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NORTH DAKOTA ACADEMY OF SCIENCE
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2000-2001

93rd Annual Meeting
April 26–27, 2001
Bismarck, North Dakota

HISTORY

The Proceedings of the North Dakota Academy of Science (NDAS) was first published in 1948, with Volume I reporting the business and scientific papers presented for the 40th annual meeting, May 2–3, 1947. Through Volume XXI, the single yearly issue of the Proceedings included both abstracts and full papers. Commencing with Volume XXII, the Proceedings was published in two parts. Part A, published prior to the annual meeting, contained an abstract of each paper to be presented at the meeting. Part B, published later, contained full papers by some of the presenters.

In 1979 (Volume 33) the Proceedings changed to the present 8 ½ x 11-inch format. It was produced from camera-ready copy submitted by the authors and issued in a single part to be distributed initially at the annual meeting. Commencing with Volume 51 all submissions were on computer disk; the entire Proceedings was then assembled by desktop publishing software. This approach allowed the Editor control over all formatting; many of the papers are reformatted, in order to give the *Proceedings* a more consistent look. Also, incorporating all of the submissions on computer allowed production of an electronic copy of the Proceedings for the first time.

VOLUME 55 ORGANIZATION

The communications of this volume of the Proceedings are presented in three sections. The first section contains presentations of the symposia offered at the 93rd annual meeting. These papers are organized in the same sequence as presented in the respective symposia. The second section contains the collegiate communications presented in the A. Rodger Denison Student Research Paper Competition. The third section of this volume contains the communications presented in the professional sections of the annual meeting. Readers may locate communications by looking within the major sections of these Proceedings (see table of contents) or by referring to the author index on page 83.

Symposia Communications

The symposia presented in this volume represent a variety of strategies to convey information to other scientists, scholars, students, and the public. As a result, greater flexibility was required in organizing symposia agenda (verbal presentations) with respect to written communications; thus please note that there is not necessarily a one-to-one match between titles of verbal and written communications. Commencing with the 88th annual meeting [Volume 50], presenters of Symposia annual meetings are given the opportunity to contribute an expanded or full-length article consisting of a multiple-page contribution, thus providing a presentation of much greater depth and scope than possible in a singe-page communication.

This approach has allowed speakers to present more educationally oriented lectures or workshop-type discussions and still provide a rigorous or more technical professional paper to the Proceedings. In a few cases, a speaker does not have a written communication. Again, this approach was taken to allow the symposia convenors the greatest flexibility possible in organizing speakers for the benefit of the audience.

Collegiate and Professional Communications

Each Collegiate and Professional 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 information to the reader than does an abstract, and yet still provides the advantages of timeliness and ease of production.

Constitution and Bylaws

This issue of the Proceedings also contains the Constitution and Bylaws of the Academy, a list of officers and committee members, a list of all Academy members as of March 2001, a copy of unapproved minutes from last year's annual business meeting, a listing of past presidents of the Academy, and an index of presenters and paper authors.

IN APPRECIATION

The Academy wishes to specially acknowledge current and emeritus members of the Academy who have supported the mission of the North Dakota Academy of Science Research Foundation through their special gifts. A listing of these supporters is found on page 78 of these Proceedings. The Academy also wishes to express its thanks to the convenors of the symposia for organizing, reviewing, and editing their respective communications. The President of the Academy also wishes to sincerely thank our special guest, Dr. Robert Nordlie, for speaking at this year's awards banquet.

Jon A. Jackson
Secretary-Treasurer
Proceedings Editor

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President

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Past-President

* The Statement of Financial Status will be compiled separately and mailed with the first newsletter following the Annual meeting.

Agenda
NDAS Symposium on the Little Missouri Grasslands

North Dakota Heritage Center

Thursday 9:45 - 12:45 p.m.

Grasslands

A symposium focusing on the proposed uses of the Little Missouri National Grasslands and the impacts of policy decisions.

Moderator: *Rich Barkosky,* Minot State University

9:45 Introductory remarks -- Rich Barkosky, Department of Biology, Minot State University

10:00 Jill Dechant*, Douglas H. Johnson, Christopher M. Goldade, and Lawrence D. Igl, U.S. Geological Survey, Northern Prairie Wildlife Research Center, Jamestown

10:25 Darla Lenz and Dan Svingen*, USDA Forest Service, Dakota Prairie National Grasslands Supervisors Office, Bismarck

10:50 Chad Prosser*, TEAM Leafy Spurge, USDA Agricultural Research Service, Sidney, Montana

11:15 Break

11:25 F. Larry Leistritz* and Dean Bangsund, Department of Agribusiness and Applied Economics, North Dakota State University, Fargo

11:50 Jeff DiBenedetto*, Linda A. Spencer, and John R. Lane, USDA Forest Service, Custer National Forest Supervisor's Office, Billings, Montana

12:15 Gerald Reichert*, The Nature Conservancy

12:30 **Discussion**

RESPONSES OF GRASSLAND BIRDS TO MANAGEMENT PRACTICES: LESSONS FROM THE LITERATURE

Jill A. Dechant, Douglas H. Johnson, Christopher M. Goldade, and Lawrence D. Igl
U.S. Geological Survey, Northern Prairie Wildlife Research Center, Jamestown, ND 58401

North American grasslands historically were maintained by fire, grazing by native ungulates, and a climate that generally discouraged woody vegetation. Since European settlement, North America's once vast grasslands have been greatly reduced. Some of the largest remaining grasslands in the United States are now managed by the U.S. Forest Service. The Forest Service is responsible for managing National Grasslands for multiple uses (*e.g.*, grazing, recreation), while at the same time maintaining the natural resources of the grasslands. To evaluate the effects of management on the avian component of those natural resources, managers must first understand the habitat requirements of birds. The effects of management on birds often are evaluated by relating measures of bird abundance and reproductive success to features of the vegetation, such as vegetation height, vegetation density, litter depth, and percentage cover of shrubs, forbs, and bare ground. We have summarized literature relating to the effects of management practices (*e.g.*, livestock grazing, prescribed fire) on grassland birds and describe our products, which are available to resource managers to aid in management decisions.

Since 1996, staff at the U.S. Geological Survey, Northern Prairie Wildlife Research Center (NPWRC), have reviewed both published and unpublished literature to summarize information on the habitat requirements of grassland-breeding birds and their responses to habitat management. Information has been summarized from more than 4000 papers. Species accounts have been written for 36 bird species. Managers and others may access the accounts on the World-Wide Web at http://www.npwrc.usgs.gov/resource/literatr/grasbird/grasbird.htm. The accounts are designed to aid managers in understanding the vegetation structure required by each species, and can provide an information base so that grazing and burning regimes can be manipulated to attain desired results.

The literature review has resulted in three products; the primary product is the series of 36 species accounts. Each account includes a range map; a capsule statement identifying key components for managing habitat for the species; a table of habitat requirements organized by author and state or province; sections on suitable habitat, area requirements, brood parasitism, breeding-season phenology, species' response to management, and management recommendations; and literature cited.

The second product is a searchable bibliography, located on the aforementioned Web site, in which original abstracts and annotations by NPWRC staff may be viewed. An abbreviated example of an entry occurs below.

The third product is a summary of the specific habitat requirements for each of the grassland-breeding species. A table, excerpted below (Table 1), allows comparison of habitat requirements among bird species. For example, Baird's Sparrows require vegetation that is moderate to tall in stature, sparse to moderately dense, with moderate forb cover, sparse to moderate litter, and low amounts of woody vegetation. Chestnut-collared Longspurs (*Calcarius ornatus*) require vegetation that is moderate in stature, sparse, with low to moderate forb cover, sparse litter, and low amounts of bare ground and woody vegetation. Dickcissels (*Spiza americana*) require vegetation that is moderate to tall in stature, moderate to highly dense, with low to high forb cover, low to moderate litter, and low amounts of bare ground and woody vegetation.

Despite the large number of articles reviewed (>4000), our knowledge of habitat requirements of grassland birds is far from complete. Further, some species have been studied in only one or a few areas or during a limited number of years. Certain species may respond to vegetative or other environmental features that were not measured in the studies. More detailed, long-term, and extensive studies will be necessary to understand more completely the habitat needs of grassland birds and how these birds respond to management practices. Nonetheless, the summaries developed by NPWRC provide managers with our best assessments based on extant literature.

A sample entry:

TITLE: **Passerine communities and bird-habitat relationships on prescribe-burned, mixed-grass prairie in North Dakota.**

AUTHOR Madden, E M.

SOURCE M.S. thesis Montana State University, Bozeman. 153 pp.

DATE 1996

ABSTRACT [as written by Author]: To more effectively manage remaining native grasslands and declining populations of prairie passerine birds, linkages between disturbance regimes, vegetation, and bird abundance need to be more fully understood Therefore, I examined bird-habitat relationships on northern mixed-grass prairie at Lostwood National Wildlife Refuge in northwestern North Dakota...

SUMMARY [as written by NPWRC]: The effect of prescribed fire on grassland bird populations was examined at Lostwood National Wildlife Refuge in northwestern North Dakota during 1993 and 1994. Predictive models to assess occurrence of selected species were based on vegetative characteristics. Baird's Sparrows (*Ammodramus bairdii*), Grasshopper Sparrows (*Ammodramus savannarum*), Le Conte's Sparrows (*Ammodramus leconteii*), Sprague's Pipits (*Anthus spragueii*), Western Meadowlarks (*Sturnella neglecta*), and Bobolinks (*Dolichonyx oryzivorus*) were absent from unburned areas. Baird's and Le Conte's sparrows and Bobolinks reached highest abundances 1-3 yr postfire. Species richness peaked 1-2 yr postfire. Sprague's Pipits and Grasshopper Sparrows were most abundant 2-3 yr postfire, but sometimes up to 7 yr. Savannah Sparrows (*Passerculus sandwichensis*) reached maximum abundance 6-7 yr postfire. Clay-colored Sparrows (*Spizella pallida*) and Common Yellowthroats (*Geothlypis trichas*) were most abundant >8 yr postfire. Savannah Sparrows and Brown-headed Cowbirds (*Molothrus ater*) showed no significant response to fire. Baird's, Grasshopper, and Le Conte's sparrows, Bobolinks, Sprague's Pipits, and Western Meadowlarks demonstrated a positive response to fire, increasing in abundance. Clay-colored Sparrows and Common Yellowthroats demonstrated a negative response.

Species richness was highest in areas experiencing many fire events and was lowest in unburned areas and areas <1 yr postfire. Prairies that had not been burned for long periods did not attract Baird's, Grasshopper, or Le Conte's sparrows, Bobolinks, Sprague's Pipits, or Western Meadowlarks. The author suggested that managers should provide for prairie areas with short (2-3 yr), moderate (4-7 yr), and long (8-10 yr) fire-return intervals.

Occurrence of Baird's Sparrows was positively associated with frequency of native grasses. Grass cover (44.4%), percent live vegetation (41.9%), frequency of native grasses (28%), and frequency of Kentucky bluegrass/native grasses (20%) were significantly higher at points where Baird's Sparrows were found. Shrub cover (20.1%), visual obstruction (16 cm), vegetation density (18.6), and frequency of snowberry/silverberry shrubs (1%) were significantly lower at occupied than at unoccupied point counts. Of seven vegetation variables, grass cover best predicted occurrence, followed by forb cover.

Occurrence of Sprague's Pipits was positively associated with frequency of native grasses (36%). Occupied point counts had significantly lower shrub cover (17.8%), visual obstruction (13 cm), and frequency of snowberry/exotic grasses (2%) than unoccupied counts. Occurrence was best predicted by visual obstruction.

[Detailed information for eight other species is included in the actual entry.]

Table 1. Vegetation requirements for three species of grassland-nesting birds.

Vegetative features	Baird's Sparrow	Chestnut-collared Longspur	Dickcissel
Mean vegetation height (cm)	14-30	15-23	20-98
Maximum height (cm)	30-43	unknown	150
Visual obstruction reading (cm)	6-21	6	14-82
Forb cover (%)	25	6-18	3-60
Shrub cover (%)	1-20	≤3	≤11
Bare ground (%)	unknown	1-15	≤16
Litter depth (cm)	<4	2	≤5

FAUNAL AND FLORAL INVENTORIES AND THEIR ROLE IN LAND MANAGEMENT DECISIONS ON THE DAKOTA PRAIRIE NATIONAL GRASSLANDS

Darla Lenz and Dan Svingen*
USDA Forest Service, Dakota Prairie National Grasslands Supervisors Office, Bismarck, ND

The Dakota Prairie Grasslands contains hundreds of plant and animal species. For most taxa, little information is available on habitat use or population levels and trends. This data gap hampers the Forest Service's land management ability. Under new budget and land management direction, the Dakota Prairie Grasslands will be increasing its emphasis on inventory and monitoring. This presentation discusses the role of inventory and monitoring in USDA Forest Service land management decisions, describes how projects are selected and funded, and presents an overview of inventory and monitoring program.

Current inventory and monitoring projects include: raptor nest surveys, raptor habitat use, prairie grouse habitat and population surveys, butterfly surveys, rare plant surveys, fish surveys, development of conservation assessments and strategies, prairie dog and small mammal surveys, western prairie fringed orchid monitoring, development of a rare plant habitat model, floristic quality assessments, and general vegetation mapping. The majority of these projects are being accomplished through partnerships with other agencies, contractors, or universities. Additional participation from North Dakota researchers, biologists and botanists is encouraged.

LEAFY SPURGE CONTROL -- EMPHASIZING INTEGRATED PEST MANAGEMENT

Chad Prosser*
TEAM Leafy Spurge, USDA Agricultural Research Service, Sidney, MT.

TEAM Leafy Spurge is a USDA-ARS research and demonstration program focused on the Little Missouri River drainage in Wyoming, Montana and Dakotas, and other spurge-infested drainages in the region. Its goal is to research, develop and demonstrate ecologically based integrated Pest Management strategies than can be used to achieve effective, affordable and sustainable leafy spurge control. Integrated Pest Management (IPM) combines management tools to provide more effective control than any single tool could produce. Biological control provides the foundation for TEAM Leafy Spurge's emphasis on an integrated approach. Biocontrol agents like *Apthona.spp* (flea beetles) are used with other tools – multi-species grazing, herbicides, etc. – for an effective, affordable and ecologically sustainable control. IPM offers the flexibility landowners need to devise different strategies for different situations.

TEAM Leafy Spurge has assembled some of the nation's most experienced leafy spurge researchers into a focused, goal-oriented team. This collaboration allows participants to share expertise, data and resources to more effectively work toward a common goal. This effort is based on a regional approach in evaluating the leafy spurge problem rather than on a local, or situation-by-situation basis.

ECONOMIC IMPACTS OF PROPSED CHANGES IN MANAGEMENT OF THE LITTLE MISSOURI NATIONAL GRASSLANDS IN NORTH DAKOTA

F. Larry Leistritz* and Dean A. Bangsund
Department of Agribusiness and Applied Economics, North Dakota State University, Fargo, North Dakota

Abstract

More than 1.1 million acres of National Grasslands, administered by the U.S. Forest Service, are located in North Dakota. Recently proposed changes in the management of these lands would reduce livestock grazing, restrict petroleum exploration and extraction, and constrain recreational access. This paper describes the methods and approaches used to estimate the direct and secondary economic impacts associated with changes in grazing, petroleum exploration and extraction, and recreation-tourism activities on the Little Missouri National Grasslands in North Dakota.

Introduction

The National Grasslands are located primarily in the Great Plains region and comprise several million acres, of which 1.1 million acres are located in North Dakota. These lands are administered by the U.S. Forest Service and historically have been used primarily for livestock grazing, while outdoor recreation (principally hunting) and petroleum production have long been important secondary uses. In 1999, the U.S. Forest Service proposed substantial changes in the management of the National Grasslands in North Dakota. Some specific effects of the proposed management plan would be to a) reduce livestock grazing (by 35 to 50 percent), b) restrict petroleum exploration and extraction, and c) restrict recreational access by declaring some areas off-limits to all motorized access and limiting motorized travel in the remaining areas to a limited number of designated travel routes (1). (Throughout this paper, the Draft Environmental Impact Statement (DEIS) by the U.S. Forest Service of 1999 is referenced. DEIS is used in this report to refer to the Draft Environmental Impact Statement with corresponding reference to page(s) cited.) These proposed changes have been a source of considerable concern for livestock producers and petroleum firms that depend heavily on the Grasslands, for hunters and other recreational users, and for local businesses and governments in the affected areas. At the same time, the proposed changes are supported by some national environmental groups, including the Sierra Club. Because the economic consequences of the proposed management changes are a major concern to individuals, industries, and governments which rely on the National Grasslands in North Dakota, the authors were engaged to assess the economic impacts of the proposed changes.

The purpose of this paper is to describe the methods and approaches used to estimate the direct and secondary economic impacts associated with changes in grazing, petroleum exploration and extraction, and recreation-tourism activities on the Little Missouri National Grasslands in North Dakota. The subsequent use of this information in the evolving debate over the future of the National Grasslands will also be described.

Affected Area

The Little Missouri Grasslands area is a semi-arid, sparsely populated region remote from major population centers (Figure 1). The primary industries are agriculture (largely cattle grazing and dryland wheat production) and petroleum exploration and production. Continuing trends of mechanization in agriculture have led to fewer and larger farms and to decreases in the area's population. The four counties that encompass the Little Missouri National Grasslands all lost population from 1980 to 1990 and again from 1990 to 1998 (Table 1). Employment trends in the area have been similar to those for population.

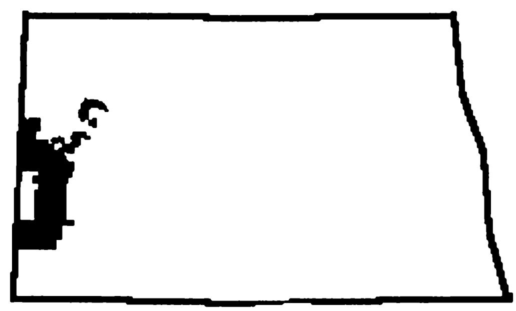

Figure 1. Little Missouri National Grasslands, North Dakota

Estimates of the economic base (*i.e.*, revenue received from outside the area) of the Little Missouri Grasslands area counties highlight the importance of agriculture and petroleum production to the region. The energy sector (gross receipts from sales of oil and gas) was the area's largest economic base sector in 1997, with revenues of $245 million representing 55 percent of the total economic base (Table 2). Agriculture was the second largest sector (and the largest in two individual counties) with total revenues from livestock and crop sales of $115 million, representing 26 percent of the area's economic base. Tourism is the fourth largest economic base sector, accounting for about 9 percent of the area's economic base in

1997. This sector has grown in recent years, with much of the increase associated with the growth of tourist-oriented businesses in Medora, a restored frontier town located adjacent to the Theodore Roosevelt National Memorial Park. The park is the area's major tourist attraction and offers visitors the opportunity to view Badlands scenery and native wildlife (*e.g.*, buffalo, prairie dogs).

The changes in management of the Little Missouri National Grasslands proposed in the Revised Management Plan were a source of major concern to area leaders. The proposed reductions in grazing and oil development posed direct threats to the two largest components of the region's economic base. These reductions might have major revenue implications for local governments as the area's counties and school districts rely heavily on oil-related revenues (local share of federal royalties and lease revenues and state energy taxes). Also, leaders were concerned that reduced grazing and energy activities would exacerbate recent trends of declining employment and population in the region.

Impact Assessment Methods

Evaluation of the economic effects of the proposed Revised Management Plan for the National Grasslands required several steps. First, direct economic impacts were determined by estimating the change in basic sector revenues associated with a change in National Grassland outputs. Subsequently, secondary economic impacts were estimated using input-output analysis. Finally, effects on local and state tax revenue and regional employment resulting from changes in outputs from the Little Missouri National Grasslands were estimated. While the Forest Service has described five alternatives (each with a different emphasis) in its planning documents (*1*), the analysis presented here focuses on Alternative 3, which has been identified as the U.S. Forest Service's preferred alternative.

Changes in the use of the National Grasslands will result in changes in revenues to various sectors of the North Dakota economy. An important element in determining the change in basic-sector revenues was estimating changes in the physical quantities of outputs derived from the National Grasslands. Changes in physical outputs were estimated by comparing levels of use under current National Grassland management to the estimated level of use under the proposed Revised Management Plan. Basic-sector revenues associated with the change in outputs from the National Grasslands were then estimated. To evaluate the economy-wide effects of changes in basic sector revenues, input-output analysis was used. The input-output model used in this study has 17 sectors and is based on primary (survey) data collected from firms and households (*2, 3*). The model is closed with respect to households (*i.e.*, households are included in the model) and the gross business volume (gross receipts) of the trade sectors is used (for both expenditures and receipts) rather than value added by those sectors.

Regional Economic Effects

The Little Missouri National Grassland, located in southwestern North Dakota, encompasses about 1,043,000 acres of Federal rangeland. Three industries are directly linked to the Little Missouri National Grasslands: **Agriculture**, through livestock grazing; **Energy**, through exploration and extraction of oil and natural gas; and **Tourism**, through both consumptive and nonconsumptive wildlife and nonwildlife-related recreational activities. The effects of the proposed Revised Management Plan were evaluated on an industry basis.

Effects of Alternative 3 on Grazing Activities

Grazing within the National Grasslands is predominately organized through the various grazing associations. Grazing associations are collective organizations through which ranchers negotiate with public agencies to secure/retain permission (permits) to graze cattle on public lands (*4*). The Medora, Little Missouri, Horse Creek, and McKenzie County Grazing Associations control livestock grazing on the Little Missouri National Grasslands (LMNG) in Slope, Golden Valley, Billings, and McKenzie Counties. The four grazing associations in the LMNG control about 1.8 million acres and 675,000 animal unit months (AUMs) of grazing (Table 3). An animal unit month is an average figure of the amount of forage needed to feed one animal unit (AU) for one month. An AU is typically considered a mature cow weighing approximately 1,000 pounds or an equivalent grazing animal(s) based on an average feed consumption of 26 pounds of dry matter per day (*5*). The grazing associations in the LMNG control about 70 percent of the grazing land and AUMs in Billings, Slope, Golden Valley, and McKenzie Counties. Public lands collectively produce about 44 percent of the estimated grazing output in Billings, Slope, Golden Valley, and McKenzie Counties.

Changes in Federal grazing in the Little Missouri National Grasslands under Alternative 3 were estimated to range from a 36.5 to 48 percent decrease from permitted levels, based on permitted grazing levels reported by the Medora, Horse Creek, Little Missouri, and McKenzie County Grazing Associations (Table 4). A change in Federal grazing capacity (stocking rates) affects much of the land under grazing association control. Due to the complexities of the rules governing the use of Federal, state, and private lands within each grazing association, the various grazing associations provided the acreage and AUMs of private and state grazing lands that would be affected by a change in the Federal stocking rate for the National Grasslands. Data provided on lands affected by Federal stocking rates was based entirely on the rules and by-laws governing the associations.

Changes in Federal stocking rates would affect more than one million acres of Federal rangeland in the Little Missouri National Grasslands. According to the grazing associations, 281,000 acres or 43 percent of private land controlled by the associations also would be affected. In addition, about 46,000 acres or 47 percent of state land controlled by the associations would be affected. Total acreage affected would equal 1.4 million acres or 77 percent of all lands controlled by the grazing associations. The amount of land affected (in total and in percentage) by Federal grazing rates in the various associations would not be equal, as about 86, 52, and 84 percent of all lands under the Medora, Little Missouri and Horse Creek (combined), and McKenzie County Grazing Associations would be affected, respectively.

Collective grazing capacity on Federal, state, and private lands would be reduced by 187,300 AUMs to 246,600 AUMs, high and low estimate in Alternative 3, respectively (Table 5). The levels of grazing reduction in Alternative 3 result in a 28 to 37 percent decrease in total grazing capacity within the grazing associations.

Changes in grazing capacity were assumed to have corresponding changes in herd size. Decreases of 187,308 AUMs (137,221 Federal and 50,087 state and private) under the high level in Alternative 3 in the Little Missouri National Grasslands would translate to a reduction of 17,575 cow-calf equivalent units (Table 5). Decreases of 246,639 AUMs (180,675 Federal and 65,964 state and private) under the low level in Alternative 3 would translate to a reduction of 23,143 cow-calf equivalent units (Table 5).

Direct and Secondary Economic Effects of Grazing Changes

The economic impact of the proposed Revised Management Plan for the Little Missouri National Grasslands was measured by first estimating the **direct effects** on sales/receipts in affected sectors (*i.e.*, through changes in cow-calf production which translate to reductions in livestock sales) and then applying these direct effects to the interdependence coëfficients of the input-output model. The resulting estimates indicate the **total** (direct plus secondary) changes in gross business volume (gross receipts) for each economic sector that are expected to result. Estimates of a change in secondary employment that may result are obtained by applying ratios of gross business volume to employment (derived from historical relationships) for each sector to the changes in gross business volume.

Direct effects of a reduction in Federal grazing were based on a reduction in basic sector revenues (*i.e.*, sales to final demand) associated with a reduction in cow-calf herds. Production coefficients for cow-calf operations in western North Dakota were used with a 10-year average (1989 through 1998) of livestock prices received by producers in North Dakota to estimate basic sector revenues (sales to final demand) lost with a reduction in cattle numbers (North Dakota Farm and Ranch Business Management *various years*, N.D. Agricultural Statistics Service *various years*).

Grazing reductions in the Little Missouri National Grasslands translated into basic sector revenue decreases of $6.5 million to $8.6 million annually for the high and low level grazing scenarios, respectively (Table 6). Reductions in livestock sales, which represent direct economic impacts, were allocated to the *Agricultural-livestock* sector of the North Dakota Input-Output Model. A decrease in livestock sales of $6.5 million and $8.6 million in the Little Missouri National Grasslands would generate $22.8 million and $30 million in <u>secondary</u> economic impacts in the region, respectively (Table 6).

The <u>annual</u> loss in gross business volume (direct and secondary effects) in the region resulting from a reduction in grazing activities under Alternative 3 in the Little Missouri National Grasslands ranged from $29.3 million to $38.5 million (Table 6). The economic sectors of the regional economy that had the greatest overall economic impact included: *Agriculture-livestock* ($7.9 million to $10.4 million), *Households* (which represents economy-wide personal income) ($6.8 million to $9 million), *Retail Trade* ($4.6 million to $6.1 million), *Agriculture-crops* ($2.6 million to $3.4 million), and *Finance, Insurance, and Real Estate* ($1 million to $1.3 million). Losses in secondary employment within the region were estimated to range from 282 to 364 full-time equivalent jobs (Table 6).

A portion of the grazing fees levied on Federal lands is returned to the counties. The amount of lost local government revenues from the intergovernmental transfer of grazing fees was estimated to range from $46,400 to $61,000 annually for the counties within the Little Missouri National Grasslands. Lost local government revenues from reduced collections of grazing fees on Federal lands were included in Table 9.

The effect on state tax collections resulting from reduced grazing activity in the Little Missouri National Grasslands under Alternative 3 of the proposed Revised Management Plan was estimated. Input-output analysis was used to estimate personal income, retail trade, and other business activity, which was used with tax collection coefficients to estimate tax revenue. Annual decreases in estimated tax revenues to the state from grazing reductions in the Little Missouri National Grasslands ranged from $213,000 to $281,000 in sales and use taxes, $89,000 to $117,000 in personal income taxes, and $35,000 to $46,000 in corporate income taxes (Table 6). Total reduction in annual state collections from sales and use, personal income, and corporate income taxes ranged from $337,000 for the high level of grazing in Alternative 3 to $444,000 for the low level of grazing in Alternative 3.

Effects of Alternative 3 on Energy Activities

Energy activities in the Little Missouri National Grasslands include oil and natural gas exploration and extraction. A number of provisions in the proposed Revised Management Plan indicate that substantial restrictions on energy activities are likely under Alternative 3. Alternative 3 will place surface occupancy and timing restrictions on substantial acreages within the Little Missouri National Grasslands. Additional restrictions on energy activities will result from special use areas, such as back country recreation, roadless areas, and bighorn sheep habitat. Other factors potentially affecting energy activities included no net gain in roads and no new utility corridors (preventing electricity and pipelines needed for energy extraction activities).

The Oil and Gas Division of the N.D. Industrial Commission and the North Dakota Geological Survey have studied the provisions of Alternative 3 with regards to its effect on oil and gas activities in the Little Missouri National Grasslands. Information from Oil and Gas Division *(6)* and North Dakota Geological Survey (*7*) provided the basis for this study's assessment of the economic effects of Alternative 3 on energy activities in the Little Missouri National Grasslands. Changes in physical outputs were determined by comparing estimated future energy production under current National Grassland management to the estimated future level of production under Alternative 3 of the proposed Revised Management Plan.

The reports cited above (*6, 7*) estimated that the provisions in Alternative 3 would eliminate the drilling of 103 wells in the Little Missouri National Grasslands over the 10 years that the proposed Plan would be enforced. Of the 103 wells eliminated, 77 percent was assumed to be successful in producing oil and natural gas. A declining production schedule, typical of oil and natural gas output for wells in the area, was used to estimate 10-year total oil production per well. Each producing well was expected to generate 190,193 barrels of oil over 10 years and produce one MCF (one thousand cubic feet) of natural gas for each barrel of oil produced. About 68 percent of a producing well's 10-year output would occur in the first three years of production *(6)*.

The exact number of wells eliminated in any particular year was impossible to determine, since drilling activity in any given year is related to a number of factors outside the scope of the Oil and Gas Division study *(6)*. Thus, the Oil and Gas Division averaged the number of wells eliminated over 10 years. Averaging the number of wells over 10 years yielded 10.3 drilled wells or about 7.9 producing wells eliminated annually within the boundaries of the Little Missouri National Grasslands. However, since wells were assumed to produce oil and gas annually for 10 years, some lost production from producing wells would occur for nine years after the 10-year period of the proposed management plan. For example, a well that would start producing in year 8 of the 10-year management plan would continue to produce oil for 7 years after the end of the 10-year plan. As a result, oil and natural gas production was scheduled for nine years beyond the end of the 10-year plan to capture full production from producing wells that started in years 2 through 10 of the management plan. The loss of oil and natural gas production was estimated annually for 19 years, based on a 10-year declining production schedule per well. Total lost oil production under Alternative 3 within the boundaries of the Little Missouri National Grasslands was estimated at 15,087,207 barrels of oil and 15,087,207 MCF of natural gas over 19 years (Table 7).

The amount of lost energy production was estimated for Billings, McKenzie, Slope, and Golden Valley Counties *(6)*. Of the lost energy production in the Little Missouri National Grasslands, about 37, 33, 23, and 7 percent would occur in Billings, McKenzie, Slope, and Golden Valley Counties, respectively.

The distribution of lost energy activities was estimated by land ownership *(6)*. About 67 percent of the reduction in energy activities was estimated to occur on Federal lands in each of the four counties (Table 7). Lost energy production from state lands was estimated at 5.7 percent in each county (*6*). The remaining 27.3 percent of lost production was assumed to occur on private land.

Economic Impacts of Changes in Energy Extraction

The economic impacts of a reduction in energy activities under Alternative 3 were divided into regional effects and effects on revenues received by county, state, and Federal treasuries. Annual losses in oil and natural gas revenues (*i.e.*, sales to final demand) were based on the volume of production eliminated and the expected value of oil and natural gas outputs. A price of $20 per barrel for oil and $2 per MCF of natural gas was used for all years *(6)*. The per unit values used in this study represented 7-year averages of the current expected future prices for oil and natural gas *(6)*.

Due to the declining production schedule per well and the even distribution of lost wells over the 10-year length of the proposed management plan, the majority (80 percent) of energy production eliminated occurs in the first 10 years (Figure 2). The remaining 20 percent occurs in the nine years following the end of the proposed management plan. The reduction in energy sector sales/receipts under Alternative 3 in the Little Missouri National Grasslands was averaged over two periods. The first period (Period I) represented the 10 years of the management plan (Figure 2). This period represented the time frame when well drilling and producing wells were eliminated. The second period (Period II) represented the time frame required (9 years) to capture lost production from wells that would have started producing during the 10-year management plan (Period I).

Reductions in energy sector sales, which represent direct economic impacts, were allocated to the *Oil Exploration and Extraction* sector of the North Dakota Input-Output Model. A decrease in energy sector sales of $26.5 million annually for Period I and $7.4 million annually for Period II would generate $24.5 million and $6.8 million in annual secondary economic impacts in the region, respectively (Table 8). Energy activities eliminated in the Little Missouri National Grasslands under Alternative 3 decreased total basic sector revenues by $331.9 million over 19 years. Direct employment losses in the Little Missouri National Grasslands were estimated at 0.75 FTE job per producing well and 3.5 FTE per well drilled *(6)*. Total direct jobs lost from producing wells would range from 5.9 FTE in year one to 59 FTE in year 10 of Period I. Average annual employment lost from producing wells would be 32.7 in Period I. Total direct jobs lost due to the elimination of drilling activities was estimated at 36.1 FTE per year in Period I. Total annual reductions in employment would be about 68.8 FTE during the Period I.

The annual loss in gross business volume (direct and secondary effects) in the region resulting from a reduction in energy activities under Alternative 3 in the Little Missouri National Grasslands ranged from $51 million during Period I to $14.2 million in Period II (Table 8). The following economic sectors of the regional economy had the greatest overall annual economic impact: *Petroleum Exploration and Extraction* ($29 million—Period I to $8.1 million—Period II), *Households* (which represents economy-wide personal income) ($8.5 million-Period I to $2.4 million—Period II), *Retail Trade* ($4.9 million—Period I to $1.4 million—Period II), *Construction* ($3 million—Period I to $0.8 million–Period II), and *Communication and Public Utilities* ($1.4 million—Period I to $0.4 million—Period II). Losses in secondary employment within the region were estimated to range from 388 full-time equivalent jobs per year in each of the first 10 years to 93 jobs per year in each of following 9 years (Table 7).

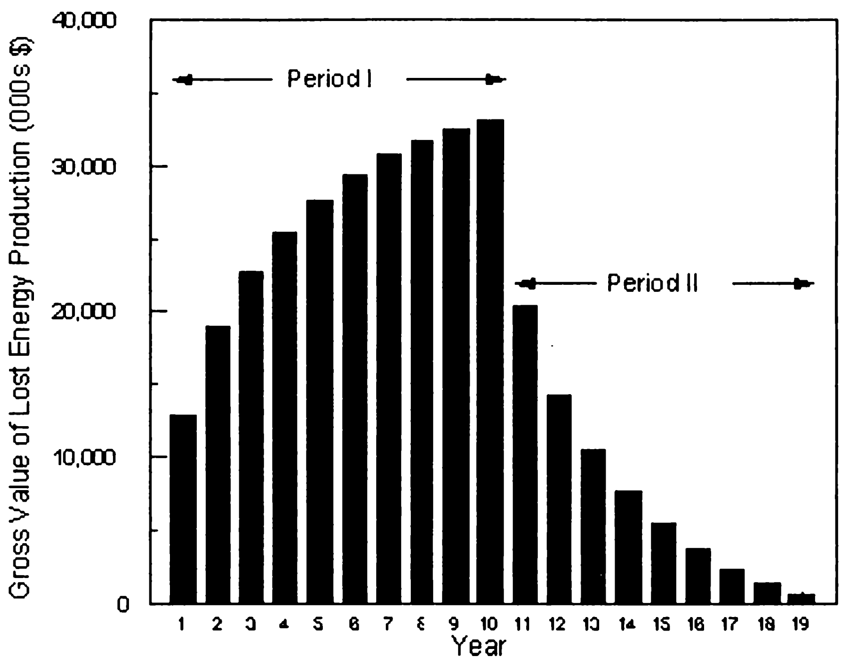

Figure 2. Estimated Loss in Energy Sector Sales by Year, Little Missouri National Grasslands, Alternative Three

Input-output analysis was used to estimate personal income, retail trade, and other business activity, which was used with tax collection coefficients to estimate tax revenue from state general taxes. Annual decreases in estimated tax revenues to the state from reductions in energy activities in the Little Missouri National Grasslands ranged from $226,000 (Period I) to $63,000 (Period II) in sales and use taxes, $111,000 (Period I) to $31,000 (Period II) in personal income taxes, and $128,000 (Period I) to $36,000 (Period II) in corporate income taxes (Table 8). Total reduction in annual state collections from sales and use, personal income, and corporate income taxes ranged from $464,000 for Period I to $130,000 for Period II.

A number of revenue streams arise out of energy production in North Dakota. These revenue streams include state energy taxes (oil and gas gross production tax and oil extraction tax), royalties on production from state-owned lands, royalties retained by county governments on some Federal lands, portions of Federal royalties returned to the state and counties from oil and gas production on Federal lands, and revenues from Federal mineral leases and bonuses.

As a result of energy production eliminated by Alternative 3 in the Little Missouri National Grasslands, North Dakota would not collect, over 19 years, $14.2 million in oil and gas gross production taxes and $5.5 million in oil extraction taxes. Combined energy tax collections lost would equal $19.7 million. Other revenues lost, over the 19 years, to the North Dakota treasury would include a loss of $3.2 million in state royalties on oil and gas production on state-owned lands, $5.3 million from North Dakota's share of Federal royalties from energy production on Federal Public Domain lands, and $2.1 million from North Dakota's share of Federal mineral leases and bonuses on Federal Public Domain lands. However, not all revenues accruing to the state treasury are retained by the state. The state redistributes a portion of its share of royalties, leases, and bonuses from Federal Public Domain lands back to the producing counties. Also, portions of the gross production tax are returned to counties, cities, and school districts within the producing counties. Thus, net revenues retained (after redistributing revenues back to local governments) from all sources were estimated at $24.9 million over 19 years (Table 9).

Similar to revenues accruing to North Dakota, the Federal treasury also collects revenues from energy production on Federal Acquired and Public Domain lands in the form of royalties, leases, and bonuses. In addition to lost revenues from oil activities, the Federal treasury collects grazing fees from the Little Missouri National Grasslands. The net revenues retained (*i.e.*, after redistributing those revenues to North Dakota and counties in the Little Missouri National Grasslands) by the Federal treasury that would be lost under Alternative 3 were estimated at $26.4 million over 19 years (includes only 10 years of lost grazing fees) (Table 9).

Billings, Golden Valley, McKenzie and Slope Counties each receive revenues to their treasuries from oil production within their respective county and from energy production on Federal Acquired lands in all counties in the Little Missouri National

Grasslands. Revenues to county governments can accrue from county royalties retained on some Federal Acquired lands (*i.e.*, Billings and McKenzie Counties), redistribution of the county's share of Federal royalties from energy production on Federal Acquired lands, redistribution of the county's share of the state share of Federal royalties on Federal Public Domain lands, redistribution of state oil and gas gross production taxes, redistribution of Federal mineral leases and bonuses from Federal Acquired lands, redistribution of the county's share of the state share of Federal mineral leases and bonuses from Federal Public Domain lands, and redistribution of grazing fees collected on Federal grazing lands. In addition to county government revenues, cities and school districts within oil producing counties receive some revenues from the state oil and gas gross production tax. Total government revenues accruing to Billings, Golden Valley, McKenzie, and Slope Counties, over 19 years (includes only 10 years of grazing fee collections), were estimated at \$3.4 million, \$0.8 million, \$5 million, and \$2.4 million, respectively (Table 9).

Effects of Alternative 3 on Tourism

The tourism sector was the fourth largest sector of the area's economic base in 1997 and has been a growing sector during the past decade (Coon and Leistritz, *unpublished data*). Unfortunately, little quantitative information is available concerning tourism activities in the region (*e.g.*, origins of visitors, length of stay, types of activities engaged in). Information regarding the role of the Little Missouri National Grasslands in visitors' activities is particularly lacking. Local informants and state tourism officials, however, agree that most tourism activity in the Little Missouri Grasslands area is directly or indirectly associated with events and attractions in and around Medora, with visitation at Theodore Roosevelt National Park, with outdoor activities (*e.g.*, hunting, camping, backpacking, trail rides, canoeing), and general sightseeing. The four-county area encompasses the heart of the North Dakota Badlands region, which is generally viewed as a weekend destination for state residents and a stopover attraction for persons from outside the region (who may be traveling to or from other attractions such as Yellowstone or Glacier National Parks). Two major U.S. highways (I-94 and U.S. 85) pass through the four-county area.

The role of the Little Missouri National Grasslands in these tourist activities is not clear, as little information is available concerning recreational use of the Grasslands. The U.S. Forest Service (*1*) reports that the two activities most often reported by Grasslands visitors are hunting and motorized sightseeing, but little other information is available.

The U.S. Forest Service's DEIS (*1*) indicates that recreational use of the Little Missouri National Grassland should be enhanced by the actions proposed under Alternative 3. Major effects are indicated to be (a) enhanced wildlife habitat and populations and (b) greater variety of recreational opportunities (*e.g.*, primitive camping, picnicking, wildlife viewing, wildflower viewing, hiking, backpacking, mountain biking, and horseback riding). However, many local leaders question how more diverse vegetation and landscapes would translate into greater levels of participation in those activities, particularly because the Little Missouri National Grasslands is located in a very sparsely populated area remote from major population centers. Questions also may be raised concerning the local economic impact of these types of recreational activities. Keith and Fawson (*8*) surveyed wilderness users in Utah and found that their expenditures were not sufficiently large to influence county economies.

On the other hand, the proposed restrictions on motorized access to the Grasslands may curtail some traditional uses (particularly hunting). In a number of areas, totaling more than 170,000 acres, no motorized use (except administrative use) would be allowed, and motorized travel would be subject to seasonal restrictions on an additional 118,000 acres. On the remainder of the Grasslands, motorized travel would be restricted to designated routes (*i.e.*, hunters could not leave the designated roads, even to retrieve game). Another consideration is that the population base in North Dakota and the Upper Great Plains is aging, yet many of the outdoor activities suggested by the U.S. Forest Service as potentially increasing on the National Grasslands do not appear to be activities quickly adopted by aging individuals (*e.g.*, mountain biking, backpacking, primitive camping).

Because of the lack of information about the composition of tourism and recreation activities in the Little Missouri National Grasslands area and the role of the National Grasslands in attracting visitors, as well as the uncertainties regarding the effects of Alternative 3 on tourism in the area, no quantitative estimates were developed of the economic effects of changes in tourism that might result from implementation of the Revised Plan. Instead, comparisons of the amount of local and regional expenditures from recreation that would be required to compensate local and regional economies for reductions in basic sector revenues from livestock grazing and petroleum production were provided. Recreation associated with the National Grasslands within Billings County would need to generate \$11.6 to \$12.2 million in additional local (*i.e.*, captured by residents/businesses within the county) expenditures annually to compensate the county's economy for reductions in basic sector revenues from livestock grazing and petroleum production. Similarly, recreation-based expenditures would have to increase by \$11.9 million to \$12.9 million to offset losses in McKenzie County. Local recreation expenditures would need to increase by \$9.5 million to \$10 million annually in the Slope and Golden Valley Counties' economy. Thus, local expenditures from recreation on the Little Missouri National Grasslands would need to increase by \$33 million to \$35 million (sustained annually) in order to offset annual losses in basic sector revenues from livestock grazing and petroleum production. Increases of this magnitude appear very unlikely to occur. Indeed, the authors consider an overall negative effect on area tourism to be as likely to result from the Revised Plan as a positive effect.

Implications of Findings

Based on the analysis summarized above, it is clear that the proposed Revised Management Plan (Alternative 3) would have very substantial effects on two of western North Dakota's key basic industries — agriculture and petroleum. The livestock sector in the affected counties is heavily dependent on grazing obtained from the National Grasslands, and the proposed plan would reduce the overall county-wide (*i.e.*, across all Federal, state, and private grazing lands) grazing capacity in those counties by 20 to 26 percent. Substantial reductions in livestock production and sales would result in major secondary effects on other sectors of the regional economy. The total secondary (multiplier) effects on the regional economy are estimated to range from $23 million to $30 million. This level of economic activity would support from 282 to 364 secondary jobs in various sectors.

The impacts on the petroleum sector are estimated to be equally severe. The restrictions embodied in Alternative 3 are estimated to result in 103 fewer wells being drilled during the 10-year period that the Plan is assumed to be in effect. Of the 103 wells eliminated, 79.3 are assumed to be producing wells, which would result in about 15.1 million barrels of oil and 15.1 million MCF of natural gas production being eliminated. The average annual impact of these reductions in petroleum sector output during the ten years that the Plan is assumed to be in effect (Period I) includes a reduction in petroleum sector revenue of $26.5 million, a further $24.5 million in secondary economic impacts, and a loss of about 388 secondary jobs, in addition to 69 direct jobs in oil exploration and extraction that were estimated to be lost.

In conclusion, the proposed Plan (Alternative 3) would have very substantial negative effects on the livestock and petroleum sectors — sectors which have traditionally been the pillars of the affected counties' economies. The reduction in livestock and energy sector sales resulting from Alternative 3 would represent about a 7.5 percent decrease in the total economic base of the Little Missouri National Grasslands region. The total economic impact of these losses would result in a decrease in gross business volume in the region of $80 to $90 million annually and a loss of 740 to 820 jobs in the area economy. While not all of these job losses would occur in the four-county area (some would occur in trade centers located in neighboring counties), these losses represent 15 to 17 percent of the area's total employment in 1998. Whether the Plan would have positive or negative effects on the tourism sector is unclear at this point, but positive effects on tourism sufficient to offset more that a small fraction of the reductions in the livestock and petroleum sectors seems highly unlikely.

Use of Findings in Public Decision-making

The Forest Service released the proposed Plan in July 1999. Within a few weeks, leaders in the Little Missouri National Grasslands area had become alarmed about the possible implications of the Plan and had organized a coalition (Heritage Alliance of North Dakota or HAND). HAND held a series of meetings with the North Dakota Governor and members of the Congressional delegation, who pointed out that an evaluation of the regional economic impacts of the Plan would be critical to ultimate decisions regarding its acceptability. In August 1999, HAND engaged the authors to conduct the economic impact study.

The study was completed in early December, 1999 and was the subject of briefing sessions for the Congressional delegation and the Governor's staff, as well as a press conference organized by HAND. Since that time, the findings have been presented to numerous regional groups and gatherings. At the time of this writing (April 2001), no decision regarding the acceptability of the Plan has been announced. However, a revised Plan is due to be released in May 2001.

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Table 1. Population and Employment of Counties encompassing the Little Missouri National Grasslands, North Dakota

County	Population *1980*	*1990*	*1998*
Billings	1,138	1,108	1,058
Golden Valley	2,391	2,108	1,876
McKenzie	7,132	6,383	5,682
Slope	1,157	907	865
Total	11,818	10,506	9,481
	Employment		
	1986	*1996*	*1998*
Billings	791	564	508
Golden Valley	1,031	915	851
McKenzie	3,080	3,173	3,112
Slope	463	397	392
Total	5,365	5,049	4,863

Table 2. Economic Base of Counties encompassing the Little Missouri National Grasslands, 1997

	Sector					
County	***Agric.***	***Gov't***	***Energy***	***Mfg.***	***Tourism***	***Total***
	$ million (1997)					
Billings	15.0	3.0	115.7	0.0	22.4	156.1
Golden Valley	27.3	8.0	8.4	1.3	2.0	47.0
McKenzie	46.4	29.5	115.4	2.9	15.3	209.5
Slope	26.5	2.7	5.8	0.3	0.8	36.1
Total	115.2	43.2	245.3	4.5	40.5	448.7
	percent					
Billings	9.6	1.9	74.1	0.0	14.3	100.0
Golden Valley	58.1	17.0	17.9	2.8	4.2	100.0
McKenzie	22.1	14.1	55.1	1.4	7.3	100.0
Slope	73.4	7.4	16.1	0.8	2.2	100.0
Total	25.7	9.6	54.7	1.0	9.0	100.0

Table 3. Private, State, and Federal Grazing Acres and Animal Unit Months under Grazing Association Control, Little Missouri National Grasslands, North Dakota, 1998*

	County Totals		Controlled by associations	
Land	***Acres***	***AUMs***	***Acres***	***AUMs***
Federal	1,043,421	377,298	1,037,226	376,220
State	147,737	49,127	98,288	32,875
Private	1,316,909	534,782	646,643	266,135
Total	2,508,067	961,207	1,782,157	675,230

*Data in table represent potential AUMs produced and controlled based on average land productivity and grazing conditions in the various counties only. Actual AUMs grazed will differ from AUMs controlled in any particular grazing season. Grazing estimates did not include the grazing of crop aftermath.

Table 4. Change in Federal Grazing, Alternative Three, Proposed Revised Management Plan, Little Missouri National Grasslands

	1998 Permitted	Estimated Range of Grazing Use[b]		Percentage Change[c]	
Area	AUMs[a]	High	Low	High	Low
Medora District	189,497	120,917	98,932	-36.2	-47.8
McKenzie District	186,329	117,833	96,409	-36.8	-48.3
Total	**375,826**	**238,750**	**195,341**	**-36.5**	**-48.0**

[a] Permitted AUMs reported by grazing associations.

[b] Estimated grazing use reported by U.S. Forest Service adjusted to reflect current animal units per cow-calf pair. Does not represent guaranteed grazing use. Allocation of grazing use by the U.S. Forest Service within the various districts may vary from estimates presented when actual grazing levels are set in the site-specific allotment management planning process (*1*).

[c] Based on comparing estimated grazing use reported by the U.S. Forest Service to permitted AUMs reported by grazing associations.

Table 5. Land, AUMs, and Cow-Calf Equivalent Pairs Affected, Little Missouri National Grasslands, Alternative Three, Proposed Revised Management Plan, North Dakota

Land Ownership	*Amount of Production* Current Acres (000s)	AUMs (000s)	Acres Affected (000s)	Change from Current Situation Under Alternative 3 High	Low	High	Low
				AUMs (000s)		AUMs (000s) (% change)	
Federal	1,037	376	1,037	238	195	-137 (-36.5)	-180 (-48.0)
State	98	32	46	23	20	-9 (-29.5)	-12 (-38.8)
Private	646	266	280	225	212	-40 (-15.2)	-53 (-20.0)
Total	1,782	675	1,364	487	428	-187 (-27.7)	-246 (-36.5)
	—— number of head ——						
Cow-calf equivalent Pairs	63	na	na	45	40	-17	-23

Table 6. Annual Loss in Regional Economic Activity from Grazing Reductions, Alternative Three, Proposed Revised Management Plan

Economic Measure	*High Grazing Est.* — *000s $* —	*Low Grazing Est.* — *000s $* —
Lost Livestock Sales	6,518	8,579
Secondary Economic Effects	22,764	29,962
Gross Business Volume	29,282	38,541
State Tax Collections		
Sales and Use	213.3	280.8
Personal Income	88.6	116.7
Corporate Income	35.4	46.4
Total	337.3	443.9
Secondary Employment Lost (FTE)	282	364

Table 7. Energy Production Eliminated, Alternative Three, Proposed Revised Management Plan, Little Missouri National Grasslands

Item	*Amount*	
Drilled Wells Eliminated	103	
Producing Wells Eliminated	79.3	
Oil Production per Producing Well	190,193	barrels
Natural Gas Production per Producing Well	190,193	MCF
Total Oil Production Eliminated	15,084,200	barrels
Total Natural Gas Production Eliminated	15,084,200	MCF
Oil Production Eliminated on Federal Lands	10,106,400	barrels
Public Domain	3,864,300	barrels
Acquired Lands	6,242,100	barrels
Natural Gas Production Eliminated on Federal Lands	10,106,400	MCF
Public Domain	4,062,600	MCF
Acquired Lands	6,043,800	MCF
Oil Production Eliminated on State Lands	859,800	barrels
Natural Gas Production Eliminated on State Lands	859,800	MCF
Oil Production Eliminated on Private Lands	4,118,000	barrels
Natural Gas Production Eliminated on Private Lands	4,118,000	MCF

Table 7. Energy Production Eliminated, Alternative Three, Proposed Revised Management Plan, Little Missouri National Grasslands

Item	***Amount***	
Drilled Wells Eliminated	103	
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Total Oil Production Eliminated	15,084,200	barrels
Total Natural Gas Production Eliminated	15,084,200	MCF
Oil Production Eliminated on Federal Lands	10,106,400	barrels
Public Domain	3,864,300	barrels
Acquired Lands	6,242,100	barrels
Natural Gas Production Eliminated on Federal Lands	10,106,400	MCF
Public Domain	4,062,600	MCF
Acquired Lands	6,043,800	MCF
Oil Production Eliminated on State Lands	859,800	barrels
Natural Gas Production Eliminated on State Lands	859,800	MCF
Oil Production Eliminated on Private Lands	4,118,000	barrels
Natural Gas Production Eliminated on Private Lands	4,118,000	MCF

Sources: (*6*) and unpublished U.S. Forest Service data.

Table 8. Annual Loss in Regional Economic Activity from Energy Sector Reductions, Alternative Three, Proposed Revised Management Plan, Little Missouri National Grasslands, North Dakota

Economic Measure	***Period I***[a]	***Period II***
	000s $	
Energy Sales	26,525	7,401
Secondary Economic Effects	24,524	6,844
Gross Business Volume	51,049	14,244
State General Tax Collections		
Sales and Use	225.7	63.0
Personal Income	110.5	30.9
Corporate Income	127.8	35.7
Total	464.0	129.6
Secondary Employment Lost (FTE)	388	93

[a] Period I is for 10 years of the management plan and Period II represents the nine years following Period I.

Table 9. Total Gross and Net Government Royalties, Energy Taxes, and Grazing Fees Eliminated with Reduced Energy Production and Livestock Grazing, Alternative Three, Proposed Revised Management Plan, Little Missouri National Grasslands

Government/Revenue Source	Total Revenues to Government Treasuries Gross[a]	Net[a]
	000s $	
North Dakota		
Royalties from State-owned Lands	3,153	3,153
Share of Federal Royalty on Public Domain Lands	5,338	3,390
Share of Federal Mineral Lease/Bonus on Public Domain Lands	2,058	1,441
Oil and Gas Gross Production Taxes	14,232	11,433
Oil Extraction Tax	5,453	5,453
Totals	30,234	**24,870**
Federal Government		
Grazing Fee Collections[b]	2,148	1,611
Royalties on Public Domain Lands	10,676	5,338
Royalties on Acquired Lands	16,582	12,437
Mineral Leases/Bonuses on Federal Lands	10,765	7,045
Totals	40,171	**26,431**

Counties	Loss of Grazing Fees (000s $) (over 10 years)		Energy & Grazing
Billings	121 - 161	na	3,386 - 3,426
Golden Valley	41 - 54	na	808 - 821
McKenzie	232 - 304	na	4,985 - 5,057
Slope	70 - 92	na	2,401 - 2,423
Totals	**464 to 610**		**11,580 - 11,726**

na - not applicable.

[a] Gross revenues were estimated before the revenues were redistributed to other governments. Net revenues represent gross revenues less the amount of revenues redistributed to the various counties and/or state.

[b] Grazing fee collections based on 10 years. Federal revenues listed were an average of the collections lost between the high and low levels of grazing in Alternative 3.

A STATE AND TRANSITION CLASSIFICATION FOR MIXED GRASS PRAIRIE HABIT TYPES

Jeff DiBenedetto*, Linda Ann Spencer, and John R. Lane
USDA Forest Service, Custer National Forest Supervisor's Office, Billings, Montana

State and transition models have been discussed in the literature for several years. They have become an accepted means for communicating successional relationships with disturbance processes and ecological functions on rangelands. Identification, classification, and description of various vegetation states and pathways associated with ecological sites or habitat types are important for understanding rangeland capability differences. Most traditional habitat type and ecological site classifications have focused on historic climax plant community descriptions. Few published examples exist in which vegetation states associated with various disturbance processes have been catalogued for a single site. The purpose of this project was to identify and classify the successional vegetation states associated with habitat types of the mixed grass prairie of western North Dakota.

Existing plot data were used for the classification to take advantage of past sampling and avoid the high costs of acquiring new data. Over 4,000 plot records from various sampling efforts during the period 1987-1999 were screened for accuracy and completeness. Of these, 2,467 acceptable plot records were sorted by habitat type and grouped into dominance types based on dominant and co-dominant species. Dominance types were grouped based on plant functional characteristics (annual, perennial, biennial; warm season, cool season; short-, mid-, or tall-grass) of the dominant species. The classification resulted in 55 vegetation states for eight grassland habitat types and 52 vegetation states for 13 shrubland habitat types. The classification provides resource managers information about capability of habitat types to support different plant communities and to evaluate their influence on ecological functions.

THE NATURE CONSERVANCE AND CONSERVATION BY DESIGN: A FRAMEWORK FOR MISSION SUCCESS

Gerald Reichert*
The Nature Conservancy

With the accelerating loss of the Earth's biological heritage and the impairment of critical ecological processes that support life on the planet, the work of The Nature Conservancy on an international scale and within the state of North Dakota could not be more important or compelling.

The mission of The Nature Conservancy is to preserve the plants, animals, and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive.

This framework translates the Conservancy's broadly stated mission into a unifying articulation of common purpose and direction – a compass bearing to align the organization in taking the most effective conservation action to achieve tangible, lasting results. It sets forth:

A clear, concise VISION for accomplishing success;
An ambitious GOAL for the year 2010 to make the necessary progress towards fulfilling this vision;
An overview of our integrated APPROACH for achieving this goal;
An outline of the MEASURES we use to monitor our organizational progress;
A description of the unique VALUES that characterize The Nature Conservancy's conservation work.

We call this framework for mission success CONSERVATION BY DESIGN.

The task of conserving biological diversity represents an extraordinary challenge. Here in North Dakota we face laws that the conservation community faces nowhere else in the United States. If our sense of place or that last great place, is within the states geographical boundaries our challenge is even more complicated, not by the values we as a community hold in these places but by the path we as individuals took in developing our values in those places.

Agenda
NDAS Symposium on the Art and Science of Alternative Medicine

North Dakota Heritage Center

Friday 9:20 - 12:00 p.m.

Alternative Medicine

A symposium discussing Native medicine, and the scientific investigation of some alternative medicinal compounds

Moderator: *Jon Jackson,* University of North Dakota School of Medicine

9:20 Introductory remarks -- Jon Jackson, Department of Anatomy and Cell Biology, University of North Dakota

9:30 Patrick Carr*, Department of Anatomy and Cell Biology, University of North Dakota

9:50 Alan Allery*, University of North Dakota

10:10 COFFEE BREAK

10:30 "Arsenic deprivation affects homocysteine remethylation in rats fed homocystine and choline." Eric O. Uthus*, USDA, ARS Grand Forks Human Nutrition Research Center, Grand Forks.

10:50 "Chinese Herbal Medicine and the Cardiovascular System: Looking in the Mirror." Dr. Jun Ren*, Department of Pharmacology, Physiology and Therapeutics, University of North Dakota

11:20 "Altered leptin-induced cardiac contractile response in ventricular myocytes under hypertension." David Relling*, Loren Wold and Jun Ren, Department of Pharmacology, Physiology and Therapeutics, University of North Dakota.

11:40 Discussion

ON THE ROLE OF ALTERNATIVE MEDICINE IN PAIN MANAGEMENT

Patrick A. Carr*

Department of Anatomy & Cell Biology, University of North Dakota, Grand Forks

Undoubtedly, complementary and alternative medical (CAM) therapies have caught the attention of both the health care consumer and provider. In some circles, however, these approaches are viewed with skepticism, condescension and disregard while what we consider as more traditional, allopathic treatments are embraced as archetypical and exclusive therapeutic strategies. Are there legitimate scientific reasons for these perceptions? Should all CAM approaches be dismissed and their importance minimized? Conversely, do all current allopathic medical therapies fit into the rigorous guidelines of evidenced based medicine? Of course, when these issues are approached with reason it becomes apparent that reality lies between the extremes.

The unsteady relationship between complementary/alternative and allopathic medical practices is changing rapidly. Not only has CAM made a great impact on preventative medicine and lifestyle/wellness practices but also in the treatment of disease states. Areas experiencing the greatest change in treatment strategies are those in which the consumer feels that conventional medical practices are somehow ineffective or undesirable. Pain management is one of these areas.

Pain is defined by The International Association for the Study of Pain as: "An unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage." This definition covers both the sensory signaling system and related cognitive, emotional and behavioral aspects. It is important to note that unlike other sensory modalities, pain cannot be defined independently of the response of the person involved. As such, pain is not just a sensory modality, but is a perception. At the extremes, there can be both nociceptor activation without pain or pain without receptor activation. This continuum of pain categories may be described as acute pain (closely associated with the noxious stimuli), prolonged/persistent pain (injury with inflammation and altered pain threshold) and chronic pain (persistence past wound healing and greater than 6 months after noxious stimuli). Chronic pain states likely involve plasticity in, or remodeling of, the nervous system suggesting dysfunction of nociceptive circuitry and a disconnect between the "protective" benefits of pain and activity in pain pathways.

How do we manage pain from an allopathic perspective? Approaches include pharmacological, surgical, behavioral and nonsurgical physical medicine techniques. From a basic science perspective, how do these approaches work? Many of the pharmacological approaches exploit either endogenous opioid pathways/receptors, cyclooxygenase activity or prostaglandin generation. Surgical techniques are focussed on lesions of peripheral nerves, dorsal roots, the sympathetic nervous system, or parts of the CNS such as the spinal cord or thalamic nuclei. Although many of the approaches currently employed in allopathic medicine have a strong foundation in well-described physiological mechanisms, not all treatment strategies can be said to have deep roots in the basic sciences. Many procedures have their value in effectiveness. The mechanism of action whereby agents such as nitrous oxide, neuroleptics, antihistamines, sympathomimetics, amphetamines and corticosteroids produce specific analgesia have yet to be defined. Similarly, many of the physical medical practices and behavioral or psychiatric treatments used in allopathic medicine draw their effectiveness from a global reduction in stress and anxiety and augmentation of physical mobility or relaxation or implementation of counterirritation therapies.

Similarly, most CAM practices also have their value in effectiveness. However, questions frequently arise concerning evidence demonstrating not only effectiveness, but also the underlying physiology, pharmacology or "basic science," of these strategies. Complementary and alternative medicine is an enormous field burdened by the lack of a strict definition. The most useful descriptions come from the *Cochrane Collaboration*:

"Complementary medicine is diagnosis, treatment and/or prevention which complements mainstream medicine by contributing to a common whole, by satisfying a demand not met by orthodoxy, or by diversifying the conceptual frameworks of medicine."

The National Institutes of Health Office of Alternative Medicine defines its office as such:

"An unrelated group of non-orthodox therapeutic practices, often with explanatory systems that do not follow conventional biomedical explanations".

Many individual therapies, all which conform to these basic guidelines, can be loosely categorized into broad groups as outlined in the non-comprehensive table below.

1) ***relaxation/stress-management/anxiolytic***	aromatherapy, Ayurvedic, spiritual healing, Reiki, Tai Chi Chuan, yoga
2) ***massage/mobility/exercise***	Alexander, Bowen, Feldenkrais, Hellerwork, osteopathy, Pilates, Qi Gong, Shiatsu, Tragerwork, yoga
3) ***counterirritation***	acupuncture, reflexology, Rolfing
4) ***behaviour modification***	hypnotherapy, psychotherapy, visualization
5) ***pharmacological***	Bach flower, Bristol, herbalism, homeopathy
6) ***unclassified***	cranio-sacral, iridology

Using our knowledge of neurophysiology, we can propose theoretical, mechanistic explanations for how many, but admittedly not all, of these CAM practices may provide pain relief. However, in analogy, proposal of a mechanism is looking at the moon, scientific demonstration is landing on it. Should we dismiss therapies lacking scientific demonstration of their method of action? If so, fairness would require dismissal of many very useful allopathic therapies. The answer has to be in the objective evaluation of the efficacy, effectiveness, safety and the cost/benefit ratio of the intervention. Both allopathic and CAM therapies should be subjected to the same rigorous scrutiny and investigation in order to develop a greater understanding of existing methodologies and to aid in the development of new treatments. Acknowledgment of the existence and influence of the placebo effect and development of restructured trials (employing treatment, placebo and no treatment arms) may be one method of separating efficacy from placebo effect from the natural history or progression of the disease condition. In light of this, it must be decided, for both allopathic and CAM therapies, whether therapy is legitimate if beneficial, or only if superior to placebo. Determination of the basic science underlying each treatment strategy will only serve to minimize the perceived or actual competition between therapeutic philosophies and, in the end, benefit the patient.

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NATIVE HEALING AS ALTERNATIVE MEDICINE - ART AS A SCIENCE

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Director of Student Health Services, University of North Dakota, Grand Forks

The traditional "American Indian" teaching method will be used to discuss some of the ideas and concepts of traditional medicine people and healers. That is no one should take notes, but rather all should focus their total being on listening, observing, and remembering.

The sessions will begin with a discussion of the use of "tobbacco" as a medium of exchange and a gift of respect for services. We'll explore why tobacco is and isn't a good medium for the same exchange in todays terms.

We'll review quickly the science of medicine (some from the native viewpoint) and then talk about the craft of medicine, including the idea that biography preceeds biology.

Then we can move to the stigma of disease or dysfunction in our society and the native concept that disease, dysfunction, *etc*., need to be brought out as a part of the healing process.

I'll talk about connecting with medicine people and their helpers and go betweens.

Lastly, we will review some plants/herbs from North Dakota that have some medicinal value.

CHINESE HERBAL MEDICINE AND THE CARDIOVASCULAR SYSTEM: LOOKING THROUGH THE MIRROR

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Cardiovascular Disease and Chinese Herbal Medicine

Cardiovascular diseases, the top killers in the US, encompass conditions afflicting the cardiac and vascular system such as coronary artery disease, arteriosclerosis, hypertension, heart failure, arrhythmia and valvular disease. Many of these problems have often developed significantly before any clinical symptoms can be noticed. Numerous contributing or risk factors have been identified including high fat intake, menopause, type A behavior, family history, smoking, stress, obesity, diabetes, and high cholesterol or triglycerides. The advancement of modern health care, mainly under mainstream allopathic or Western medicine, has improved the quality of life of patients suffering from cardiovascular diseases. However, each year, more and more people (over 60 million Americans) use herbal remedies and other types of alternative medicine instead of, or in additional to, mainstream allopathic medicine to cure or prevent disease. The growing use of herbal medicine is largely due to its "natural" properties, making it inherently safer than drugs produced artificially. Herbal medicine also offers hope in those patients who have lost faith in allopathic medicine, especially when it has failed.

Herbal remedy, a discipline originating from Traditional Chinese medicine, has been developed over a thousand years into a unique system of theory and healing, in conjunction with the use of animal medicines, acupuncture and moxibustion. It covers the disciplines of microbiology, biochemistry, physiology, and pharmacology. Herbal remedies have been used in patients with cardiovascular diseases such as congestive heart failure, hypertension, angina pectoris, atherosclerosis, stroke, venous insufficiency, and arrhythmia. A number of theories have been postulated for the mechanism of the tonic effect, represented by the '*Yin-Yang and Orbit Doctrine*' concept. However, careful scientific assessment of herbal remedies is still lacking. Being "tonic", herbs appear to be less toxic and unlikely to jeopardize human health, although some have the potential to cause serious toxic effects and major drug-to-drug interactions. With the high prevalence of herbal use in the US for treatment or for nutrition, the potential benefit and harm of prescribing or dispensing of herbal medicine frequently becomes an important issue. Continuing research is necessary to elucidate the pharmacological activities of the many herbal remedies now being used to treat cardiovascular diseases.

The goal of modern herbal research is to derive preparations from medicinal herbs to meet present-day international standards of quality, safety and efficacy. Major constituents of herbal drugs should always be identified, isolated and structurally characterized, to understand the overall pharmacological activity and efficacy. Elucidation of the complete pharmacological profile should include the cellular and molecular biological mechanisms followed by toxicological studies. For example, the study on ephedrine proceeded the discovery of norepinephrine and contributed to modern investigation and understanding of sympathomimetic agents. It needs to be pointed out that herbal medicine as a unique system has its own integrity. Although herbal treatments play the most important role in Traditional Chinese medicine, they are small parts of the whole. In ancient China, there were no clear-cut divisions between medicines and tonic products in form of foods, e.g. ginger and cassia bark are described as both flavorings and herbal medicines. It is important to investigate these medicines or those with similar origin, determining which surfaces as a 'tonic effect' instead of a 'therapeutic one.' Thus, herbal remedies should be more beneficial to mankind, not only in curing disease but also in disease prevention.

Therapeutic Potential of Herbal Medicine in Cardiovascular Diseases by Classes

Herbal medicine has a lot to offer in keeping the cardiovascular system healthy, as long as it is supported by appropriate exercise and a healthy diet. Proper use of these gentle medicines has been proven to be beneficial. Traditional Chinese herbal medicine may be classified into many categories according to their clinical effects, comparable to allopathic medicine. However, one classification system is considered indispensable although not familiar or accepted by allopathic medicine. This system views the herbs as being 'tonic', 'restorative' or 'strengthening', and classifies the herbs, based on the pharmacological actions, into four categories: a) Energy-promoter; b) Blood-promoter; c) Yin-promoter; d) Yang-promoter. Both clinical and experimental researchers have shown that each category has novel but distinct effects on the cardiovascular system.

Energy-promoters are beneficial to angina pectoris, myocardial infarction, and heart failure, conditions that are often accompanied by tissue anoxia. The best example of this class is the famous <u>Ginseng</u>. <u>Ginseng</u> means "root of man" and has the ability to increase physical and mental endurance. It is capable of bringing a person into his/her physical peak and has been used by athletes as a performance enhancer. Ginseng has 'adaptogenic' characteristics due to its unique ability to normalize body function. Ginseng may enhance glyceric acid diphosphate and decrease the affinity of hemoglobin to oxygen, therefore allowing tissues to release more oxygen to compensate for the additional needs of the damaged area. The therapeutic effects of ginseng have been attributed to its active ingredients, ginsenosides, sugar conjugates of dihydroxyl or trihydroxyl dammarane triterpenes known as panaxadiol and panaxatriol. Ginseng extracts rich in ginsenosides have been found to facilitate learning and memory, delay the aging process, and prevent neuronal loss under hypoxia. Data regarding the effect of ginseng or ginsenosides on the cardiovascular system has, however, been controversial. Some studies reported enhanced cardiac function (*1*), others have claimed little or depressed cardiac function (*2*). Ginseng and ginsenoside have been reported to regulate membrane Ca^{2+} channel activity and stimulate nitric oxide production (*3*), both of which play crucial roles in cardiovascular function. It was demonstrated that ginsenosides can protect anoxia/reoxygenation and reperfusion injury of cultured myocytes and isolated rat hearts. Our group recently reported that ginsenosides Rb_1 and Re directly depressed ventricular myocyte contraction, consistent with the notion of reduced oxygen demand in the heart (*4*). Ginseng is currently sold in the U.S. as a food additive and thus needs not meet specific safety and efficacy requirements of the Food and Drug Administration. With the growing use of ginseng, it is important to know the direct cardiac effects of ginseng.

Blood-promoters are a group of medicines that enhance hematopoietic actions such as thrombolysis and invigoration of blood production. Experiments both *in vivo* and *in vitro* showed that Chinese angelica, *Salvia miltiorrhiza* (DANSHEN), *Paeonia lactiflora* (CHISHAO), safflower and their main principles could increase coronary blood flow, decrease myocardial oxygen consumption, antagonize experimental myocardial ischemia and arrthymia (*5*). Chinese angelica can lengthen the effective refractory period, eliminate refraction, extend the platform phase, inhibit ectopic rhythms and reduce ventricular fibrillation; all of these are crucial in antagonizing arrhythmia. *Salvia miltiorrhiza* and its effective components may prolong hypoxia toleration time, dilate coronary artery, protect from ischemic EKG changes and shrink the myocardial infraction range. It is concluded that *Salvia miltiorrhiza* or its effective components may be similar or even better than dipyridamole and propranolol. The anti-arrhythmic effect has also been reported in *Stephania tetrandra*. *Ligusticum wallichii* (CHUANXIONG) and *S. miltorrhiza* exhibited a beneficial effect in dilating vessels especially renal arterioles which could result in a decrease of arterial blood pressure and an improvement in the microcirculation of the lung and kidney. The effect of *Lingusticum wallichii* and safflower in lowering arterial resistance might be stronger than that of 654-2, but of a shorter duration. *Paeonia lactiflora* lowers experimental portal hypertension. Tetramethylpyrazine, which is the effective component of *L. wallichii*, was shown to improve blood flow in acute renal failure and prevent sodium re-absorption through inhibiting angiotensin-II synthesis. Combined use of *L. wallichii*, Salvia miltiorrhiza and Chinese angelica may antagonize adrenaline-induced microvascular contraction even to an opposite dilating state, benefiting microcirculation. If used with certain energy-promoters, marked pharmacological effects may develop including antagonizing shock-induced drop of blood pressure, reducing endotoxin-induced declination of plasma viscosity, disturbing the formation of microthrombus and eliminating the obstruction by plates and leukocytic aggregation. A Ca^{2+}-antagonism similar to that of verapamil was noted in *Stephania tetrandra*.

Yin (negative)-promoters regulate the metabolic processes. They have been defined as drugs that replenish cellular constitutes, promote anabolism and the feedback system in cellular activities. The representatives are Wolfberry fruit (GOUJIZI), *Lingustrum lucidum Ait* (NUZHENZI), Rehmannia root (DIHUANG), *Schisandra chinensis* (Turcs) Bail (WUWEIZI), *Ophiopogen japonica* (Thunb) Ker-Gawl (MAIMENDONG), and *Scrophularia ningpoensis Hemsl* (XUANSHEN). Some yin-promoters have been shown to facilitate myocardial metabolism, enhance hypoxia tolerating capacity, decrease oxygen consumption, increase artery-vein blood oxygenic pressure difference and coronary blood flow, and maintain ATP as well as glucagon content in hypoxia myocardium at a comparably high level. In addition, *Ganoderm lucidum* may stimulate the formation of 2, 3-DPG in erythrocyte *in vivo* and the function of hemoglobin. An anti-arrhythmia effect of *Ophiopogen japonica* was noted in restoring $Bacl_2$-induced tachycardia. Furthermore, studies on *O. japonica* injection verified it could antagonize ischemic T wave changes evoked by the posterior pituitary lobe and increase cardiac coronary blood flow so as to strengthen myocardial hypoxia tolerance and contractility.

Yang (positive)-promoters activate cellular metabolism especially catabolism, through production of the release factor in cellular activity. *Epimedium grandiflorum* (YINYANGHUO), *Psoralea corylifolia L.* (BUGUZHI), *Encommia ulmoides* (DUZHONG), pilose antler, *Cuscuta chinensis Lam.* and *Curculigo orchioides Gaertn.*, are the most important compositions in this category of tonic medicines. *Encommia ulmoides, psoralea corylifolia L.* and *Epimedium grandiflorum* could exert diverse cardiovascular actions such as a hypotensive effect, coronary artery dilation, and/or an increase in coronary blood flow.

Other herbs are also available to strengthen the cardiovascular system but may not fall into a particular category listed above. One cardiac tonic is Hawthorn berry, which is rich in bioflavonoids. Hawthorn normalizes the heart by either stimulating or depressing cardiac activity depending upon the need. It may be safely used in heart weakness and palpitations by improving coronary flow and oxygen supply. Another example is Motherwort for treating racing heartbeat caused by anxiety and tension. Special emphasis has been given to the wonder herb, Garlic. This amazing herbal medicine and food does everything from treating ear infections to preventing heart disease. The most important cardiovascular effect of garlic is on blood pressure and blood cholesterol depression.

The intake of flavonoids has been reported to reduce the risk of cardiovascular disease. Gingko biloba, which contains flavonoids and terpenoids, has been shown to be cardiovascular protective. It has been shown that Gingko biloba prevents ischaemia-induced oxidation, improves cerebral circulation and antagonizes the action of platelet-activating factor (PAF). In Europe, Gingko biloba, designated as 'EGB 761', has been used clinically to treat peripheral vascular disease and cerebrovascular insufficiency. The mechanism of anti-ischemic/reperfusion action of EGB 761 has been attributed to its antioxidant/free radical scavenging effects. EGB 761 improves cardiac function and reduces free radical formation during ischemia in both non-preconditioned and preconditioned, non-diabetic and diabetic rats. Morphological studies revealed that EGB 761 treatment could prevent loss of myofibriles and myocyte growth defects, diminish interstitial fibrosis and reduce endothelial and muscular basement membrane thickening of the diabetic myocardium. This effect was believed to be helpful to prevent late diabetic complications (6). Furthermore, as a powerful antioxidant, EGB 761 may also slow the aging process.

SUMMARY

Herbal remedies can facilitate disease cure or prevention. Thus, if modern allopathic medicine had been applied to the studies from the very beginning of the usage of herbal medicine, there would have been but one system of medical doctrines today, and a priori theory would have been but one single discipline of pharmacology. However, unfortunately or fortunately, history has witnessed different courses of development of the two systems, each with its own characteristic ideology and methodology. Fortunately in Asia, especially in China and Japan, we have persevered traditional tonic medicines, both through resources and knowledge. At this time, it is a very important but complex task for herbal biomedical researchers to absorb and assimilate Western modern techniques. The examples of work on herbal medicine mentioned here illustrate in part the efforts made by herbal medicine researchers along with herbal medical doctors in trying to narrow the gap between herbal medicine and allopathic medicines by studying the pharmacological actions of the former with modern methods, many even at the cellular level. Successes and failures, more or less, have brought about different opinions and arguments. It appears that many difficulties will have to be overcome, among which differences in terminology and way of thinking are most notable. Herbal medicine seems to put more on the concept of integrity than analytical methods. For these reasons it appears that much work remains to be done before achieving a unified medical science, including a unified pharmacology. Advances in the pharmacological studies of tonic herbal medicines by all means would help shorten the distance and the time required for approaching this goal.

ACKNOWLEDGEMENT

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COMMUNICATIONS

UNDERGRADUATE

A. Rodger Denison Competition – Undergraduate Division
Moderators:

1:00 Welcome and Overview

1:10 "Effect of auxin transport inhibitors on leaf expansion in the common bean (*Phaseolus vulgaris*)." Traci Tranby* and Christopher P. Keller, Minot State University.

1:30 "Biological control of leafy spruge on the Medora Ranger District of the Dakota Prairie Bational Grasslands." Carmen Waldo*, Dickinson State University.

1:50 "Sheyenne River bioassessment at Faust Dam." RaMona Lockwood*, Amber Bilden, Tanya Hurlimann. Jessie Pfau, Aaron Sours, and Bonnie Alexander, Department of Biology, Valley City State University.

2:10 "Influence of IGF-1 supplementation on cardiac excitation-contraction coupling in diabetes." Faye Norby*, Loren Wold, and Jun Ren, Department of Pharmacology, Physiology, and Therapuetics, University of North Dakota.

2:30 "The effects of food, temperature, and light on growth, metamorphosis, and sexual maturation in the mole salamander (Ambystoma talpoideum)," Justin Andrist, Cari-Ann Hein, Evan Barker, and Chris Beachy, Department of Biology, Minot State University

2:50 BREAK

3:10 "Using a geographic information system to address the "selfish herd" hypothesis in Gunnison's prairie dogs (Cynomys gunnisoni)" Daniel McEwen*, Donna Bruns Stockrahm and Bryan Watters, Minnesota State University-Moorhead.

3:30 "*Herpetotherium valens* from the Medicine Pole Hills local fauna (Chadron Formation: Late Eocene) Bowman County, ND, " Karew Schumaker*, Allen J. Kihm, and Dean Pearson, Dept. of Geosciences, Minot State University.

3:50 "COX-2 activity is required for Aβ-dependent neuronal toxicity," Peter Colligan* and Colin Combs, Department of Pharmacology, Physiology, and Therapuetics, University of North Dakota.

4:10 "Influence of insulin resistance on Insulin-like Growth Factor I (IGF-1)-induced cardiac contractile response in ventricular myocytes from sucrose-fed rats," Kadon Hintz*, Loren Wold and Jun Ren, Department of Pharmacology, Physiology, and Therapuetics, University of North Dakota.

4:30 Judges discussion

EFFECT OF AUXIN TRANSPORT INHIBITORS ON LEAF EXPANSION IN THE COMMON BEAN (*PHASEOLUS VULGARIS*)

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INTRODUCTION

Auxin (indole acetic acid), a plant growth hormone, is synthesized primarily in the apical bud (1). Transported downward it controls stem elongation and outgrowth of lateral branches. Auxin control of stem elongation is known to involve a direct hormonal response by the effected cells. Inhibition of lateral branch development by auxin is clearly indirect, possibly involving control of the concentration of other hormones in the lateral bud tissue (2).

Recent work in our lab suggests that apically produced auxin may also have a role in limiting the final blade size of leaves in *Phaseolus* (3,4). This project attempts to test an hypothesis that apically produced auxin acts directly to slow leaf growth, moving into the effected leaves from the stem rather than effecting leaf growth indirectly from the stem perhaps controlling transport of nutrients or other hormones into the growing leaf. Experimentation involved selectively inhibiting the transport of auxin through the leaf petiole between the blade and the stem. Two known auxin transport inhibitors were employed; 2,3,5-triiodobenzoic acid (TIBA) and N-1-naphthylphthalamic acid (NPA). TIBA is believed to inhibit auxin transport in a competitive fashion and has some auxin activity itself. NPA blocks auxin transport non-competitively and lacks auxin activity (5).

METHODS

Phaseolus vulgaris var. Contender were grown in moist vermiculite under greenhouse conditions. At 14 days, plants with similar sized monofoliate leaves were selected for experimentation. Auxin transport was experimentally blocked by placing around the petiole, midway along its length, a 2-4 mm wide band of lanolin containing either 500 ppm TIBA or 1000 ppm NPA. In experimental plants, one of the monofoliate leaves was left untreated as a control. Control plants had one of their monofoliate petioles treated with lanolin alone. Initial blade length was measured for both monofoliate leaves of each plant. Blade length was then re-measured repeatedly for up to 14 days. In other experiments, lanolin containing 150 ppm naphthalene acetic acid [NAA; a well characterized auxin analog] was placed either distally or proximally to the NPA transport block to test whether exogenous auxin might rescue the effects of NPA.

RESULTS AND DISCUSSION

Placement of lanolin containing 500 ppm TIBA on the petiole of one monofoliate was found to significantly increase the length and weight of both the treated and untreated leaves after 14 days. Some distortion of expanding trifoliate leaves growing above the monofoliate leaves also occurred. NPA, on the other hand, greatly inhibited the expansion of the treated leaf relative to both the untreated leaf or of either leaf of the lanolin control. NAA in lanolin, placed either distally or proximally to NPA, was unable to rescue the effects of NPA. Interpretation of this result will be discussed. The effect of NPA on expansion of epidermal cell surface area will also be reported.

The results of this study are consistent with an hypothesis that apically produced auxin acts directly as an inhibitory hormone to limit the expansion of monofoliate leaves of the common bean.

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BIOLOGICAL CONTROL OF LEAFY SPURGE ON THE MEDORA RANGER DISTRICT OF THE DAKOTA PRAIRIE NATIONAL GRASSLANDS

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Medora Ranger District, Dakota Prairie National Grasslands, US Forest Service, Dickinson, ND

Leafy spurge (*Euphorbia esula*) was introduced to the northeastern United States approximately 200 years ago. Since then, it has experienced multiple introductions to other parts of the United States, including the northern Great Plains, where it has thrived as a noxious weed. It has been estimated that leafy spurge, left unchecked, expands its range at a rate of 10% per year, doubling its original area about every 7 years (1). Leafy spurge tends to present the largest problem with infestations on range land. The economic costs of long term chemical control on range land are prohibitive because of the need for continued reapplication of herbicide.

Among alternative control methods being utilized by public land managers, including the US Forest Service, are the biological control agents of the order Coleoptera (beetle), genus *Aphthona*. A biological control program was initiated by the Medora Ranger District in 1989 with the receipt of insects from Regina, Saskatchewan, and from Hungary. The insects were very expensive, and difficult to acquire due to limited availability. Consequently, numbers purchased were small, and it was years before significant numbers could be harvested from local areas for redistribution. In recent years, this has changed. The beetles are thriving on the western North Dakota grasslands. The success rate of insectary sites established in Billings and Golden Valley counties by the Medora Ranger District in 1998 and 1999 was 94.59% and 96.05% respectively. These are higher rates of establishment than the rates cited for successful establishment of sites throughout North Dakota. It has been approximated that throughout the state, 30% of releases become established and leafy spurge stem count reduced, while another 30% of releases establish with a population density too low to be effective. All other sites fail to establish (2).

Sites that were established as field insectaries for future harvest purposes during the two year period 1998 and 1999 were staked, photographed, and the locations identified with Global Positioning System technology (GPS). In 1998, 37 insectaries were established. Twelve sites were *Aphthona nigriscutis* (black dot leafy spurge flea beetle), and 25 were *Aphthona lacertosa* (brown legged leafy spurge flea beetle). One *A. nigriscutis* site and one *A. lacertosa* site established with a population density too low to be effective. All other sites established with a high population density and obvious reduction of stems. In 1999, 76 insectaries were established. Five sites were *A. nigriscutis* and 71 sites were *A. lacertosa*. Three *A. lacertosa* sites established with a population density too low to be effective. All other sites established with a high population density and obvious reduction of stems. There were no sites that failed to establish during this period.

With the establishment of biological control sites, palatable species of grasses are returning without the aid of seeding. Among the dominant species noted in a small study area are Kentucky Bluegrass (*Poa pratensis*), Western Wheatgrass (*Agropyron smithii*), Green Muhly (*Muhlenbergia racemosa*), Plains Muhly (*M. cuspidata*), Little Bluestem (*Schizachryrium scoparium*), and Smooth Bromegrass (*Bromus inermis*). Also noted in lesser amounts were Green Needlegrass (*Stipa viridula*), Blue Grama (*Bouteloua gracilis*), Prairie Junegrass (*Koeleria pyramidata*), and Prairie Sandreed (*Calamovilfa longifolia*).

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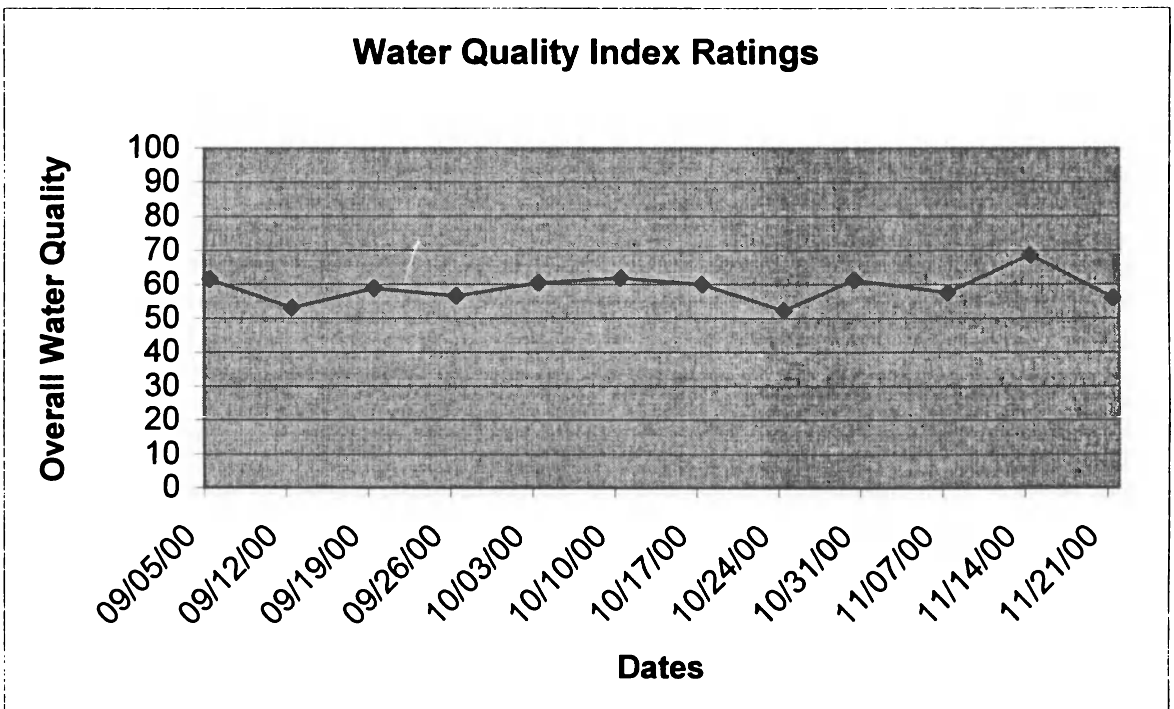
SHEYENNE RIVER BIOASSESSMENT AT FAUST DAM

RaMona Lockwood*, Amber Bilden, Tanya Hurlimann, Jessie Pfau, Aaron Sours, and Bonnie Alexander
Department of Biology, Valley City State University, Valley City

Four VCSU Ecology students conducted a bioassessment of the Sheyenne River at Faust Dam Park for twelve weeks between September 5 and November 21 of 2000. The study area is located six miles upstream from Valley City and six miles downstream from Baldhill Dam. The purpose of the study was to assess the health of the Sheyenne ecosystem through water quality data collection and analysis. Water samples and physical measurements were taken weekly. Water samples were processed in the field using field kits. Samples for chlorophyll, total phosphates, total solids (TDS and TSS), sulfates and nitrates were shipped to the North Dakota Department of Health for analysis. Other data collected included: water temperature, depth, air temperature, secchi disk, dissolved oxygen, fecal coliform, *p*H, biochemical oxygen demand (BOD), bird survey, invertebrates, vegetation and soil. Dissolved Oxygen levels ranged from 0.0 to 9.0 mg/L (X = 5.25 mg/L), percent saturation ranged between 0.0 and 75 (X = 48.58), total solids ranged between 595 to 613 mg/L (X = 604 mg/L). Total phosphate ranged between 0.261 to 1.8 mg/L (X = 0.434 mg/L). The North Dakota Department of Health recommends a maximum level of 0.1 mg/L (1). Nitrates remained at 0.88 mg/L throughout the study period. The North Dakota Department of Health recommends a maximum level of 0.25 mg/L (1). Sulfates ranged between 198 to 214 mg/L (X = 203 mg/L). No fecal coliform bacteria were detected during the study. Collected data was used to calculate a water quality index for the river using the index developed by the National Sanitation Foundation (2). The following water quality tests were included in the index; dissolved oxygen, fecal coliform, pH, BOD, water temperature, total phosphates, nitrates, turbidity and total solids. The index values for the Sheyenne River ranged between 52.26 and 61.95 with a mean of 59.01. The water quality index categories are; Excellent = 90 – 100, Good = 70 – 90, Medium = 50 – 70, Bad = 25 – 50, Very Bad = 0 – 25. For the duration of this study the Sheyenne River fell within the medium health range. Factors that contributed negatively to the index were the high levels of nitrates, phosphates and total solids found within the river system.



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INFLUENCE OF IGF-1 SUPPLEMENTATION ON CARDIAC EXCITATION-CONTRACTION COUPLING IN DIABETES

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INTRODUCTION

Diabetes is one of the major risk factors leading to cardiovascular mortality and morbidity due to heart failure and vascular dysfunction (1). Diabetic cardiomyopathy is a myopathic state independent of macrovascular coronary artery complications and is the leading cause of death in both type I and type II diabetes (2). This disorder is characterized by decreased compliance, prolonged myocardial relaxation and altered intracellular Ca^{2+} homeostasis and diastolic dysfunction is the most prominent mechanical defect (3). Insulin-like growth factor I (IGF-1) is known to promote growth and contraction in the cardiovascular system. However, the level of IGF-1 is attenuated in diabetes (4). The aim of the present study was to evaluate the cardiac contractile response of myocytes from diabetic and chronic IGF-1-supplemented diabetic cardiomyocytes.

METHODS

Male Sprague-Dawley rats were separated into four groups: control, control+IGF-1, diabetic and diabetic+IGF-1. A single injection of streptozotocin (STZ; 55mg/kg) was used to induce diabetes. Chronic IGF-1 supplementation (6mg/kg; every second day) was performed for six weeks. Single ventricular myocytes were isolated enzymatically from the hearts of all groups. Myocytes were electrically stimulated at 0.5 Hz and mechanical properties were evaluated using a video-based edge-detection system. Contractile properties analyzed included peak shortening (PS), time-to-90% PS (TPS), time-to-90% relengthening (TR_{90}) and maximal velocities of shortening and relengthening (±dL/dt). Intracellular Ca^{2+} transients were measured as changes in fura-2 fluorescence intensity (?FFI).

RESULTS

The single injection of STZ caused massive weight loss and significantly increased blood glucose levels in animals in both diabetic groups. Diabetic animals showed significantly reduced PS and enhanced TPS and –dL/dt compared to control. Chronic supplementation with IGF-1 attenuated the PS and –dL/dt response. The fluorescence decay rate was significantly increased in diabetes, however IGF-1 also attenuated this response.

DISCUSSION

The blood glucose test confirmed the validity of this diabetic model. This is also supported by the mechanical dysfunction of ventricular myocytes from the diabetic animals, consistent with our previous reports using the same STZ model. IGF-1 ameliorated many of the devastating cardiac myopathic effects of diabetes, including altered cardiac contractility and intracellular Ca^{2+} clearing. These results lend support to the cardioprotective effects of IGF-1 and its therapeutic potential in diabetic cardiomyopathy.

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Sponsored by a fellowship to FN from the North Dakota Experimental Program to Stimulate Competitive Research and the American Diabetes Association.

THE EFFECTS OF FOOD, TEMPERATURE, AND LIGHT ON GROWTH, METAMORPHOSIS, AND SEXUAL MATURATION IN THE MOLE SALAMANDER (AMBYSTOMA TALPOIDEUM)

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INTRODUCTION Paedomorphosis is the retention of juvenile characteristics in the adult stage or sexually mature stage of development. The mole salamander (*Ambystoma talpoideum*) is one of the few animal species said to be facultatively paedomorphic, meaning it can exhibit either a complex life cycle (CLC) by undergoing metamorphosis, or a simple life-cycle (SLC) by achieving sexual maturity as a larva, making *A. talpoideum* an ideal species for the study of life-cycle evolution (1). We manipulated three pertinent environmental factors (food, light, and temperature) in a laboratory growth experiment to determine the effects on growth rate, temperature and light regime on life cycle expression (LCE, i.e., metamorph, immature larva, or paedomorph) and sexual maturation in the *A. talpoideum*.

METHODS Approximately 200 viable eggs were collected from one female on 29 February 2000 and placed in a container to develop and hatch. As hatchlings began to emerge, both eggs and hatchlings were randomly assigned to a treatment. Treatments were assigned based on the three factors being manipulated: food, light, and temperature. Individuals were placed in five-liter clear polyethylene containers (32 cm long by 19 cm wide by 11 cm deep) with one liter of reverse-osmosis water. The experimental protocol was set up to with treatments in high and low food, high and low temperature, and light and dark. The experiment was terminated on 29 August 2000 (day 189) and all the animals were weighed. All individuals were sacrificed in 1% MS-222 solution and preserved in 10% formalin. The animals were then measured using calipers and dissected to determine their sex and reproductive status. The statistical analysis was performed as a three-way multivariate analysis of variance (MANOVA) with food, temperature, and light as main effects in the analysis.

RESULTS AND DISCUSSION MANOVA indicated an effect of food on growth and life cycle expression, light on gonad development, and temperature on growth and life cycle expression. As expected, treatments had a significant effect on growth (F=13.263, P=0.001). Light had no significant effect on growth (F=0.079, P=0.780), but temperature did (F=25.088, P<0.001) highlighting the importance of temperature on metabolism. Interactions of food/light (F=0.001, P=0.977) and light/temp (F=0.194, P=0.663) yielded no significant effects.

Food had a significant effect on LCE (F=44.421, P<0.001), as all individuals undergoing metamorphosis were maintained in high food/high temp treatment. Light did not significantly effect on LCE (F=0.002, P=0.961). However, temperature did have a significant effect on LCE (F=35.493, P<0.001). Additionally, there were no significant interactions observed, either for food/light (F=0.584, P=0.451) or light/temp (F=0.085, P=0.772).

Food treatments did not influence maturation (F=0.123, P=0.728), though five of six maturing animals were in the high food treatments. Light had a significant effect on maturation (F=6.29, P=0.018), as all six maturing individuals belonged to dark treatments. The food/light interaction also had a significant effect on maturation (F=12.492, P= 0.001) as mean gonad scores changed dramatically from low food to high food in the dark, but very little from low food to high food in the light. Temperature treatments did not significantly affect maturation (F=0.928, P=0.343), but the light/temp interaction had a significant effect (F=5.465, P=0.026). Gonad scores were much higher in the dark (mean=2.27) at high temperature than in the light (mean=2.00) at high temperature.

The significant effect of light was largely unforeseen, since models of paedomorphosis make no predictions for light regime. In retrospect, there is support for these results in the literature. The importance of advanced gonad development in the dark is most likely related to a physiological tradeoff whereby maturation is accelerated when the metamorphosis-inducing hormone thyroxine is repressed (2). Additionally, thyroxine has been shown to be less effective in the dark (3). Evolutionary evidence supports this, since cave-dwelling salamanders are obligate paedomorphs (4), and removal of these salamanders to the lab often stimulates metamorphosis (5). Other research even suggested a certain antagonism between metamorphosis and maturation whereby sex hormones inhibit the conversion of T4 to T3 and potentially inhibit the production of thyrotropin stimulating hormone, which facilitates the production of thyroxine.

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USING A GEOGRAPHIC INFORMATION SYSTEM TO ADDRESS THE "SELFISH HERD" HYPOTHESIS IN GUNNISON'S PRAIRIE DOGS (*CYNOMYS GUNNISONI*)

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INTRODUCTION Gunnison's prairie dogs (*Cynomys gunnisoni*) are social ground squirrels, living in complex colonies in the southwestern United States. Coloniality entails energy costs for individual members associated with competition for reduced habitat, food, and mates as well as health risks associated with disease and parasitism. Coloniality must provide benefits that surpass the disadvantages for it to have evolved. Hamilton (1) hypothesized that the evolution of gregariousness might be attributed to "selfish herd" behavior. This behavior suggests that isolated prey are more vulnerable to predation than individuals surrounded by others based on the probability that a predator will attack peripheral individuals before getting to enveloped animals. Thus, animals will seek to surround themselves with others for protection from predation. Hoogland (2) studied possible factors contributing to the evolution of coloniality in the very social black-tailed (*C. ludovicianus*) and less social white-tailed prairie dogs (*C. leucurus*) with reference to what he termed "selfish herd effects." In this paper, we investigated if selfish herd behavior might be a factor in *C. gunnisoni* coloniality by looking at spatial patterns of prairie dog capture locations related to burrow density and central positioning.

METHODS Our study site was a subcolony of a larger *C. gunnisoni* prairie dog town in Archuleta County, Colorado (center, 37° 39' N, 107° 15' W). During the summers of 1991 through 1997, prairie dogs were live-trapped, weighed, sexed, aged, ear-tagged, and released. Traps were rotated to all areas of the study site and positioned around numbered burrow entrances so all capture locations could be recorded. Coordinates of burrow entrances were ascertained using a Global Position System (GPS) in 1996. These coordinates, along with burrow attribute data, were mapped using ArcView Geographic Information System (GIS) software (Environmental Systems Research Institute, Inc., Redlands, CA). The 90% utility distribution of burrow entrances was computed, outlining three distinct groupings from which centroid positions were calculated and used as the centers of the subcolony. An Animal Movement Extension (3) was then used to map a spider diagram from all burrow entrances to their nearest center. Capture locations were used to determine movements and average distances of each animal to the centers.

RESULTS Analyses presented here were based on a total of 742 mapped burrow entrances (covering 3.15 ha) associated with 1,837 captures of 342 different animals. A *nearest neighbor* analysis (based on the minimum convex polygon) was performed to identify the spatial arrangement of burrow entrances within the subcolony, and it indicated a clumping pattern ($n = 742$, $R = 8.22e\text{-}006$, $Z = -52.111$). Ten zones, which were in 10.2-m increments from the centers, were established around the subcolony's centers. Increasing burrow density was correlated with zones closer to the center (*Spearman Rank Correlation Test*, $r_s = 0.855$, $p < 0.01$). Within zones, we found no significant difference between proportions of burrows, proportions of captures, or proportions of distinct animals caught at each burrow (*Friedman-Test*, $p > 0.05$). Several comparisons of different subgroups of prairie dogs were made based upon different breakdowns by age, sex, dispersal, and life span. Adults were located closer to the subcolony's centers than were pups ($Z = 2.061$, $p < 0.05$). However, we did not find a significant advantage in terms of a longer life span being correlated with closer-to-center positions.

DISCUSSION Our data indicated that density of burrows and burrow activity decreased systematically further away from centers. While this did not necessary support the selfish herd hypothesis, this arrangement was consistent with its prediction. If all animals were attempting to surround themselves with other animals, burrow densities and activity densities should decrease systematically away from the centers. Adults were, on average, more centrally located than pups. If competition for center positions was occurring, then stronger or more aggressive animals, which in this case would be adults, should dominate and be more centrally located. Prairie dog colonies might be so efficient at selfish herd behavior that predation does not serve as an appreciable factor in mortality. If this were the case, it could explain why we found no correlation between longevity and central positions. In conclusion, selfish herd behavior cannot be dismissed as a possible explanation of the coloniality of Gunnison's prairie dogs, and our investigations will continue.

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COX-2 ACTIVITY IS REQUIRED FOR AB-DEPENDENT NEURONAL TOXICITY

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Although senile plaques represent a defining hallmark of Alzheimer's disease (AD) brains their role in disease pathophysiology remains unclear. Plaque core constituents are proteolytically derived fibrillar aggregates of β-amyloid peptides (Aβ1–40/42). The fibrillized peptides are surrounded by reactive microglia and astrocytes and invested with numerous dystrophic neurites. This presentation has lead to the hypothesis that senile plaques represent a focus of fulminating inflammation and death in the brain (1).

Extensive literature supports the hypothesis that the pathophysiology of AD involves an inflammatory component (2). However, the specific mechanism of inflammatory events and their contribution to disease progression remain speculative. The purpose of this study was to explain the aberrant, elevated neuronal expression of a specific proinflammatory marker, cyclooxygenase-2 (COX-2) in Alzheimer's disease brains. Although increased expression of this protein in AD is attributed to an "inflammatory" process occurring in the brain, neither the stimuli nor the consequences of this are known. Answering these questions will provide insight into the unknown mechanism of AD progression and ultimately help identify molecular targets for therapeutic neuroprotection.

Our data demonstrates that toxic Aβ fibril treatment stimulates an increase in neuronal COX-2 protein levels (Fig. 1). The Aβ-dependent death occurs in an apoptotic-type fashion involving nuclear condensation and fragmentation (Fig. 2). More importantly, inhibition of COX-2 activity using the COX-2 selective inhibitor, NS398 results in a dose-dependent attenuation of Aβ-induced cell death (Fig. 3). These data directly demonstrate that Aβ-induced death requires increased COX-2 expression and activity in mouse cortical neuron cultures. We propose a novel mechanism of neuronal death in AD involving Aβ stimulation of increased neuronal COX-2 expression and activity suggesting that selective COX-2 antagonists represent therapeutic agents for treating this disease.

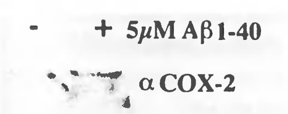

Figure 1. Aβ fibril stimulation leads to increased neuronal expression of COX-2. Mouse cortical neuron cultures (E16, 5 days *in vitro*) were incubated alone (-) or with 5μM Aβ1-40 fibrils for 72 hours. Cells were lysed in RIPA buffer and proteins resolved by 7.5% SDS-PAGE. COX-2 expression was monitored by Western analysis of cellular lysates using anti-COX-2 antibody.

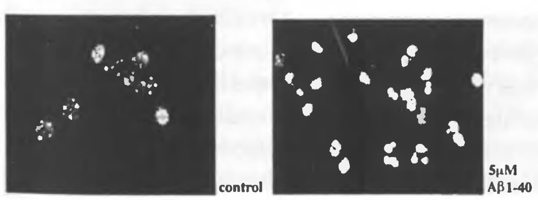

Figure 2. Aβ stimulation of cortical neurons induces neuronal apoptosis. 5μM Aβ1-40 fibrils were applied to mouse cortical neuron cultures (E16, 5 days *in vitro*) for 72 hours. Neurons were fixed in 4% paraformaldehyde and endonuclease cleaved DNA was visualized by DAPI staining.

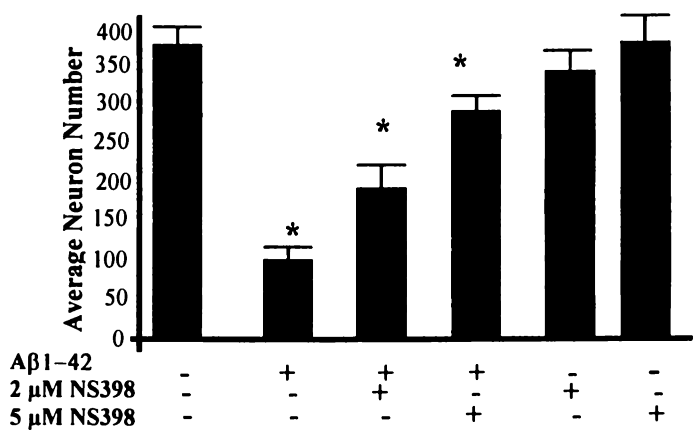

Figure 3. Selective COX-2 inhibitor, NS398, is protective against Aβ fibril-induced apoptosis. 5μM Aβ1-42 fibrils were applied to mouse cortical neuron cultures for 72 hours both in the presence and absence of 2μM, 5μM NS398. Neurons were fixed in 4% paraformaldehyde and labeled with anti-MAP2 antibody using Vector VIP as the chromagen. A counting grid was placed over the wells and surviving cells counted. The experiments were performed in duplicate. Data shown are mean results (+/- SD) representative of 3 independent experiments (*= p<0.001).

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INFLUENCE OF INSULIN-RESISTANCE ON INSULIN-LIKE GROWTH FACTOR I (IGF-1)-INDUCED CARDIAC CONTRACTILE RESPONSE IN VENTRICULAR MYOCYTES FROM SUCROSE-FED RATS

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Introduction: Insulin-like growth factor I (IGF-1) is known to promote cardiac growth and contraction. However, both a decrease in the circulating levels and a resistance to the action of IGF-1 have been observed in diabetes (1). Furthermore, abnormal IGF-1 levels and function are believed to play a role in the development of diabetes. The cellular consequences of diabetes on heart muscle have been well established (*e.g.*, prolonged action potentials, slowed cytosolic Ca^{2+} clearing and prolonged relaxation), but up to date, little is known about the role of IGF-1 in the pre-diabetic stage. Recently, we found a cardiac contractile dysfunction characteristic of diabetic cardiomyopathy early on in the development of type 2 diabetes (*i.e.*, during the insulin resistant phase) (2). The aim of the present investigation was to evaluate the cardiac contractile response to IGF-1 under insulin resistant conditions, in order to better understand the role of the hormone in insulin-resistant cardiomyopathy.

Methods: Sucrose feeding was used to induce whole body insulin resistance (2). Adult male Sprague-Dawley rats (200-250 g) were fed either a normal starch (ST: control) or a high sucrose (SU: experimental) diet. After 7-8 weeks, single ventricular myocytes were isolated enzymatically from the hearts of both groups. Myocytes were electronically stimulated at 0.5 Hz and mechanical properties were evaluated using a video-based edge-detection system. Contractile properties analyzed included peak shortening (PS), time-to-90% PS (TPS), and time-to-90% relengthening (TR_{90}). Intracellular Ca^{2+} transients were measured as changes in fura-2 fluorescence intensity (ΔFFI).

Results: Sucrose feeding did not affect the body weight, heart to body weight ratio, kidney weight or the resting cell length, but did increase the liver weight. A glucose tolerance test showed a significantly slowed clearing rate after a single dose (2 g/kg) glucose challenge in SU compared to ST rats. Myocytes from SU rats also displayed decreased PS, TPS and TR_{90}, but exhibited an increase in resting FFI compared to the ST group. IGF-1 (10^{-10}-10^{-6} M) caused a comparable dose-dependent decrease in PS in myocytes isolated from both groups. This decrease in PS was blunted by IGF-1 receptor antagonist H-1356, but not by nitric oxide (NO) synthase inhibitor L-NAME in myocytes from both groups. Interestingly, IGF-1 elicited a dose-dependent increase in ΔFFI in ST myocytes, but had no effect (slight decrease at highest dose) in SU myocytes.

Discussion: The glucose tolerance test confirmed the validity of the insulin resistance animal model. The biometric data indicate that early stages of insulin resistance may be devoid of cardiac hypertrophy. The observation of comparable cardiac contractile response to IGF-1 between the SU and ST groups does not favor the existence of IGF-1 resistance in cardiac contractile function under insulin resistance. This suggests that IGF-1 resistance observed in diabetes has not yet developed in the insulin-resistant stage of diabetes. Furthermore, the IGF-1-induced response seems to be mediated through the IGF-1 receptor and not through NO production, based on the H-1356 and L-NAME data. Interestingly, the discrepancy between the IGF-1-induced response in PS and FFI may indicate an alteration of the myofilament Ca^{2+} responsiveness under insulin resistance, which has been reported in diabetes (3).

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This work was sponsored by a fellowship to KH from the North Dakota Experimental Program to Stimulate Competitive Research and the American Diabetes Association.

HERPETOTHERIUM VALENS FROM THE MEDICINE POLE HILLS LOCAL FAUNA (CHADRON FORMATION: LATE EOCENE) BOWMAN COUNTY, ND

Karew K. Schumaker*, Allen J. Kihm and Dean A. Pearson*
Department of Geosciences, Minot State University, Minot and *Pioneer Trails Regional Museum, Bowman

INTRODUCTION Faunal lists for the Medicine Pole Hills (MPH) Local Fauna have been reported (1,2), however, the only element of the fauna that has been studied in detail is the artiodactyl, *Leptomeryx* (3). The current study is the first description of the marsupials from the fauna. The MPH Local Fauna was designated for a series of stratigraphically similar localities in the Medicine Pole Hills, south of Rhame, North Dakota (1). The deposits have been considered to represent the Chalky Buttes Member of the Chadron Formation (4). They unconformably overlie the late Paleocene Tongue River Formation and form the uppermost exposed unit. Specimens in this study came from a single quarry sample (Pioneer Trails Regional Museum, PTRM, locality V89002) in a yellowish-brown, medium to coarse grained, poorly consolidated sandstone approximately 3.5 m above the base of the formation. Only upper molars were considered in this study.

REFERRED SPECIMENS: PTRM RM1 4794, 1338, 2708; LM1 4798, 4802, 1339, 2076; RM2 4801, 4800, 4796, 1340, 2706; LM2 4799, 4797, 4795, 1340; RM3 4803, 4804, 4805, 1341, 2626, 2654; LM3 2636; RM4 4746; LM4 1334.

DESCRIPTION M1 forms a right triangle with nearly equal length and width. The protocone is on the anterior margin of the tooth and the metacone is the largest cusp. A preparacrista connects to stylar cusp B, which is always present. All teeth show a small anterior flange, but only 4802 has a distinct cusp A. Cusp C is absent, except on 4802 where it is distinct. Cusp D is elongate along the buccal margin. Specimens 4802 and 2076 show a ridge extending off the posterior side of cusp D towards the posterobuccal corner. Cusp E is absent. The ectoflexus is narrow, very shallow and anterior to the midline. Conules are not well developed, but rather are expansions of the terminal ends of the protocristae. A metaconule is more common than a paraconule. There is a narrow anterior cingulum, confined to the buccal half of the tooth. M2 is similar to M1 except it is more symmetric in shape. Cusp A is absent, except in 4795 in which it is only slightly developed. Stylar cusp C is variable, absent on some specimens, well developed on others. In 4795 there are two cusp C's. The anterior cingulum is variable. M3 is triangular, wider than long and nearly symmetric. It is generally similar to M2 except the protocone is closer to the anterior-posterior midline and cusp C is the largest of the stylar cusps. There is no cusp D or E. Conules, if present, are expansions of the protocristae, but in general are poorly developed. There is a narrow anterior cingulum confined to the buccal half of the tooth. The M 4/ is wider than long. Cusps A and C are present on the only complete specimen. The paracone is on the anterior margin of the tooth and is larger than the metacone, which is on the posterior margin. A narrow anterior cingulum is present.

DISCUSSION The material represents a didelphid because the metacone is larger than the paracone, stylar cusps A, B, C and D are present, although variable, the stylar shelf is wide, and the centrocrista is V-shaped. The upper molars have conules and an anterior cingulum, both are absent in peradectids (5). Korth (5) recognized *Herpetotherium* and *Copedelphys* as the only middle Tertiary didelphid genera in North America. *Copedelphys* has only stylar cusp B on M1 and M2, cusp D on M3 and lacks stylar cusps on M4. The MPH specimens are assigned to *Herpetotherium* because of the dominance of cusp D and relatively large cusp B on M1 and M2 and the size of cusp C on M3. They are assigned to *H. valens* because of the development of cusp B on M1 and M2 and its presence on M3. In later species of *Herpetotherium*, cusp C is not distinct. The variation in the MPH sample matches the variation in *H. valens* described by Eberle and Storer (6).

BIOCHRONOLOGY *Herpetotherium valens* has been reported from the Calf Canyon (late early or middle Chadronian) and KSW (late Chadronian) Local Faunas of the Cypress Hills Formation (7), and the middle Chadronian Pipestone Springs Local Fauna (5). It has been suggested that the MPH Local Fauna is earliest Chadronian in age (3). Our identification of *H. valens* in the fauna cannot be used to corroborate that interpretation. However, marsupials are not well known from early Chadronian localities and the absence of *Herpetotherium* from the early Chadronian fauna may be an artifact of preservation.

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COMMUNICATIONS

GRADUATE

A. Rodger Denison Competition – Graduate Division

Moderator: Dr. Margaret Nordlie, University of Mary

1:00 Welcome and Overview

1:10 "An allelism test for species cytoplasmic specific (*scs*) genes." Sarah Gehlhar*, SF Kianian, SS Maan, and KJ Simons, Department of Plant Sciences, North Dakota State University, Fargo.

1:30 "Characterization of excitation-contraction coupling in diabetic hypertensive cardiomyopathy in adult rat ventricular myocytes," Loren Wold*, David Relling, and Jun Ren, Department of Pharmacology, Physiology & Therapeutics, University of North Dakota, Grand Forks.

1:50 "Hogback Ridge, McHenry County, ND: revelations from a trench," Trent D. Hubbard* and John R. Reid, Department of Geology and Geological Engineering, University of North Dakota.

2:10 "Analysis of scleral collagen fibrils in normal and lumican-deficient mice." Bobbie Austin*, CH Coulon, W-Y Kao, CY Liu and JA Rada, Department of Anatomy and Cell Biology, University of North Dakota, Grand Forks.

2:30 "Fine structure mapping of the species cytoplasmic (scs) gene in durum," Kristin Simons*, SF Kianian, SS Maan, and SB Gehlhar, Department of Plant Sciences, North Dakota State University, Fargo.

2:50 BREAK

3:10 Judges discussion

AN ALLELISM TEST FOR SPECIES CYTOPLASMIC SPECIFIC (*scs*) GENES

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INTRODUCTION

Wild related species have been and will be a useful reservoir of genetic diversity in the development of emerging wheat germplasms. Lack of genetic recombination and hybrid sterility are obstacles that commonly occur with the use of alien germplasms. Restoration of fertility (*Rf*) genes have been traditionally used to restore fertility in sterile hybrids, however these genes do not function in all situations. A two-gene system has been found to restore fertility in several situations where *Rf* genes do not restore fertility. The genes involved in this system include the species cytoplasmic specific (*scs*) gene and the vitality (*Vi*) gene (1). An *scs* gene (*scs'*) has been isolated from *Triticum timopheevii* which improves nuclear-cytoplasmic compatibility of a *T. turgidum* nucleus in *T. longissimum* (*lo*) cytoplasm (1). A second *scs* gene has been derived from *T. turgidum* (scs^d) (2). The scs^d gene is very similar to the *scs'* gene, producing plump seed. However, the scs^d gene does not restore vigor to the plants as the *scs'* gene does. The objective of this study is to determine if the *scs* genes isolated from *T. turgidum* and *T. timopheevii* are allelic. A better understanding of nuclear-cytoplasmic interactions has direct applications to plant breeding and crop improvement, such as more extensive use of alien species and more efficient gene introgression.

MATERIALS AND METHODS

The scs^d gene was crossed in its homozygous state in a durum cytoplasm (*d*), also referred to as *line-1*, to an individual hemizygous for *scs'* in (*lo*) cytoplasm. The resulting heterozygote progeny, (*lo*)*scs'*,scs^d, were then crossed to normal durum (56-1) to create a segregating population (2) which can be used to determine allelism between the two genes. The population was grown in the greenhouse during the fall of 2000 under favorable conditions of temperature, moisture, and photoperiod for production of wheat. Two heads of each vigorous plant were then crossed to 56-1 and harvested at maturity. Two heads from random plants were also crossed to a homozygous *line-1* plant and harvested at maturity.

RESULTS

The population grown in the greenhouse segregated for normal vigor and weak plants in a one to one ratio of *scs'*,- to scs^d,- genotypes respectively. The ratio was tested for goodness of fit at the 95% level of confidence. This is our initial indication of an allelic state for the two genes. The presence of plump and shriveled seed set in those plants crossed with 56-1 and absence of a plant setting only plump seeds is another indication of an allelic state. By planting the resulting plump seed from the crosses made to random plants by *line-1* and crossing the resulting progeny with 56-1, we will generate a second population to reconfirm our findings that *scs'* and scs^d are alleles.

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CHARACTERIZATION OF EXCITATION-CONTRACTION COUPLING IN DIABETIC HYPERTENSIVE CARDIOMYOPATHY IN ADULT RAT VENTRICULAR MYOCYTES

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Diabetes and hypertension are among the major risk factors leading to the increased mortality and morbidity due to cardiovascular dysfunction (1, 2). Both clinical and experimental evidence has demonstrated the existence of independent and specific cardiomyopathies associated with either diabetes or hypertension. Diabetic cardiomyopathy, a myopathic state independent of macrovascular coronary artery complications, is the leading cause of death in both type I and type II diabetes (3). Diastolic dysfunction is the most prominent mechanical defect of diabetic cardiomyopathy.

Hypertensive, or hypertrophic, cardiomyopathy, is characterized by myocardial hypertrophy, most commonly affecting the interventricular septum and disorganization of cardiac myocytes and myofibrils. Hypertrophic cardiomyopathy also displays abnormalities in diastolic function including prolonged relaxation, reduced rate of rapid filling and increased left ventricular stiffness.

Ventricular myocytes were isolated from adult male rats and contractile properties and intracellular Ca^{2+} properties were analyzed using video-based edge-detection. Contractile properties analyzed in cells electrically stimulated at 0.5 Hz included: peak shortening (PS), time-to-90% PS (TPS), time-to-90% relengthening (TR_{90}) and fluorescence intensity change (ΔFFI).

The experimental animals exhibited enlarged heart size, elevated blood glucose or systolic blood pressure. PS was unchanged (SHR), enhanced (WKY-STZ) or depressed (SHR-STZ). Myocytes from all experimental groups displayed prolonged TPS and TR_{90} compared to the WKY group, although only those from the hypertensive groups (SHR, SHR-STZ) were associated with reduced ± dL/dt. Resting intracellular Ca^{2+} levels were either reduced (SHR, SHR-STZ) or elevated (WKY-STZ) compared to the WKY group. Myocytes from STZ-treated (WKY-STZ, SHR-STZ) rats exhibited a reduced FFI in response to electrical stimuli. Consistent with the prolonged TR_{90}, myocytes from all experimental groups possessed a slowed fluorescence decay rate. Furthermore, myocytes from WKY-STZ hearts were less responsive to increases in extracellular Ca^{2+}, whereas myocytes from SHR-STZ group showed a faster decline of PS in response to increased stimulus frequency, compared to the WKY group.

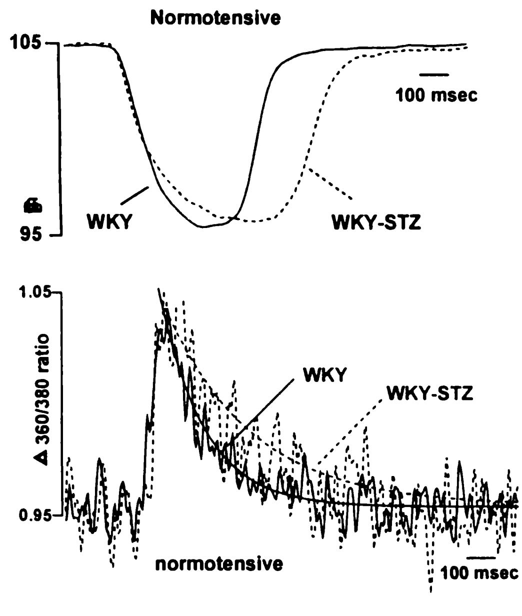

Fig. 1. Cardiomyocyte contraction and intracellular Ca^{2+} transients from WKY and WKY-STZ cardiomyocytes.

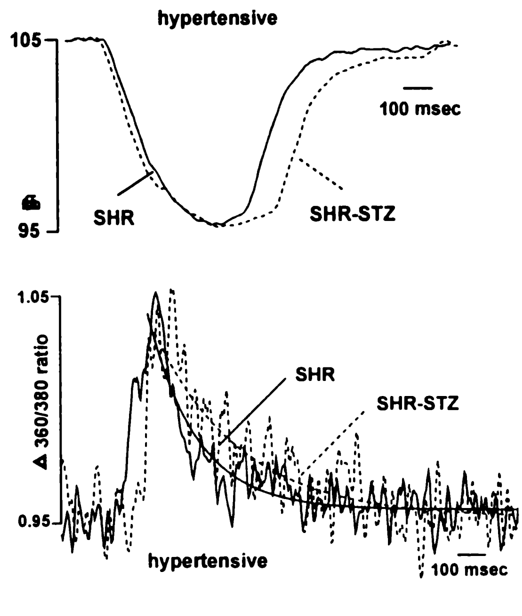

Fig. 2. Cardiomyocyte contraction and intracellular Ca^{2+} transients from SHR and SHR-STZ cardiomyocytes.

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HOGBACK RIDGE, MCHENRY COUNTY, ND: REVELATIONS FROM A TRENCH

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In southeastern McHenry County near the town of Balfour, ND, is a series of long linear landforms whose origin has long been of interest to geologists attempting to understand the mechanics of glaciation in the Northern Plains.

Other authors have described these ridges as drumlins or drumlinoid in form but recognize that they are not the classic shape (1). The features are similar in morphology to flutes although larger in size. My assumption is that the formation of the ridges in this area can be understood by comparing their geologic character and determining shear stress at time of formation with that of modern flutes near the Saskatchewan Glacier, Alberta, Canada.

Previous workers examining Hogback Ridge, the largest of these ridges in ND, found gravelly sand, silt, and clay (till deposits), bedded sands and silts (lacustrine deposits), bedded sand and gravel (fluvial deposits) (1,2,3,4). At the up-glacier end of this ridge is what was concluded to be a block of ice thrust- material. A series of excavations along this ridge in 1987 exposed numerous faults dipping away from the axis as well as lenses of till within the sand and gravel, in addition to sand/ and gravel lenses within the till. Based on those excavations, it was suggested that masses of ice thrust material initiated subglacial cavities into which sediment was squeezed. This squeezing resulted in troughs parallel and adjacent to the ridges.

An additional trench was excavated across Hogback Ridge in 2000 to determine sediment types and structures for comparison with similar excavations of smaller flutes near the Saskatchewan Glacier. The trench, oriented north/south at an oblique angle to Hogback Ridge was approximately 31 meters (120 ft) long by 3 meters (10 ft) wide by 3 meters (10 ft) deep. In addition to the main trench, three extensions were excavated along the east wall, one in the middle and two along the outer margins of the ridge to examine sedimentary structures along and perpendicular to the ridge.

The excavation revealed many of the same sediments observed by previous workers. However, there was little evidence of structures associated with squeezing of materials in toward the center of the trench. Lack of such structures, in addition to large amounts of bedded silts, sands, and gravels, suggest that fluvial processes were responsible for the formation of the ridge at this site. Previous workers suggested that the bedded sediments were frozen masses incorporated into the ridge during its formation (1,2,3). This would have created the highly disturbed bedding they observed. However, most of the sediments at the new site appeared undisturbed.

The theory proposed here is that high porewater pressure caused thrusting of material that initiated a straight tunnel along the base of the glacier. Water then discharged through this tunnel, carrying with it sands and gravels from the lake sediments being overridden farther up-glacier. The straightness of the tunnel was controlled by the flow direction of the ice so the classic esker shape was not created. At the same time, sediment may have been squeezed into the tunnel from the sides, creating the structures observed. This theory explains abundant faults dipping away from the axis in some areas but an absence elsewhere. From the fieldwork here it appears that the formation of the ridges in this region may be more complex than originally discussed. Previous theories never addressed the core of massive sand found in some of the smaller ridges within the region. This theory may help to explain this.

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ANALYSIS OF SCLERAL COLLAGEN FIBRILS IN NORMAL AND LUMICAN-DEFICIENT MICE

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PURPOSE

Our purpose was to compare collagen fibrils in lumican knockout and heterozygous (control) sclera. Parameters used for comparison were collagen fibril diameter, center-to-center spacing, and edge-to-edge spacing.

METHODS

Anterior and posterior mouse sclera from 6-month-old heterozygous and 6-month-old lumican deficient mice was analyzed with transmission electron microscopy. Collagen fibril measurements were obtained using a macro, specifically created for this application, in Object Image 2.02.

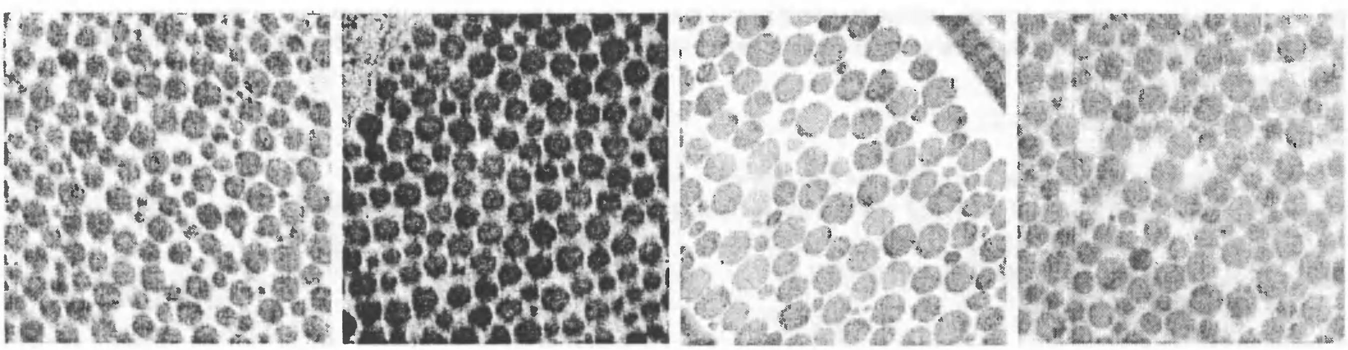
RESULTS

There are highly significant differences (p=0.000) in diameter between anterior heterozygous (65.0992 nm) and posterior heterozygous (76.9172 nm) collagen fibrils, but there are no statistically significant differences in center-to-center spacing or edge-to-edge spacing for anterior versus posterior normal collagen fibrils. Highly significant differences (p=0.000) in collagen fibril diameter exist for both anterior heterozygous (65.0992 nm) versus anterior mutant (89.6860 nm) and posterior heterozygous (76.9172 nm) versus posterior mutant (82.0831 nm). Additionally, there are moderate differences (p=0.009) in center-to-center collagen fibril spacing for anterior heterozygous (566.4689 nm) versus anterior mutant (113.8549 nm) and edge-to-edge spacing for anterior heterozygous (502.2635 nm) versus anterior mutant (25.2743 nm). However, in posterior sclera, which is developmentally younger, there are no statistically significant differences in center-to-center or edge-to-edge collagen fibril spacing.

CONCLUSIONS

Scleral collagen fibrils show significant abnormalities in size and arrangement in lumican-deficient mice as compared with heterozygous mice. This data shows that lumican plays a role in scleral extracellular matrix organization.

Figure 1. Mouse scleral collagen fibrils: representative regions of interest.



anterior heterozygous | posterior heterozygous | anterior lumican deficient | posterior lumican deficient

Support: NIH EYO9391 (JAR); Sigma Xi Grant in Aid of Research (BAA).

FINE STRUCTURE MAPPING OF THE SPECIES CYTOPLASMIC (*scs*) GENE IN DURUM

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INTRODUCTION

A better understanding nuclear-cytoplasmic interactions has direct applications to plant breeding and crop improvement. Understanding nuclear-cytoplasmic interactions and compatibility would permit more extensive use of alien species and more efficient gene introgression. Nuclear-cytoplasmic interactions can be demonstrated when crossing *Triticum logissiumum* with either *T. aestivum* or *T. turgidum*. In the *T. aestivum* cross, one observes compatibility between the nucleus and the cytoplasm by the presence of plump viable seeds. In the *T. turgidum* cross, incompatibility is indicated by the presence of shriveled seeds. A two-gene restoration system was found to restore compatibility, vigor, and vitality to progeny with a *T. longissiumum* (*lo*) cytoplasm and a *T. turgidum* nucleus (1). The first gene in the system is the *species cytoplasmic specific* (*scs*) gene. In *T. aestivum*, this gene is located on chromosome 1D. A homoeologous gene was derived from *T. timopheevii* and is located on chromosome 1A. It restores compatibility between the *T. turgidum* nucleus and (*lo*) cytoplasm as well as plant vigor but the plants are male sterile. The second gene is the *vitality* gene (*Vi*). *Vi* is believed to be a mutated *restoration of fertility* (*Rf*) gene and is located on chromosome 1B. It restores compatibility between the nucleus and cytoplasm and restores male fertility; however the plants lack vigor (1). A previous mapping study has placed the *scs* gene near the centromere on the long arm of chromosome 1A (2). In that study an alloplasmic mapping population was utilized [(*lo*) *T. turgidum* (-,-;*Vi*,-) with (*lo*) *T. turgidum* (*scs*,-;*Vi*,-)]. Our objective is to find flanking markers for the *scs* gene.

METHODS

Two major steps were taken to reach this objective. First, a segregating F_2 population was developed by selfing the progeny from a cross of the intervarietal chromosomal substitution line, Langdon-dicoccoides 1A [LDN(Dic1A)] (3), with an euplasmic line homozygous for the *scs* gene. The genotypes of the F_2 individuals were determined by test crossing to an alloplasmic line hemizygous for the *scs* gene. Genotypes were determined to a 90% level of confidence (4). All plants were grown in the greenhouse under optimal growth conditions for wheat. Second, a linkage map was generated to find flanking markers for the *scs* gene. Parental screening with Simple Sequence Repeats (SSRs) (5), Restriction Fragment Length Polymorphisms (RFLPs), and Amplified Fragment Length Polymorphisms (AFLPs), was used to determine possible beneficial polymorphisms. The linkage map was generated from the data using MAPMAKER 3.0b with a LOD score of 3.0.

RESULTS

A segregating population of 107 individuals was developed and consisted of 22 homozygous individuals with *scs*, 53 hemizyous individuals with *scs*, and 32 homòzygous individuals without *scs*. The χ^2 equaled 1.88 with 2 degrees of freedom. Of the 69 total markers screened, 46 polymorphic loci were detected. A map was generated using the polymorphic loci. The RFLP locus, Xbcd12b, was located proximal to the *scs* gene at 4.1 centimorgans and the microsatellite locus, Xgwm357a, was distal to the *scs* gene at 6.4 centimorgans.

DISCUSSION

We were able to accomplish two steps essential to reaching our objective. First a population segregating for the *scs* gene in a normal durum background was developed. Second, flanking markers for the *scs* gene were found. The segregating population in an euplasmic background allowed the recovery of all individuals in the population. LDN(Dic1A) line was used to increase the number of polymorphisms. The linkage map was created using the segregating loci detected by SSR and RFLP markers. Currently, AFLPs are being used to more fully saturate the map. We have flanking markers for the *scs* gene but they are not close enough to be used for positional cloning. Once obtained, closely linked flanking markers will be used to clone and sequence the *scs* gene. The gene will then be analyzed for type and function. Understanding of the gene action will introduce some knowledge of how the nucleus and cytoplasm interact in a polyploid species. Eventually, this will lead to more wide spread use of alien species in breeding programs and increase the efficiency of gene introgression.

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Cultivating the Civic Scientist

by **KATHARINE S. MILLER**

- Fewer than one-third of all Americans understand the term "DNA."
- Fewer than 15 percent understand the term "molecule."
- Only about 50 percent know that humans didn't live at the time of the dinosaurs.

+ *Science & Engineering Indicators 2000*, published by the National Science Foundation

To reduce scientific illiteracy, scientists need to write and teach about science whenever and however they can, be connected to the news media and advise policy makers when an important scientific question arises, say two Stanford faculty members.

Michael Riordan, a particle physicist, spoke as part of a Feb. 16 panel called "Cultivating the Civic Scientist" at the annual meeting of the American Association for the Advancement of Science. Microbiologist Lucy Shapiro was scheduled to appear on that panel as well but, at the last minute, was unable to attend. She spoke in a recent interview.

Scientists need to speak out, Shapiro said, because without scientific understanding, people fear things they don't understand, the press legitimizes erroneous pseudoscience and the government promulgates wrongheaded and dangerous public policies.

According to Riordan, "A civic scientist is one who is willing to engage in a dialogue about the nature of science, the future of science and its potential impacts on society. The highest expression of the term 'civic scientist' refers to a scientist who disinterestedly makes his expertise available to further the welfare of the country."

On issues from missile defense to antibiotic resistance and breast cancer policies, the government needs the advice that only scientists can provide. Riordan and Shapiro both fulfill that civic obligation, but also educate the public through their writing and speaking.

"People are hungry to hear this stuff," Shapiro said, referring to the public's appetite for clear explanations of science. "Newspeople consistently underestimate the curiosity of a typical TV audience and their tolerance for learning something." About 15 years ago, Shapiro decided she had to do something about it. "I lecture whenever I can because I'm a clear speaker," Shapiro said. "Not everyone can do it, but those who can should."

Riordan agrees that the popular press isn't capable of covering the more difficult science. That's one reason he has written four popular books, with a fifth on the way. "The more complex stories may have to be written by scientists themselves," he said.

The civic physicist

Riordan was part of the team that discovered the so-called "top quark" at Stanford's Linear Accelerator Center (SLAC) in the early 1970s. But his career has taken a different path in the last 15 to 20 years: He writes books for the general public about science, the history of science and science policy.

He also gets calls from the press on a regular basis and often is quoted in newspapers and magazines. His own stories for the New York Times and New Scientist and Science magazines have covered such topics as the discovery of neutrinos, the search for the Higgs boson and the need for an American quark-busting machine.

During his career, Riordan has worked closely with a number of people he considers great civic scientists. He points to SLAC's Wolfgang Panofsky and Sidney Drell, whose contributions to nuclear arms control are widely known.

Riordan himself helped formulate the American Physical Society's recently published official position on the technical viability of a national missile defense system, urging the United States not to deploy such a system unless it is proven effective against anticipated countermeasures.

But Riordan says scientists don't have to be bigshots to play important roles in public life.

"To become a scientist involved in policy, you must spend time on committees getting to know the policy issues and the policy makers," he said. Federal agencies like the Environmental Protection Agency, the Nuclear Regulatory Commission and the National Science Foundation all need science advisers.

Scientists also play an important role in civic life when they interact with the press. Unfortunately, Riordan said, many scientists are leery of the press. "They see that the press doesn't always get things right and it leaves out complexities and qualifiers scientists feel are necessary to explain their work."

Nevertheless, scientists have to overcome their fears and distrusts and learn to tell the public, through the news media, why it's important to do what they do, he said: "The press is the conduit to a large and influential audience."

The civic biologist

Lucy Shapiro, the Virginia and D. K. Ludwig Professor in the departments of Developmental Biology and Genetics, is a laboratory scientist, first and foremost. But about 15 years ago she decided she could also be a civic scientist. It's hard to do both in early stages of a scientific career, she said. When she was an assistant and then associate professor, she was too busy getting grants, running a lab and starting a family.

"But there comes a time in your career when you can do more," Shapiro said. She could have written a textbook or started a company, but making science accessible to the public was the best fit for Shapiro's strength: public speaking.

"I'm just a run-of-the-mill scientist trying to make people less frightened about technology," she said. "To make intelligent decisions, there's no substitute for real information."

The talks she gives to the public often reach only a few people, but on occasion she speaks to policy makers. At one point, Shapiro was invited to the White House along with several other scientists to speak to President Clinton and his Cabinet about the risks biologically altered pathogens pose to national security and the food supply.

After several hours of scripted presentation, the Cabinet members were getting sleepy. When she stood up to speak, Shapiro went off-script. "Do you know what genetic engineering is?" she asked.

"Why don't you tell us," Clinton said.

As she spoke, Clinton shooed away aides, who were peeved because Shapiro had made him late for other appointments.

So Shapiro taught the Cabinet members that genetic engineering goes on in nature all the time: Bacteria can pick up genetic material from other bacteria and add it to their own, all without human intervention. In fact, she said, nature added a toxin gene to the E. coli that made killers out of Jack in the Box hamburgers in 1993. And it is nature that encourages the evolution of bacteria into antibiotic-resistant forms. The lesson: We have more to fear from nature than from international terrorists.

During a videotaped talk to the National Academy of Sciences (NAS), Shapiro delivered the same message. The tape is one of the most commonly requested in the NAS collection.

Before she began speaking to the public, Shapiro "worked very hard to do it right." Early on, she practiced her speeches on her physicist husband, who had to stop her "every two seconds to ask what a word meant." She eventually learned that she need not use complicated lingo to get the information across.

Though her research involves bacteria, Shapiro also speaks about other scientific subjects. A few years ago she decided to address people's fears about breast cancer. She made it her business to learn everything she could about breast cancer, and she started speaking to groups of women about it. "This is what is real," she told the women. "Only 5 percent of breast cancer is inherited."

Katharine S. Miller writes for the Stanford News Service.
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COMMUNICATIONS

PROFESSIONAL

NDAS SENIOR ACADEMY PROGRAM

Thursday, April 26th Moderator: Chris Keller, Minot State University

1:00 Welcome and opening remarks, Chris Keller, Department of Biology, Minot State University

1:10 "Influences of muskrat predation on population structure of *Margaritifera margaritifera*." J. Mark Erickson*, Saint Lawrence University, Canton, N.Y.

1:30 "Halothane enhances presynaptic GABA release by increasing intracellular calcium from ryanodine-sensitive stores." Van Doze*, Department of Pharmacology, Physiology and Therapeutics, University of North Dakota.

1:50 "Historical explanations of phenotypic variation in the plethodontid salamander, *Gyrinophilus porphyriticus*." Chris Beachy* and Dean C. Adams, Department of Biology, Minot State University and Department of Zoology and Genetics, Iowa State University.

2:10 "Purification of a photoaffinity-labeled proteolytic fragment from cloned human dopamine transporter." Margaret Lowe* and Roxanne Vaughn, Department of Biochemistry and Molecular Biology, University of North Dakota.

2:30 "Hormonal control of leaf expansion in the common bean (*Phaseolus vulgaris*)."Chris Keller*, Department of Biology, Minot State University.

2:50 COFFEE BREAK

3:10 "Paleontology and stratigraphy of the basal Fort Union Formation (Paleocene: Puercan) from Slope county, North Dakota." Dean A. Pearson*, Department of Paleontology, Pioneer Trails Region Museum, Bowman, ND.

3:30 "The last freshwater molluscan assemblage of the Cretaceous? A new locality from the Ludlow Formation of North Dakota." Joseph Hartman*, KR Johnson, and DJ Nichols, Department of Geology and Geological Engineering University of North Dakota.

3:50 ***Moderated discussion***

4:10 **Adjournment**

HISTORICAL EXPLANATIONS OF PHENOTYPIC VARIATION IN THE PLETHODONTID SALAMANDER *GYRINOPHILUS PORPHYRITICUS*

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[2]Department of Zoology and Genetics, Iowa State University, Ames, IA 50011

INTRODUCTION

Because body size varies as a correlate with life history among populations of southern Appalachian salamanders (and amphibians in general), it is important that the biogeographic consequences of the evolution of body size be elucidated (1,2). We tested several biogeographic hypotheses about the evolution of body shape, and utilized body shape as a potential predictor of gene flow. Significant variation in body shape along/within zones of parapatry and sympatry have recently shown that important patterns in body shape are generated due to processes such as character displacement and reinforcement (3). We examined morphological variation in *Gyrinophilus porphyriticus* in six geographic regions of the southern Appalachian Mountains and tested competing evolutionary hypotheses concerning body size and life history variation in this species.

METHODS

Morphology was quantified with a set of linear distance measures. We recorded length from the snout to the posterior margin of the cloaca (SVL) and eight other morphometric characters to the nearest 0.01 mm using digital calipers. The other measurements recorded were head length to the middle of the gular fold, maximal head width posterior to the orbit, maximal head depth posterior to the orbit, distance between the anterior portion of the orbit and the nostril, gape width at widest span of the jaw, trunk length between the axilla and groin, trunk width posterior to the forelimbs, and length of the third left-hind toe. Three size-adjustment methods (residuals, principal components analysis, and Burnaby's method for size correction) were used to generate shape variables from these values. Phenotypic variation was assessed using each set of shape variables, and phenotypic differentiation was represented as a matrix of generalized Mahalanobis distances among populations (4,5). Morphological variation was also examined in the context of three historical hypotheses of the evolution of body size. The relationships among the populations under each hypothesis were quantified and represented by a design matrix. The association between each evolutionary hypothesis and the observed phenotypic variation was then determined using Mantel tests (a type of partial correlation analysis).

RESULTS AND DISCUSSION

We found significant phenotypic differences among populations, regardless of which size-adjustment method was used. Populations from the Blue Ridge, Piedmont, and Nantahalas were morphologically similar, while populations from the Balsams, North Cowees, and South Cowees were each unique and distinct from other groups. None of the evolutionary hypotheses were associated with phenotypic variation, but when the effect of geography was taken into account, the river vicariance model was significantly associated with morphology (Mantel's $r = 0.53$, $P = 0.038$). Thus, there was morphological support for the river vicariance model.

To describe the phenotypic differences among populations in more detail, we inspected the character loadings on the first CV axis. For size-adjusted shape data generated from the Burnaby and PCA methods, we found high positive loadings for head length and gape width on the first CV axis, and high negative loadings for trunk length and width, and head width on the first CV axis. Thus the first CV axis describes the contrast between salamanders with *relatively* larger head length and gape width and smaller trunks (*e.g.*, Nantahalas), versus salamanders with *relatively* smaller head length and gape and larger trunks (e.g., Cowee South). These results (*i.e.*, significant levels of shape variation across parapatric boundaries), coupled with previous results concerning sexual isolation between parapatric populations in *G. porphyriticus*, suggest that morphometric variation may be a useful diagnostic character in this species complex. This species is likely to consist of several species, and a comprehensive examination of shape variation throughout the range of *G. porphyriticus* is underway.

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HALOTHANE ENHANCES PRESYNAPTIC GABA RELEASE BY INCREASING INTRACELLULAR CALCIUM FROM RYANODINE SENSITIVE STORES

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INTRODUCTION Neuronal excitability is diminished during anesthesia and is believed to result in part from enhanced synaptic inhibition. Many anesthetic agents enhance synaptic inhibition, although their cellular mechanisms are not understood. Barbiturates increase binding of γ-amino-butyric acid (GABA) to its receptors, directly activating $GABA_A$-mediated inhibitory postsynaptic currents (IPSCs) prolonging GABA action. Volatile anesthetics also enhance GABA binding and prolong channel openings. The current study examines presynaptic effects of anesthetics on GABA release and investigates the direct actions of anesthetics on inhibitory interneurons.

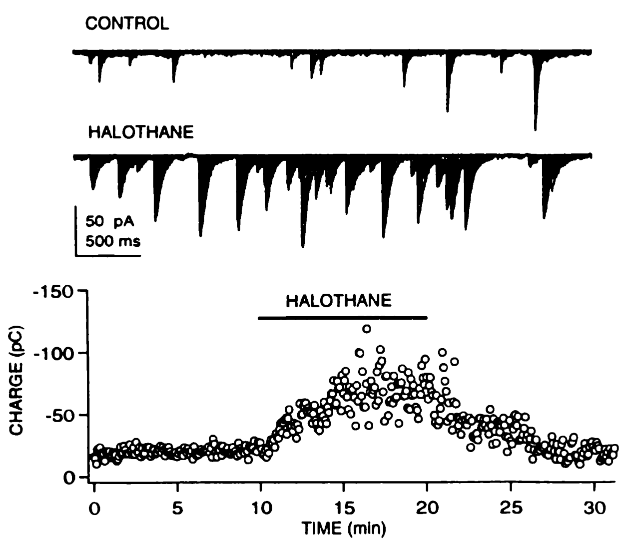
METHODS Hippocampal slices were prepared from adult, male, Sprague-Dawley rats. Electrophysiological recordings were made from visually identified interneurons and pyramidal cells using current/voltage clamp techniques. Halothane (HAL) effects on GABA release were determined by measuring the frequency of the IPSCs and other relevant electrophysiology parameters (*e.g.*, membrane potential, input resistance, and spike threshold).

RESULTS Halothane (HAL) affects IPSC frequency, time course, and peak amplitude (see Fig.). HAL increased the frequency of IPSCs to 71 ± 35% of controls. Tetrodotoxin was used to block sodium channels, but did not affect HAL-induced IPSC frequency, thus localizing the HAL effects to the synaptic terminal. Recordings from interneurons confirmed that HAL-induced GABA release must be from their terminals, as no change was detected in the resting membrane potential, input resistance, firing threshold or spike accommodation of interneurons bathed in HAL.

To determine which of several Ca^{2+} release pathways were involved in the presynaptic action of HAL, cadmium (Cd) was added to block all voltage operated calcium channels. HAL increased the frequency of IPSCs by 72 ± 49% in the presence of Cd, suggesting that external Ca^{2+} influx was not involved. Intracellular Ca^{2+} levels can also be elevated by release from internal stores via inositol 1,4,5-tris-phosphate (IP_3) receptor and ryanodine receptor Ca^{2+} release channels (CaRCs). HAL has been shown to activate CaRCs in cardiac myocytes, so we examined various CaRC modulators for their effects on HAL-induced GABA release from interneuron terminals. Pretreatment with dantrolene, which inhibits endoplasmic reticulum (ER) release of Ca^{2+}, abolished the HAL-induced increase in IPSCs, suggesting that Ca^{2+} release from the ER is required for the GABA release.

To determine which CaRCs were involved in HAL-mediated GABA release, the effects of thapsigargin (THP) and cyclopiazonic acid (CPZ), which selectively deplete IP_3-sensitive pools of Ca^{2+}, and ryanodine (RYD) which blocks Ca^{2+} transport at the ER, were examined. In the presence of THP and CPZ, HAL still increased IPSCs 71 ± 32% of controls, but RYD blocked the action of HAL on IPSCs, demonstrating that presynaptic HAL effects involve RYD-sensitive but not IP_3-sensitive Ca^{2+} stores.

Total inhibition was measured by integrating chloride currents (∫ (pA • seconds) = pC) reflecting both the increase in number and duration of IPSCs. Total GABA inhibition increased to 373 (± 111)% of control in the presence of HAL (see Fig.). About 50% of the HAL effect resulted from increased IPSC frequency.



DISCUSSION General anesthetics such as HAL increase synaptic inhibition in the CNS by enhancing GABA receptor-mediated chloride currents. This study demonstrates that HAL also acts directly on the terminals of inhibitory hippocampal interneurons to release more GABA. This presynaptic HAL effect was shown to be dependent on the release of intracellular Ca^{2+} from RYD-sensitive Ca^{2+} stores. Furthermore, this enhanced presynaptic GABA release combined with HAL-augmented postsynaptic GABAergic actions to synergistically enhance the overall synaptic inhibition. These effects would be expected to contribute to the CNS depression associated with HAL anesthesia.

INFLUENCES OF MUSKRAT PREDATION ON POPULATION STRUCTURE OF *MARGARITIFERA MARGARITIFERA* (MOLLUSCA: UNIONOIDEA) AT STREAM SITES IN ST. LAWRENCE COUNTY, NEW YORK

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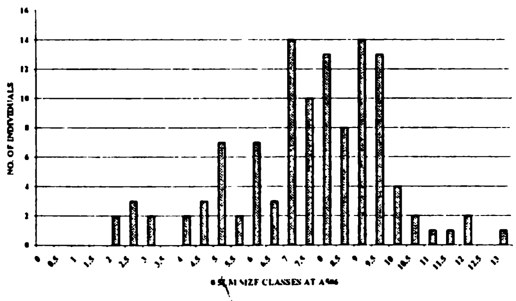
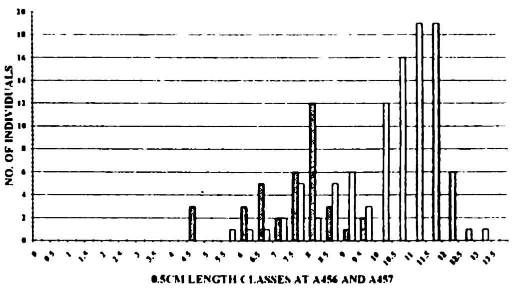
The native North American freshwater mussel fauna is the most diverse in the world. Unionoid clams are a significant portion of the invertebrate biomass of many streams yet, until recently, their ecological roles in these settings have gone unstudied. Extirpation by exotic species such as *Dreissana polymorpha* and *D. quagga*, poaching by shell exporters, and elimination by habitat degradation are now quickly endangering many native species before their ecological roles have been understood. Since 1971, I have been examining mussel species distributions and collecting population data across a wide area in northern New York. Recent interest in the predation ecology of muskrat (*Ondatra ziebethecus*) on unionids in the Mississippi River of Minnesota (1) has prompted this discussion of some 1985 data relevant to muskrat predation of *Margaritifera margaritifera*, the eastern pearlshell. *Margaritifera margaritifera* is a mussel of headwater streams of 2nd, 3rd, and 4th order, having cobble and gravelly sand bottoms and generally cool, clear, uless-productive, well-oxygenated soft water. These are Adirondack trout streams therefore the brook trout, *Salvinellus fontinalis* and brown trout, *Salmo trutta*, not surprisingly, are glochidial hosts for the species. *M. margaritifera* often is the only mussel in these streams. Rarely, it will co-occur with one, two or three other unionids. I have recorded the species at more than 50 sites in north-flowing Adirondack drainage tributary to the St. Lawrence River in New York. The holarctic eastern pearlshell is *bradytytic*. Population structures determined using length, width and height measurements accompanied by growth line counts, reveal much about the organism's ecological strategies. *M. margaritifera* in Europe are known to have lived 116 years (2) although there are presently no populations with specimens that age extant in the region. Populations are typically modest in numbers with maximum ages in the 20-to-30-year-old range (3). As the sole unionoid present in these drainages, *M. margaritifera* is a food source of several mammal species. Muskrat often rely on mussels where the shellfish are common. This study has shown that at those sites muskrat predation has a significant impact upon population structure.





To illustrate impact, data from unpredated and predated populations are presented in Figures 1 and 2. Site A 506 contained a population that was not obviously associated with muskrat middens or other evidence of recent predation. When hand-picked by fish scope and snorkel, live mussels ranged from 2.6-to-12.4cm in length with growth ring counts that suggest minimum ages well in excess of 20 years. Size distributions are nearly normal around a mean of 7.8cm. Site A456 was associated with an active muskrat midden, collected as A457 (Fig. 2, solid bars). There live *M. margaritifera* ranged from 5.5-to-13.2cm long and the population was skewed with a mean at 10.4cm. Measurement of all specimens in the midden produced a near-normal distribution with a mean at 7.5 cm. Predated sizes range from 4.5-to-9.7 cm which are a range of sizes with reduced representation in the living population of A456 (Fig. 2, open bars.). Muskrats using *M. margaritifera* preyed most heavily on the **8.0**–to-8.4cm size class. Mussels larger than 10cm and smaller than 4cm are not predated, suggesting that larger size provides refuge from muskrat predation whereas smaller size requires excessive energy to find either because of difficulty to locate, scarcity or both in agreement with previous studies (1). Similarly, but for different species, Tyrell and Hornbach (1) reported shells in the 3-to-8cm lengths to be most common in middens on two Minnesota rivers. These relationships may have more significance for the eastern pearlshell in Adirondack streams where it tends to have great longevity, relatively low recruitment rates and where large specimens are the targets of human poaching.

I wish to acknowledge efforts of Harold Cashman, A.R. Fetterman, T. Abrantes, Andrew Solod and many SLU students.

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HORMONAL CONTROL OF LEAF EXPANSION IN THE COMMON BEAN (*PHASEOLUS VULGARIS*)

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INTRODUCTION

The plant hormone auxin (indole acetic acid) is produced primarily in the youngest leaves of the apical bud (1). Transported basipetally (downward) it is believed critical to stem elongation and to be a principal controller of the development of lateral branches. Auxin, however, was long thought to have only a limited role in the development of leaves (2). Recent work, however, has established that excised tobacco leaf tissue has a substantial growth response when treated with auxin (3, 4). Other workers have since established evidence that a specific protein (*i.e.* auxin binding protein 1) is the hormone receptor in tobacco leaf cells responsible for sensitivity to the hormone by cells in excised tobacco leaf tissues (5, 6).

What has not been established is whether auxin produced by the shoot apex controls the development of leaves in the intact plant. Decapitation (*e.g.*, removal of the hormone source) of bean plants (*Phaseolus vulgaris*) has been shown to enhance the growth of the primary leaves (7). In an initial study (8), we found that when the shoot apex was replaced with a lanolin paste containing a high concentration of auxin, the first monofoliate leaves grew more slowly and reached a smaller final size than those treated with lanolin paste alone. While this result suggests there is a role for apically-produced auxin in the control of leaf expansion, the concentration applied was non-physiologically high. The current study attempts, first, to determine if lower concentrations of auxin applied in place of the apex are also inhibitory to leaf growth. Secondly, reports (9) that auxin applied directly to bean leaves produces a transient increase (rather than decrease) in growth were also re-investigated.

METHODS

Phaseolus vulgaris var. Contender were grown in moist vermiculite under greenhouse conditions. After 10 to 14 days, plants with similar monofoliate leaf blades (*i.e.*, measuring between 45 to 55 mm in length in most experiments) were selected for experimentation. In some experiments the plants were decapitated just below the apical bud and a lanolin paste containing up to 1500 ppm naphthalene acetic acid (NAA), a well-characterized auxin analog was then applied to the stump. An initial blade length was measured for both monofoliate leaves of each plant. Blade length was then re-measured each day for 6 or more days. In other experiments NAA (up to 1 mM; buffered to *p*H 6.0 with BTP) was applied directly to leaf surfaces in aqueous solutions.

RESULTS AND DISCUSSION

In decapitation experiments where the apex was replaced with an NAA containing lanolin paste, all auxin concentrations (5000 to 1.5 ppm) were found to inhibit leaf elongation, final blade weight, and final surface area over a 14 day period. Applied once directly to leaves, NAA in aqueous solution at 1.0 and 0.1 mM was found to significantly inhibit leaf blade elongation throughout a six day period. Final length, six days after treatment with 1.0 mM NAA, of treated leaf blades was approximately 80% of controls. Preliminary results show epidermal cells of treated leaves to be much smaller (surface area approximately 40% of controls).

The results support the hypothesis that final leaf size is controlled, at least in part, in intact plants by the inhibitory effect of apically-derived auxin and that it is the post cell division phase of growth (cell expansion) that is inhibited by the hormone.

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PURIFICATION OF A PHOTOAFFINITY LABELED PROTEOLYTIC FRAGMENT FROM CLONED HUMAN DOPAMINE TRANSPORTER

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INTRODUCTION

The dopamine transporter is a transmembrane protein which removes dopamine from the synapse into the nerve cell after excitation. Inhibition of this transport is considered to be the major physiological action of cocaine. To understand the normal action of the transporter and how cocaine affects it we need to know the transporter's molecular structure and the substrate binding site. The amino acid sequence of the transporter is known and it belongs to a family of monoamine transporters believed to consist of twelve transmembrane helices. Previous work has implicated transmembrane domains 4-7 as a potential binding site for the cocaine analogue RTI-82 (1). The goal of this research is to locate more precisely the attachment site on the dopamine transporter of the photoaffinity label, [^{125}I]-RTI-82. Locating this site would suggest at least some of the residues in the vicinity of the cocaine binding site.

METHODS

HEK293 cells transfected with polyhistidine tagged human dopamine transporter (hisDAT) were obtained from J. Justice of Emory University. Radioiodinated RTI-82 was obtained from John Lever of John Hopkins; non-radioactive RTI-82 was obtained from F. I. Carroll of Research Triangle Institute. Western blots were done with primary antibodies generated against synthetic DAT peptide sequences and secondary antibodies conjugated with HRP from Sigma. Silver staining was done with the Bio-Rad Silver Stain Plus Kit. Mass spectroscopy was done in the laboratory of Dr. Justice.

RESULTS AND DISCUSSION

Digestion of photoaffinity-labeled hDAT demonstrated that limit digests with chymotrypsin produced a 2-3 kDa photoaffinity labeled fragment which was not further digested by either trypsin or V-8 protease. This work is an account of the successful purification of that fragment.

HEK293 cells transfected with polyhistidine tagged human dopamine transporter were broken with a polytron homogenizer and cell membranes collected by centrifugation. The cell membranes were photoaffinity labeled and solubilized with 2% triton and 6 M urea. The hisDAT was partially purified on a NiNTA column and the column fractions were examined using SDS-PAGE, autoradiography, silver staining and western blotting. The fractions containing hisDAT were dialyzed, concentrated, and electrophoresed. The hisDAT bands were located by autoradiography, excised, and incubated in a solution of chymotrypsin. As the chymotrypsin hydrolyzed the hisDAT in the gel, peptide fragments from the hisDAT were released into the surrounding solution. Electrophoresis and autoradiogrphy of the eluates showed a 2-3 kDa fragment containing radiolabel.

The gel piece containing the radioactive peptide was cut out, eluted with 0.01 M NH_4HCO_3 and the eluates were freeze-dried. Mass spectroscopic examination of the sample indicated a single peptide of 2644 Da which corresponds to residues 233 to 254 of hDAT; this sequence is partially included in the fourth transmembrane domain. These results suggest that RTI-82 binds to the transporter near this region. They represent one of the first indications of a contact site for cocaine. The results are consistent with previous reports, however the current work is significantly more specific. This work also represents the most significant progress to date on purifying the DAT protein.

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PALEONTOLOGY AND STRATIGRAPHY OF THE BASAL FORT UNION FORMATION (PALEOCENE: PUERCAN) FROM SLOPE COUNTY, NORTH DAKOTA

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INTRODUCTION The purpose of this study was to inventory the occurrence of vertebrate, invertebrate and plant specimens within the basal Fort Union Formation and to plot these occurrences relative to the Hell Creek/Fort Union formation contact. This study was restricted to those sediments lying between the Hell Creek/Fort Union formation contact and the overlying Marmarth Ash/Bentonite. It was also important to document the stratigraphy of of this study horizon, to determine its age and to determine the stratigraphic placement of the Marmarth Ash/Bentonite. This study is also meaningful in establishing what reappeared into the local environment following the extinction at the end of the Cretaceous.

METHODS A total of twelve columns were used to provide the stratigraphic database (1-3). These columns were located in sections 5, 8, 9, 10, 15, 16, 20, 21, and 22 all in T133N R105W Slope County, North Dakota. In some instances, columns already in place were re-examined for pollen; in others, new columns were made. The pollen analysis established the position of the Cretaceous-Tertiary (K-T) boundary relative to the Hell Creek/Fort Union formation contact. The position of the Marmarth Ash/ Bentonite horizon was established by the lateral tracing of the outcrop throughout the study area and correlation of its position into the stratigraphic columns. The study horizon, bounded by the overlying Marmarth Ash/Bentonite and the underlying Hell Creek/Fort Union formation contact, was then searched for vertebrate, invertebrate, and plant remains. When any remains were found through surface collection or minor excavation, they were correlated into the nearest stratigraphic column for comparison.

RESULTS We recorded a total of 20 vertebrate taxa, representing 18 families. These included 4 fish, 1 salamander, 7 turtles, 1 champosaur, 2 crocodilians, 1 alligator, and 4 mammals. Two of the mammals, *Oxyacodon priscilla* and *Oxyprimus galadrielae*, are only known from the Puercan Land Mammal Age (4). Paleomagnetism studies from the immediate area seem to indicate that Chron 29R may be present up to 10 meters above the formation contact (1). This presence of Chron 29R is also an indicator of Puercan age. The vertebrates first appear at 3.50 meters above the formation contact and all 20 taxa are present at 7.63 meters above. Gastropods and mollusks are present in the form of steinkerns and occur from 5 to 6 and 5 to 7 meters above the formation contact, respectively. Identifiable leaf remains were present from 5.90 meters on upwards through the studies section and represent the FU1 flora of Johnson (5). The Marmarth Ash/Bentonite horizon is located 9.5 to 11.00 meters above the formation contact throughout the study area and in most instances appears as a highly-weathered, dark, bentonitic drape. The sediments in our study horizon indicate wetter environments, supporting coal swamps (1-3) as seen in the alternating horizons of variegated bedding, mudstones, carbonaceous shales and lignites. A local channel, PITA Flats (4), incises down through the Marmarth Ash/ Bentonite and replaces it when present. Most of the vertebrates recovered are laterally equivalent to this channel. The location of the K-T boundary throughout this study area is the basal Fort Union Formation (1-3, 6-7), and is at least as high as 2.37 meters above the formational contact, as seen in one section [NDAS], where we inadvertently failed to sample high enough to locate the boundary.

DISCUSSION The Marmarth Ash/Bentonite is located in the basal Fort Union Formation and not the upper Hell Creek Formation, as previously recorded (8, 9). The mammalian fauna and the possibility of Chron 29R in the study horizon suggests continual deposition in the area following the K-T boundary and the age of the sediments to be Puercan. The occurrence of the K-T boundary at least 22.37 meters up into the Fort Union Formation places the lowest vertebrate horizon to at least within 1.13 meters of the boundary, indicating a very short duration, if any, that followed the terminal Cretaceous extinction event prior to local repopulation of the environment.

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THE LAST FRESHWATER MOLLUSCAN ASSEMBLAGE OF THE CRETACEOUS? A NEW LOCALITY FROM THE LUDLOW FORMATION OF NORTH DAKOTA

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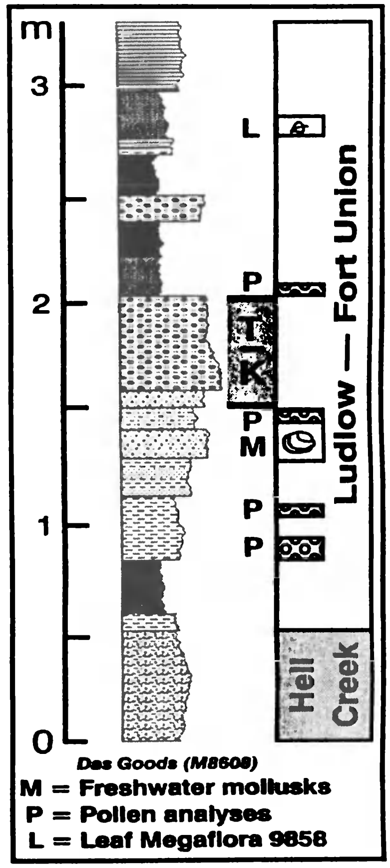
INTRODUCTION

The freshwater molluscan record of the uppermost Cretaceous is replete with numerous localities containing species-rich assemblages of highly sculptured freshwater unionids (Family Unionidae). Nonmarine molluscan biostratigraphy during this time is best known from the Williston Basin of Montana (1), where the Hell Creek Formation is fossiliferous throughout most of its extent. Sampling is particularly robust in the upper half of the formation in part because of the accessibility of strata in badland exposures. The upper few meters of the formation appear to be less well sampled, but the absence of fossils is due more to the rarity of fossil occurrences subjacent to the Cretaceous–Tertiary (K/T) boundary. In North Dakota, the K/T boundary is usually found within the basal meters of the Ludlow Member of the Fort Union Formation (2). This contribution represents the first record of mollusks from the Cretaceous portion of the Ludlow and is a rare glimpse of an assemblage of freshwater mollusks at the very end of the Cretaceous.

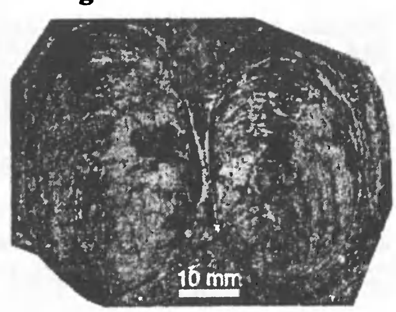
Figure 1. L6516 Stratigraphy



OBSERVATIONS

While prospecting in 1998, Kirk Johnson (3) and Tim Farnham discovered molluscan fossils (Figure 1, M = Hartman Locality L6516) in sec. 9, T. 134 N., R. 106 W., in Little Missouri River badland exposures in Slope County, North Dakota. Collections from the 1998, 1999, and 2000 field seasons represent an assemblage dominated by unionid bivalves and a species of caenogastropod belonging to the family Viviparidae. The bivalves are unsculptured and typically ovate in marginal outline (Figure 2). Morphotypes have been identified, but in the absence of distinctive features, no generic or specific names have been assigned. Fossils are preserved as compressed external molds, most often articulated or with valves butterfly-open, in a pale yellowish brown (10YR 6/2-5YR 5/2) clay-rich, slightly sandy siltstone, rich with plant debris. Diagnostic palynomorphs were identified by Doug Nichols from the Badland Draw and Das Goods sections (2) delimiting the K/T boundary interval (Figure 1) superjacent to the molluscan fossils.

Figure 2. L6516 Unionid



CONCLUSIONS

Hartman (1) has suggested that the absence of highly sculptured unionid clams at the very end of the Cretaceus is real and not a product of biased sampling. The extinction of bivalves and snails with tubercles, nodes, and accentuated ridges so characteristic of the Cretaceous appears complete prior to the K/T boundary. Although representing a rare occurrence, the unsculptured Ludlow bivalves reported here may reflect evidence of a molluscan faunal turnover prior to the end of the Cretaceous.

ACKNOWLEDGMENTS

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ALTERED LEPTIN-INDUCED CARDIAC CONTRACTILE RESPONSE IN VENTRICULAR MYOCYTES UNDER HYPERTENSION

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The prevalence of obesity has dramatically increased within the United States and is becoming an epidemic problem (1). Obesity is associated with many comorbidities but hypertension is the most common (1, 2). Elevated plasma concentrations of leptin, the protein product of the obese (*ob*) gene, are associated with obesity and increased sympathetic nervous system activity (3, 4). Leptin has further been shown to increase blood pressure after chronic infusion into Sprague Dawley rats (5). Our group has recently revealed a direct effect of leptin on isolated cardiomyocytes from Sprague Dawley rats through a dose-dependent inhibition of myocyte shortening and intracellular Ca^{2+} change (6). A nitric oxide (NO) dependent mechanism is believed to be partly responsible for this cardiac depressive effect of leptin.

Although there is a strong association between leptin, obesity, and hypertension, the impact of elevated blood pressure on leptin induced cardiac depression is unknown. The purpose of this study was to determine the impact of hypertension on leptin-induced cardiac depression through the analysis of cell shortening, intracellular Ca^{2+}, and nitric oxide synthase (NOS) activity in isolated myocytes from spontaneously hypertensive rats (SHR) and their control littermates (WKY).

Ventricular myocytes were isolated from adult male SHR and WKY rats. Contractile properties of peak shortening (PS), time-to-90% PS (TPS), and time-to-90% relengthening (TR90), along with intracellular Ca^{2+} properties such as fura fluorescence intensity change (DFFI), were examined using video-based edge-detection (6). The experimental protocol included assessment of myocyte contractile properties while cells were superfused with leptin (1.0-1000 nmol/L). A NOS assay was also performed on cells by the ^{3}H-arginine to ^{3}H-citrulline conversion assay.

Biometric data confirmed that SHR animals exhibited elevated blood pressure ($p<0.001$) and plasma leptin levels ($p<0.01$) compared to controls (WKY). Elevated liver weight to body weight ratios were seen in SHR ($p<.05$). Peak shortening was greatly reduced in WKY animals (~24±8.5%) but not SHR at a leptin concentration of 100 nmol/L. The diminished peak shortening in the presence of leptin was completely abolished by the addition of L-NAME. NOS assay confirmed an association between leptin concentration and NO production.

This study demonstrates an attenuated cardiac response of SHR ventricular cardiomyocytes in the presence of leptin. Decreased contractility in the WKY controls is consistent with previous research (6). Down-regulation or polymorphism of the leptin receptor has been implicated in the attenuated response to leptin in the presence of obesity induced hypertension (4, 7). Furthermore, the complete reversal of decreased peak shortening in the presence of L-NAME suggests the leptin induced cardiac contractile response is, at least in part, mediated by an NO dependent mechanism. This is strengthened by the decreased NOS production seen during leptin dose responses in SHR myocytes.

In summary, this study demonstrated an attenuated response of SHR ventricular myocytes to leptin induced cardiac depression which has been shown to be, at least in part, mediated through an NO-dependent pathway. Further research should attempt to identify the possible mechanism for this attenuation.

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ARSENIC DEPRIVATION AFFECTS HOMOCYSTEINE REMETHYLATION IN RATS FED HOMOCYSTINE AND CHOLINE

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Dietary arsenic (As) is thought to have a physiological role in methionine (Meth) metabolism (1). Some findings suggest that arsenic may be important in the remethylation of homocysteine to methionine. There are two pathways by which homocysteine can be remethylated to form methionine. One pathway, catalyzed by the enzyme methionine synthase (MS), derives its methyl group from the C1 (folic acid) pool. The other pathway derives its methyl group from choline and is catalyzed by the enzyme betaine-homocysteine methyltransferase (BHMT). Thus, the objective of this study was to assess in rats the effect of arsenic deprivation on these 2 pathways. The pathways were altered by feeding either methionine or homocystine (H-H) in conjunction with either folic acid (FA) or choline deficiency. The experiment was a 2 x 2 x 2 design with dietary variables arsenic (0 or 0.5 µg/g), DL-methionine or DL-homocystine (one or the other in the diet), and choline or folic acid (one or the other in the diet). The basal diet was lacking in folic acid and choline. Thus, the diets containing choline were deficient in folic acid and the diets containing folic acid were low in choline. After 54 days on the experimental diets, the rat were fasted overnight and then tissues were collected following ether anesthesia. Data were compared statistically by using three-way analysis of variance. Significance was assessed at $p<0.05$.

Table 1. Effect in Rats of Dietary Arsenic, Sulfur Amino Acid (SAA; Methionine or Homocystine), and Methyl Donor (Vitamin; Folic Acid or Choline) on Final Weight and the Activities of Liver Methionine Synthase and Betaine-Homocysteine Methyltransferase.

Treatment			Body	MS	BHMT
As, µg/g	SAA	Vitamin	Weight, g	nmol/min/mg protein	
0	H-H	Choline	163±9[1]	0.066±0.023	0.215±0.070
0.5	H-H	Choline	195±17	0.077±0.028	0.329±0.058
0	H-H	FA	283±20	0.107±0.031	0.147±0.035
0.5	H-H	FA	270±14	0.090±0.023	0.121±0.037
0	Meth	Choline	218±29	0.041±0.012	0.290±0.111
0.5	Meth	Choline	234±21	0.047±0.016	0.442±0.108
0	Meth	FA	298±38	0.088±0.039	0.355±0.080
0.5	Meth	FA	306±28	0.106±0.038	0.317±0.080
Significant effects			SAA, Vit AsxVit (<0.08)	Vit	As, SAA, Vit AsxVit, SAAxVit

[1]Mean ± standard deviation; N=6 per group (5 per group for 0As H-H FA).

As shown in Table 1, for body weight there was a tendency for As and Vitamin to interact. The arsenic deprived rats fed choline tended to weigh less than those fed supplemental As; this was not true in the FA-fed rats. MS activity was decreased in rats fed choline (no folic acid). BHMT was decreased by arsenic deprivation in rats fed dietary choline. The results suggest that dietary arsenic does affect remethylation of homocysteine. The data show that arsenic-deprived rats fed choline (no folic acid) can not as efficiently compensate with the enzyme BHMT to produce methionine. This finding suggests that arsenic has a physiological role related to BHMT or in the metabolism of betaine from choline, or that arsenic deprivation results in more S-adenosylhomocysteine which inhibits BHMT.

1. Uthus EO. (1994) *In*, Arsenic Exposure and Health, Science and Technology Letters. Chappell WR, Abernathy CO, Cothern CR (eds). Northwood; pp 199-208.

CONSTITUTION of the NORTH DAKOTA ACADEMY OF SCIENCE

Founded 1908, Official State Academy 1958

ARTICLE I - *Name and Purpose*

Section 1. This association shall be called the NORTH DAKOTA ACADEMY OF SCIENCE.

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

ARTICLE II - *Membership*

Membership in the Academy shall be composed of persons who share the stated purpose of the Academy and who are active or interested in some field of scientific endeavor.

ARTICLE III - *Council*

The officers of the Academy shall be a President, a President-Elect, and a Secretary-Treasurer. The Council, consisting of the officers, the retiring President, and three elected Councilors, shall be responsible for the fulfillment of the scientific and business obligations of the Academy.

ARTICLE V - *Dissolution and Limits of Action*

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

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

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

ARTICLE VI - *Amendments*

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

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

BYLAWS

BYLAW 1. *Meetings*

Section 1. *Scientific Meetings*. The Academy shall hold at least one annual scientific meeting each year at a time and place determined by the Council. Other scientific meetings, regional, state, or local, may be held at times and places determined by the Council. The Council shall establish regulations governing the presentation of papers at Academy sessions. Such regulations shall be made available to members at least three months before any meeting at which they are to apply.

Section 2. *Business Meetings*. A Business Meeting of the membership shall be scheduled at the regular, annual scientific meeting of the Academy. Ten percent of the active members shall constitute a quorum at the annual business meeting.

Section 3. *Special Meetings*. Special meetings shall be called by the President upon the request of ten percent of the active members and require twenty percent of the active members for a quorum. Notice of the time and place of such meetings shall be sent to all members of the Academy at least four weeks in advance of the meeting. Only matters specified in the call can be transacted at a special meeting.

Section 4. *Procedure.* Parliamentary procedures to be followed in all business meetings shall be those specified in "Standard Code of Parliamentary Procedure" by Alice F. Sturgis.

BYLAW 2. *Financial*

Section 1. *Dues and Assessments.* The annual dues and assessments may be changed from time to time by the Council, subject to approval by a two-thirds vote of the members at an annual Business Meeting. The student member dues shall be one-third (to nearest dollar) of the regular member dues. These dues are payable 1 December of each year.

Section 2. *Supporting Members.* Council shall maintain a program to encourage members to voluntarily contribute funds over and above the regular dues and assessments for the support of activities of the Society.

Section 3. *Sustaining Members.* Any association, corporation, institution, or individual desiring to support the Society with funds or services valued at $50 or greater may be invited by the President or designee to become a Sustaining Associate.

Section 4. *Audit and Reports.* The Nominating Committee shall appoint on a yearly basis one member who is not a member of Council to conduct at least one internal audit per year. The Secretary-Treasurer shall report on the financial affairs of the Society, including the results of an annual audit, as may be requested by the Council.

BYLAW 3. *Membership*

Section 1. *Membership Categories.* Classes of membership shall include the following: (a) Regular, (b) Student, (c) Emeritus, (d) Honorary, (e) Supporting, (f) Sustaining, and (g) Lifetime Members.

Section 2. *Eligibility and Procedure for Membership.* Candidates for membership, except Sustaining Member, may be proposed by any regular or emeritus member of the Academy by submitting the candidate's name to the chairman of the Membership Committee.

(a) *Regular Members.* Any person who is active or interested in some field of scientific endeavor shall be eligible for regular membership. A majority vote of Council shall elect to regular membership.

(b) *Student Members.* Any student who is an undergraduate or graduate student in some field of science shall be eligible for student membership. A majority vote of Council shall elect to regular membership.

(c) *Emeritus Members.* Any member in good standing upon formal retirement is eligible for emeritus membership. A majority vote of Council shall elect to emeritus membership.

(d) *Honorary Members.* The Academy may recognize, by awarding honorary membership, any person (nonmember or member) who has in any way made an outstanding contribution to science. It shall be the responsibility of the Membership Committee to be aware of individuals whom it would be fitting for the Academy to honor in this fashion. A two-thirds vote of members attending the annual business meeting shall elect to honorary membership.

(e) *Supporting Members.* Regular or student members may voluntarily contribute funds over and above the regular dues and assessments for the support of activities of the Society.

(f) *Sustaining Associates.* Any association, corporation, institution, or individual desiring to support the Society with funds or services valued at $50 or greater may be invited by the President or designee to become a Sustaining Associate.

(g) *Lifetime Members.* Any regular member in current good standing for at least one year may become a Lifetime Member by paying an assessment equal to 18 times the current annual dues in one lump sum or in two equal payments over the current and following year.

Section 3. *Privileges of Membership.*

(a) Voting at the annual business meeting is permitted of regular and emeritus members.

(b) Members of all categories may attend business meetings of the Academy.

(c) The Secretary-Treasurer and members of Council must be regular members in good standing.

(d) Regular, student, and emeritus members may submit abstracts or communications for scientific meetings of the Academy.

(e) Emeritus and Honorary Members shall be exempt from payment of dues.

(f) A Sustaining Member is provided a display area at the annual scientific meeting of five linear feet per $50 donation up to a maximum of 20 linear feet.

(g) Every member in good standing shall receive a printed copy or an electronic copy (if available and of equal or lesser cost than the printed copy) of the annual *Proceedings of the North Dakota Academy of Science*, the form to be determined by the member.

(h) Special offices such as Historian may be created by the unanimous vote of the regular members at the annual Business Meeting.

(i) All student research participants shall receive a properly inscribed certificate.

Section 4. *Forfeiture of Membership.*

(a) *Nonpayment of dues.* Members shall be dropped from the active list on 31 November following the nonpayment of dues during the membership year commencing the previous 1 December. A member may return to the active list by paying the current year dues.

(b) *Expulsion for Cause.* Membership may be terminated for conduct injurious to the Academy or contrary to the best interests of the Academy. The accused member shall be given an opportunity for a hearing before the Council. If a majority of the Council votes to expel the member, the action must be ratified by at least two-thirds of the members present at the next annual business meeting of the Academy. An expelled member shall forfeit all paid dues and assessments.

BYLAW 4. *Duties and Responsibilities of the Council and Council Members*

Section 1. *Council.* The Council shall meet, at the call of the President, at least twice a year. The Council shall:

(a) be the governing board of the Academy, responsible only to the membership.

(b) arrange for programs, approve committee appointments, be responsible for the fiscal affairs of the Academy, an transact such business as necessary and desirable for function and growth of the Academy.

(c) determine the location of the annual meeting three years in advance.

(d) annually appoint an Academy representative to the National Association of Academies of Science and to Section X (General) of the American Association for the Advancement of Science.

(e) shall appoint and may compensate a Secretary-Treasurer.

(f) shall appoint and may compensate an Editor of the PROCEEDINGS and other publications.

(g) shall be empowered to charge a publication fee of authors on a per page basis.

(h) shall control all activities of the Academy including grant applications.

Section 2. *President.* The President shall preside at meetings of the Council and over the annual business meeting of the Academy at the close of the regular term of office. The President shall vote only to break a tie. Unless otherwise specified, the President shall, with the approval of the Council, appoint members to serve on Standing Committees and *ad hoc* Committees, designate the chair of each Committee, and appoint representatives to other organizations. The President serves as Coordinator of the Local Arrangements Committee for the annual meeting that occurs at the end of the President's term.

Section 3. *President-Elect.* The President-elect shall be considered a vice president and shall serve as such in the absence of the President.

Section 4. *Past-President.* The retiring President shall serve as Past-President and chair of the Nominating Committee. The Past President shall serve ex officio on those committees designated by the President and shall serve in the absence of the President and President-elect.

Section 5. *Secretary-Treasurer.* The Secretary-Treasurer shall:

(1) Assist Council in carrying on the functions of the Academy including the receipt and disbursement of funds under the direction of Council.

(2) Manage the Academy Offices under Council's general supervision.

(3) Serve as Managing Editor of the *Proceedings of the North Dakota Academy of Science.*

(4) Prepare a summary of the most recent audit and a report of the Academy's current financial status. This information shall be shared with the membership at the annual business meeting and published in the PROCEEDINGS following the business meeting.

(5) Perform all other duties of the Secretary-Treasurer listed in the Bylaws.

(6) Serve as archivist and be responsible for all official records, archives, and historic material which shall be in reposit with the Secretary-Treasurer.

BYLAW 5. *Appointment, Nomination and Election of Members of Council*

Section 1. *Eligibility for Office.* All candidates for election or appointment to the Council must be regular members in good standing. Nominees for President-elect must be members who reside within easy commuting distance of the site of the annual meeting selected by the Council that occurs when the President-elect serves as President.

Section 2. *Nomination Procedures.* The Nominating Committee shall be responsible for all nominations to elective office, shall determine the eligibility of nominees, shall ascertain that nominees are willing to stand for office, and shall be required to advance to the Secretary-Treasurer at least two names for each open position as needed. Academy members shall have been encouraged to suggest nominees to the committee prior to the Committee submitting its report.

Section 3. *Election Procedures.* Election shall be by secret mail ballot. The Secretary-Treasurer shall prepare a printed ballot that bears all names submitted by the Nominating Committee, that contains a brief biography of each candidate, and that has space for write-in candidates for each office. This ballot is to be mailed to all members no later than 1 November. Each member wishing to vote must return the marked ballot in a sealed signed envelope to the Secretary-Treasurer postmarked not more than thirty days after the ballots were mailed out to members. The President shall appoint tellers who shall count the ballots which have been received by the Secretary-Treasurer and the tellers shall present the results in writing to the President. A plurality of the votes cast shall be necessary to elect and in the case of a tie vote, the President shall cast the deciding vote. The results of the election shall be announced at the annual Business Meeting.

Section 4. *Term of Office.* A President-Elect shall be elected annually by the membership and the following years shall succeed automatically to President and Past President to constitute a three year nonrenewable term. Three Councilors shall be elected by the membership to three-year, non-renewable terms on a rotating basis. All elected Council members shall take office at the end of the next annual Business Meeting following election and shall continue until relieved by their successors. Council is empowered to appoint and compensate a Secretary-Treasurer to successive three-year terms that commence with the beginning of the fiscal year.

Section 5. *Removal from office or position* If for any reason any elected member of Council is unable to fulfill his/her duties, the Council member may be removed from office by two-thirds vote of Council. If for any reason the Secretary-Treasurer is unable to fulfill his/her duties, the Secretary-Treasurer may be relieved of all duties by a majority vote of Council.

Section 6. *Interim vacancies.* Should a vacancy occur in the Presidency, the Council by a majority vote shall appoint a member of the Academy able to coordinate the next annual meeting to fill the unexpired term. A retiring interim President shall succeed automatically to Past President. Should a vacancy occur in the Presidency-elect, the Council shall reassess and change the location of the coinciding annual meeting as necessary and then call for a special election by mail ballot. An interim vacancy in the Past-Presidency shall be filled by the most recently retired Past-President able to fill the duties of the Past-President. Persons appointed to fill the unexpired term of Secretary-Treasurer are expected to remain in the position for a minimum of three years. A vacancy in the office of Councilor shall be filled by a majority vote of Council until the following election at which time the interim Councilor may stand for a full three year nonrenewable term.

BYLAW 6. *Committees*

Section 1. Standing Committees. Standing committees shall include but not be limited to, the following: Editorial, Education, Denison Award, Necrology, Nominating, Resolution, Membership, and Audit Committees. The President shall appoint members of committees other than the Nominating and Audit Committees.

Section 2. *Editorial Committee.* The Editorial Committee shall consist of three regular members appointed to three year terms. The duties are explained in BYLAW 7 (Publications).

Section 3. *Education Committee.* The Education Committee shall consist of five regular members and two high school teachers appointed to five year terms. The Education Committee shall work with high school students and teachers in the state, in visitation programs, Science Talent Search programs, and other programs to stimulate an interest in science by the youth of the state. It shall operate the Junior Academy of Science program and administer the AAAS high school research program.

Section 4. *Denison Awards Committee.* The Denison Awards Committee shall consist of six regular members appointed to three year terms. The Denison Awards Committee shall have as its prime duty the judging of student research and paper competitions, both undergraduate and graduate, and any other similar competitions. The committee shall also maintain the criteria to be used in the judging and selection of papers, such criteria to be circulated to prospective competitors.

Section 5. *Necrology Committee.* The Necrology Committee shall consist of three regular members appointed to three year terms. The Necrology Committee shall report to the annual meeting on those deceased during the preceding year. Obituaries may be included in the minutes of the annual meeting and/or published in the Proceedings.

Section 6. *Nominating Committee.* The Nominating Committee shall consist of the five most recent past-presidents. The major duties of the Nominating Committee are listed in BYLAW 5 (*Appointment, Nomination and Election of Members of Council*). The Nominating Committee will also administer the selection process, develop a separate funding source for a monetary award, and develop, for Executive Committee approval, the criteria for the North Dakota Academy of Science Achievement Award.

Section 7. *Resolution Committee.* The Resolution Committee shall consist of three regular members appointed to three year terms. The Resolution Committee shall prepare such resolutions of recognition and thanks as appropriate for the annual meeting. Further, the Committee shall receive suggested resolutions for the membership and transmit such resolutions and the Committee recommendation to the membership.

Section 8. *Membership Committee.* The Membership Committee shall consist of unlimited numbers of regular members appointed annually.

Section 9. *Audit Committee.* The Nominating Committee shall appoint on a yearly basis one member who is not a member of Council to conduct at least one internal audit per year.

Section 10. *State Science Advisory Committee.* The State Science Advisory Committee (SSAC) shall consist of five regular or emeritus members appointed to four year terms. The SSAC shall serve to direct questions of a scientific nature to the appropriate expert as requested, shall inform regional granting agencies and state and national science policymakers of its expertise and availability and shall counsel those agencies and persons upon their request. The SSAC shall adhere in particular to the guidelines described in Article V, Section 2 of the Constitution.

Section 11. *Ad hoc Committees.* The President may appoint such additional committees as may be needed to carry out the functions of the Academy. Ad hoc committees serve only during the tenure of the president who appointed them. Reports of ad hoc committees shall be presented to Council or to the annual meeting.

BYLAW 7. *Publications*

Section 1. *Editorial Committee.* Three regular members are appointed to the Editorial Committee for renewable three year terms. The Editorial Committee shall develop and recommend the Academy publication program and policies to the Council. It will assist the Editors of each official publication in reviewing manuscripts for those publications that include the *Proceedings* . Chairs of symposia will review manuscripts written for relevant symposia.

Section 2. *Managing Editor.* The Secretary-Treasurer shall serve as the Managing Editor of all Academy publications and as such shall oversee each Editor.

Section 3. *Editor.* Editors shall serve three year terms. The Editors shall edit all official publications of the Academy including the *Proceedings.*

BYLAW 8. *Memorial Fund*

The Council of the Academy shall establish a J. Donald Henderson Memorial Fund and administer this fund so that the proceeds will be used to promote science in North Dakota.

BYLAW 9. *Fiscal Year*

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

BYLAW 10. *Achievement Award*

The Academy establishes the North Dakota Academy of Science Achievement Award to be given periodically to an Academy member in recognition of excellence in one or more of the following:

a. Nationally recognized scientific research.

b. Science education.

c. Service to the Academy in advancing its goals.

The Nominating Committee will administer the selection process, will develop a separate funding source for a monetary award, and will develop, for Council approval, the criteria for the award.

BYLAW 11. *Research Foundation*

The **North Dakota Science Research Foundation** is established as an operating arm of the Academy. The purposes of the Foundation are:

(1) to receive funds from grants, gifts, bequests, and contributions from organizations and individuals, and

(2) to use the income solely for the making of grants in support of scientific research in the State of North Dakota.

Not less than 50% of the eligible monies received shall be placed in an endowment from which only the accrued interest shall be granted.

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

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

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

BYLAW 12. *Affiliations*

The Academy may affiliate itself with other organizations which have purposes consistent with the purposes of the Academy. Such affiliations must be approved by the Council and by a majority of those attending a regularly scheduled business meeting of the membership.

BYLAW 13. *Indemnification*

Section 1. Every member of the Council or employee of the North Dakota Academy of Science shall be indemnified by the Academy against all expenses and liabilities, including counsel fees, reasonably incurred or imposed upon him/her in connection with any proceedings to which he or she may be made part, or in which he or she may become involved, by reason of being or having been a member of the Council, or employee at the time such expenses are incurred, except in such cases wherein the member of the Council or employee is adjudged guilty of willful misfeasance or malfeasance in the performance of his or her duties. Provide, however, that in the event of a settlement of the indemnification herein shall apply only when the Council approves such settlement and reimbursement as being for the best interests of the Academy.

The foregoing right of indemnification shall be in addition to and not exclusive of all other rights to which such members of the Council or employee may be entitled.

Minutes (unapproved) of the Annual NDAS Business Meeting - April 16, 1999
Comstock Memorial Union, Moorhead State University
Moorhead, MN
12:40 pm 14 members in attendance

The annual business meeting was called to order by President Hartman. A welcome and thanks was given to organizers and moderators of the symposia and other sessions (Junior Academy, Professional, and Denison division).

The first order of business was to approve minutes from the April 1999 business meeting. The minutes were approved as presented.

Secretary-Treasurer Jon Jackson was called on to give reports.

Kim Michelsen, Director of the North Dakota Junior Academy of Science, reported the Junior Academy award winners from this year's competition, held in Jamestown: Junior division - 1st - Gregg Schildberger (Hankinson), 2nd - Magan Friskop (Hankinson), 3rd - Tracy Jentz (Hankinson). Senior division - 1st - Landon Bladow (Hankinson), 2st - Daniel Krump (Hankinson), 2st - Daniel Krump (Hankinson).

President-Elect Ron Jyring reported on the results of the A. Rodger Dension Research Award competition. Winners were: Undergraduate division – 1st - Heather Netzloff (Minot State University), runner up Toni Nardi (University of North Dakota), runner up Sarina Mattson (University of North Dakota), runner up Holly Berginski (North Dakota State University), runner up Amy Erickson (North Dakota State University). Graduate division – 1st - Tande Stenbak (North Dakota State University). The awards were presented at the Academy banquet that was held the previous night.

Meeting statistics (unofficial): 90 registered attendees, there was 1 symposium (15 presentations), 21 oral presentations in the Denison competition (9 undergraduate papers, and 11 graduate paper), and 8 professional presentations (7 oral and 1 poster).

Financial
Academy finances are typical for this time of year after payment of publishing costs for the Proceedings. It was estimated that after the meeting bills were paid, there would be $1000 – 1500 remaining in checking.

The 2000-2001 recipient of the North Dakota Science Research Foundation Grant ($500) is Dean Pearson from Pioneer Trails Regional Museum in Bowman, ND. Dean Pearson's grant project was to analyze a new core sample to better understand the timescale of the reappearance of flora and fauna following the K-T extinction event. [Editors note: Some of Dean's results from a part of this study appear in one page 44 of this issue.]

The next meeting was scheduled for April 26-27, 2001 (Thursday - Friday) in Bismarck, ND. The NDAS will attempt to use the State Capitol building or the Heritage Center as the venue.

A certificate of appreciation was promised to outgoing President Mark Sheridan.

Ron Jyring, Bismarck State College, officially took over as President of the North Dakota Academy of Science.

The meeting was adjourned shortly after 1 pm.

ACADEMY OFFICERS AND COMMITTEES

Executive Committee
Membership:
- Past-President
- President
- President-Elect
- Secretary-Treasurer
- Councilors (three-year terms)

President
Ronald K. Jyring
Bismarck State College
1500 Edwards Avenue
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Past-President
Mark A. Sheridan
Department of Zoology
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msherida@plains.nodak.edu

President-Elect
Jody A. Rada
Dept. of Anatomy & Cell Biology
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Secretary-Treasurer
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Councilor
Carl Fox (2000-2003)**
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Richard Barkosky (1999-2002)
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Larry Heilmann (2001-2004)
3535 - 31st St SW
Fargo, ND 58102
lheilmann@worldnet.att.net

Executive Committee*

Editorial Committee*

** Leaving - needs a replacement

Committees of the North Dakota Academy of Science

Education Committee*

Denison Awards Committee*

Necrology Committee*

Nominating Committee

Resolution Committee*

Membership Committee*

North Dakota Research Foundation Board of Directors*

*** indicates available openings**

PAST PRESIDENTS AND LOCATIONS OF THE ANNUAL MEETING

NORTH DAKOTA ACADEMY of SCIENCE

1909	M A Brannon	Grand Forks
1910	M A Brannon	Fargo
1911	C B Waldron	Grand Forks
1912	L B McMullen	Fargo
1913	Louis VanEs	Grand Forks
1914	A G Leonard	Fargo
1915	W B Bell	Grand Forks
1916	Lura Perrine	Fargo
1917	A H Taylor	Grand Forks
1918	R C Doneghue	Fargo
1919	H E French	Grand Forks
1920	J W Ince	Fargo
1921	L R Waldron	Grand Forks
1922	Daniel Freeman	Fargo
1923	Norma Preifer	Grand Forks
1924	O A Stevens	Fargo
1925	David R Jenkins	Grand Forks
1926	E S Reynolds	Fargo
1927	Karl H Fussler	Grand Forks
1928	H L Walster	Fargo
1929	G A Talbert	Grand Forks
1930	R M Dolve	Fargo
1931	H E Simpson	Grand Forks
1932	A D Wheedon	Fargo
1933	G C Wheeler	Grand Forks
1934	C I Nelson	Fargo
1935	E A Baird	Grand Forks
1936	L R Waldron	Fargo
1937	J L Hundley	Grand Forks
1938	P J Olson	Fargo
1939	E D Coon	Grand Forks
1940	J R Dice	Fargo
1941	F C Foley	Grand Forks
1942	F W Christensen	Fargo
1943	Neal Weber	Grand Forks
1944	E A Helgeson	Fargo
1945	W H Moran	Grand Forks
1946	J A Longwell	Fargo
1947	A M Cooley	Grand Forks
1948	R H Harris	Fargo
1949	R B Witmer	Grand Forks
1950	R E Dunbar	Fargo
1951	A K Saiki	Grand Forks
1952	Glenn Smith	Fargo
1953	Wilson Laird	Grand Forks
1954	C O Clagett	Fargo
1955	G A Abbott	Grand Forks
1956	H B Hart	Jamestown
1957	W E Cornatzer	Grand Forks
1958	W C Whitman	Fargo
1959	Arthur W Koth	Minot
1960	H J Klosterman	Fargo
1961	Vera Facey	Grand Forks
1962	J F Cassel	Fargo
1963	C A Wardner	Grand Forks
1964	Fred H Sands	Fargo
1965	P B Kannowski	Grand Forks
1966	Paul C Sandal	Fargo
1967	F D Holland, Jr	Grand Forks
1968	W E Dinusson	Fargo
1969	Paul D Leiby	Minot
1970	Roland G Severson	Grand Forks
1971	Robert L Burgess	Fargo
1972	John C Thompson	Dickinson
1973	John R Reid	Grand Forks
1974	Richard L Kiesling	Fargo
1975	Arthur W DaFoe	Valley City
1976	Donald R Scoby	Fargo
1977	Om P Madhok	Minot
1978	James A Stewart	Grand Forks
1979	Jerome M Knoblich	Aberdeen, SD
1980	Duane O Erickson	Fargo
1981	Robert G Todd	Dickinson
1982	Eric N Clausen	Bismarck
1983	Virgil I Stenberg	Grand Forks
1984	Gary Clambey	Fargo
1985	Michael Thompson	Minot
1986	Elliot Shubert	Grand Forks
1987	William Barker	Fargo
1988	Bonnie Heidel	Bismarck
1989	Forrest Nielsen	Grand Forks
1990	David Davis	Fargo
1991	Clark Markell	Minot
1992	John Brauner (elect)	Grand Forks
1993	John Brauner	Jamestown
1994	Glen Statler	Fargo
1995	Carolyn Godfread	Bismarck
1996	Eileen Starr	Valley City
1997	Curtiss Hunt	Grand Forks
1998	Allen Kihm	Minot
1999	Joseph Hartman	Grand Forks
2000	Mark Sheridan	Moorhead, MN
2001	Ron Jyring	Bismarck

Contributors to the North Dakota Academy of Science Research Foundation

Brant Bigger (Lincoln, NE)
Virgil Carmichael (Bismarck)
J. Mark Erickson (Canton, NY)
George Gilles (Charlottesville, VA)
Phyllis Johnson (Bethesda, MD)
Jennifer Larsen (Minot)
James Lindley (Fargo)
Dexter Perkins (Grand Forks)
Claude Schmidt (Fargo)
William Siders (Grand Forks)
Glenn Smith (Fargo)
Armand Souby (San Marcos, TX)
Katherine Sukalski (Grand Forks)
Robert Tarquinio (Santa Monica, CA)

Life Memberships

Ron Jyring (Bismarck)

A

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