTERBELT LAB	BOTTINEAU	ND	58318	A	1975
VANALSTINE, JAMES B.	DIVISION OF SCIENCE & MATH	UNIVERSITY OF MINNESOTA	MORRIS	MN	56267	A	1975
VENETTE, JAMES R.	BOX 5012, PLANT PATHOLOGY	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105	A	1983
VENNES, JOHN W.	MICROBIOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1957
VINCENT, MURIEL C.	COLLEGE OF PHARMACY	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105	A	1957
VOLESKY, JERRY D.	ANIMAL/RANGE SCIENCE DEPT.	SOUTH DAKOTA STATE UNIVERSITY	BROOKINGS	SD	57007	B	1981
WAHTOLA, CHARLES H.	121 MISTLETOE ROAD		GOLDEN	CO	80401	A	1970
WALI, MOHAN K.	STATE UNIVERSITY OF NEW YORK	ENVIRON. SCIENCE & FORESTRY	SYRACUSE	NY	13210	A	1970
WALLER, JAMES R.	MICROBIOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1971
WALLWORK, JAMES C.	HUMAN NUTRITION LAB	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1979
WALSH, ROBERT G.		MINOT STATE COLLEGE	MINOT	ND	58701	A	1968
WANEK, WALLACE J.	ROUTE 1	BOX 307	BEMIDJI	MN	56601	A	1965
WARDNER, C. ARTHUR		3720 CHERRY STREET	GRAND FORKS	ND	58201	C	1958
WARNER, RICHARD H.	ND PARKS AND RECREATION	BOX 700	BISMARCK	ND	58502	A	1982
WATREL, ALBERT A.		1071 WEST 5TH STREET	DICKINSON	ND	58601	A	1979
WEISSER, WILBUR O.	PHYSICS DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1957
WEST, BRUCE R.		1136 - 8TH STREET, N.	FARGO	ND	58102	B	1982
WETSCH, JOHN R.		1012 NORTHWESTERN DRIVE	GRAND FORKS	ND	58201	A	1977
WHEELER, GEORGE C.		326 LAUREL RIDGE ROAD	SAN ANTONIO	TX	78253	C	1924
WHITE, GLYNDON	902 THIRD AVE. NW, BOX 1394		JAMESTOWN	ND	58401	A	1972
WHITMAN, WARREN C.	BOTANY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105	C	1950
WICKS, ZENO W.	DEPT. OF POLYMERS & COATINGS	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1974

WIEDERANDERS, R. E.		HARMON PARK CLINIC	WILLISTON	ND	58801	A	1968
WIIDAKAS, WILLIAM	AGRONOMY DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	C	1946
WILLIAMS, RICHARD L.			LINTON	ND	58552	B	1981
WILLIAMS, RICHARD P.		1136 - 10TH STREET, N.	FARGO	ND	58102	A	1982
WILLMAN, CLYDE A.		620 - 10TH STREET, S.	FARGO	ND	58103	A	1968
WILSON, RUSSELL H.		6218 WALNUT HILL LANE	DALLAS	TX	75230	A	1966
WILSON, SHARON	VETERINARY SCIENCE	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58105	B	1982
WINCZEWSKI, LARAMIE		12614 VINDON DRIVE	HOUSTON	TX	77024	A	1977
WINGER, MILTON	MATH DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1973
WITZ, RICHARD L.	AGRICULTURAL ENGINEERING DEPT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1960
WOLF, EDWARD G.		1436 TIPPERARY	BOULDER	CO	80303	A	1977
WOLFSON, ALAN		530 TULANE DRIVE, #206	GRAND FORKS	ND	58201	B	1979
WOLLENHAUPT, NYLE	BOX 459	NORTH DAKOTA STATE UNIVERSITY	MANDAN	ND	58554	A	1982
WORTHAM, KENNETH E.	BIOLOGY DEPARTMENT	MAYVILLE STATE COLLEGE	MAYVILLE	ND	58257	A	1975
WOSICK, FREDERICK D.		569 SUNSET PLACE	BISMARCK	ND	58501	A	1975
WRENN, WILLIAM J.	BIOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1970
WYCKOFF, JOHN W.	GEOGRAPHY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1983
WYMORE, ROBERT W.		350 FIRST STREET, NW	MAYVILLE	ND	58257	A	1977
ZIEMAN, DALE M.		DICKINSON STATE COLLEGE	DICKINSON	ND	58601	A	1961
ZOELLNER, ROBERT	CHEMISTRY DEPARTMENT	KANSAS STATE UNIVERSITY	MANHATTAN	KS	66506	B	1978
ZOGG, CARL	PHYSIOLOGY DEPARTMENT	UNIVERSITY OF NORTH DAKOTA	GRAND FORKS	ND	58202	A	1979
ZUBRISKI, J. C.	SOILS DEPARTMENT	NORTH DAKOTA STATE UNIVERSITY	FARGO	ND	58102	A	1955

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