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ABSTRACTS OF PAPERS TO BE PRESENTED AT THE 55TH ANNUAL SPRING MEETING
OF THE MINNESOTA ACADEMY OF SCIENCE

(Joint Meeting With The North Dakota Academy of Science)

MOORHEAD STATE UNIVERSITY, MOORHEAD, MINNESOTA
APRIL 23, 24 & 25

(IN COORDINATION WITH CONCORDIA COLLEGE AND NORTH DAKOTA STATE UNIVERSITY)

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## CONTRIBUTED PAPERS (PROFESSIONAL)

COMPARATIVE DIETARY EFFICIENCY OF VARIOUS FOOD COMPONENTS FOR THE DEVELOPMENT OF FOUR SPECIES OF STORED-GRAIN INSECTS. K.V. Berg* and P.K. Harein Dept. of Entomology, U. of Minn., St. Paul, Minn.

Adult red flour beetles (Tribolium castaneum), sawtoothed grain beetles (Oryzaephilus surinamensis), drugstore beetles (Stegobium paniceum) and larval warehouse beetles (Trogoderma variabile) were exposed to 16 food components for 90 days. After 30, 60 and 90 days of exposure the number of dead adults, live adults, larva and live adult weight were recorded. Barley malt was the only food component that supported the development of the red flour beetle and the sawtoothed grain beetle to the adult stage of the F1 generation. The drugstore beetle survived to the adult stage on the cheddar cheese only. The larvae of the warehouse beetle did not have a significant change either in mortality or in loss of weight on any of the food components.

MOTION: A UNITY OF OPPOSITES. F. H. Meyer, President, ISUS, Inc. Minneapolis, Minnesota, 55414.

An absurd claim of some physicists is that motion and matter are inseparable, while motion and time are separable: no motion unless something moving; motion is passage of a body from one place to another. In fact, motion and matter are separable, but motion is not separable from time any more than time is separable from space. In essence and in fact, motion is a unity of opposites, one of which is time; the other, space. Space-time locations flow equably at the speed of one discrete space unit ($4.55 \times 10^{-6}$ cm) per one discrete unit of time ($1.52 \times 10^{-16}$ sec), whose unit magnitude is $2.99 \times 10^{10}$ cm/sec. A light photon is a compound immaterial physical motion with two speeds, a scalar translation of its space-time location with unit speed together with an orthogonal linear oscillation with a frequency of n units of space (time) per one time (space) unit. According to Dewey B. Larson, every type of motion involves a reciprocal relation between space and time. All physical phenomena are derived from scalar motion of physical locations.

PLASMA ESTRADIOL 17-BETA LEVELS IN LABORATORY CULTURED PIMEPHALES EXPOSED TO ACID STRESS. K.W. Palar* and C.E. Firling, Dept. of Biol., Univ. of Minnesota, Duluth, MN.

Field collected adult nonbreeding female fathead minnows, Pimephales promelas, were laboratory acclimated (7-10 days, 11°C, 14 hr lt/10 hr dk, pH 7.5) in static 40 L tanks containing continuously filtered and aerated Lake Superior water. Experimental aquaria were maintained for 20 day exposure periods at pH 7.5, 5.8, or 4.7 by the twice daily addition of 0.2 N $H_2SO_4$. Acidification of the culture water resulted in minor increases in conductivity, dissolved oxygen and carbon dioxide, calcium, and hardness; and in markedly reduced alkalinity throughout the 20 day exposure period. For the determination of plasma estradiol 17 beta levels, blood samples were obtained from the mixed caudal circulation with capillary tubes after severing the caudal peduncle. Hormone levels were determined by radioimmunoassay using $^{125}$I hormone derivatives and sheep antibodies. No significant differences ($P>0.50$) were detected in the estradiol levels of: (a) acclimated and experimental fish (mean for 20 day exposure at pH 7.5, 5.8, or 4.7 or (b) among the three experimental fish populations after 5-, 10-, 15-, or 20-days of exposure to acid stress.

SPORE WALL ANALYSIS OF TWO Glumus spp. USING LIGHT AND ELECTRON MICROSCOPY. E. L. Stewart, F. L. Pfleger, and G. Ahlstrand, Dept. of Plant Pathology, Univ. of Minnesota, St. Paul, MN.

Emphasis on spore wall structure as a species character in the Endogonaceae is increasing. The murograph concept proposed by Walker (1983) is a standardized graphic representation of wall structures. This system promotes the use of uniform terminology in describing spore wall structures using light microscopy. We have compared the spore wall structures of Glomus fasciculatum and G. geosporum using both light and electron microscopy. While the spore wall of G. fasciculatum appears as a single wall of variable thickness with laminations when viewed with a standard light microscope, the spore wall viewed with electron optics showed walls composed of numerous subunits. Each subunit consists of parallel and arc shaped microfibrils. Glomus geosporum has three spore walls when viewed with the light microscope: the outer wall is <1 µm thick, the middle wall is 3-16 µm thick, and the inner wall is < than 1 µm. With the electron microscope the spore wall appeared two layered, without the parallel, arched microfibril subunits.

A UNIQUE VIEW OF A UNIQUE PLANET: VENUS. J.L. Krause, Hibbing Com. Col., Hibbing, MN.

An elementary model of Venus is presented which defines possible causes of the very high surface temperature of Venus other than the greenhouse effect of the carbon dioxide atmosphere. The perpetual cloud cover and extremely long day (243 earth days) of the planet, Venus, can logically lead to a description of the present conditions observed for Venus. The key to this logical development is the reflectivity difference between a transparent body and an opaque (absorptive) body. In order to understand the model, energy conversions and the role that the gravitational field plays in a dynamic atmosphere are recognized. In conclusion, analysis of the model leads to a qualitatively predicted dynamic atmosphere of Venus which is very similar to that observed.

THE USE OF ECHOSOUNDERS IN LIMNOLOGY. R.O. Megard* and J.R. Tester, Dept. of Ecology and Behavioral Biology, Univ. of Minnesota, Minneapolis MN 55455.

High-frequency recording echosounders of the kind now widely used to detect game fish in lakes can provide limnological information rapidly in a concise format. They can easily detect the water masses in a stratified lake, chiefly because of acoustical back-scattering by zooplankton, which are more abundant in some layers than others. To illustrate the correspondence between water strata and scattering layers, we compare depth profiles of temperature, $O_2$, and other variables with the echotraces on synoptic echograms recorded along transects across Elk Lake, which is located near the headwaters of the Mississippi River. After calibration and selection of appropriate standard operating characteristics, periodic synoptic echograms can record the abundance of zooplankton, larval and juvenile fishes, and adult fishes in a lake at different times of the year. Hydroacoustic methods could be used during studies of fisheries or water quality to get timely information about lakes that often is not obtained because conventional methods are too expensive.

VESICULAR-ARBUSCULAR MYCORRHIZAL (VAM) FUNGI COLLECTED FROM THE MINNESOTA ORDWAY PRAIRIE. F. L. Pfleger and E. L. Stewart, Dept. of Plant Pathology, Univ. of Minnesota, St. Paul, MN.

Knowledge concerning the occurrence of VAM fungi in natural plant communities is of current interest. Accordingly, a study was conducted in the fall of 1986 to determine indigenous VAM fungi associated with plants in the Ordway Prairie, a tall grass prairie. Roots and soil samples were collected from the following plants: Artemisia ludouiciana, Aster sericeus, Boutelous curtipndula, Bromus kalmii, B. inermis, Echinachea angustifolia, Liatris pycnostachya, Setaria glauca, Sorgastrum nutans, and Schizocurium scoparius. Random root lengths from these plants were stained in lacto-phenol-trypan blue to determine the presence of VAM hyphae in roots of plants. Soil samples were wet sieved and subjected to a sucrose density gradient centrifugation to separate spores from organic matter. Spores collected were examined microscopicaly to determine the identity of each species present. The following VAM fungi were identified: Glomus geosporum, G. occultum, G. albidum, G. etunicatum G. microcarpum, G. macrocarpum, G. mosseae and Gigaspora spp.

THE YIELD AND QUALITY OF SHIITAKE MUSHROOMS FROM MINNESOTA OAK LOGS. *D.F. McInerney, E.L. Schmidt, Dept. of For. Prod., Univ. Mn., St. Paul, MN.

Six months after felling, 122 bur (Quercus macrocarpa Michx.) and 56 red (Q. rubra L.) oak logs were randomly divided into sample subsets and each subset inoculated with either MN-2 (Taiwan source) or MN-4 (Korean) strain of shiitake spawn (Lentinulla edodes [Berk.] Pegler) cultured on wooden dowels and inserted into 15-25 drilled holes per log. The bed logs were then stored upright at the Kaufert Lab courtyard except during the summer when the logs were moved under a partially shaded white pine windrow and laid horizontally with one end slightly elevated off the ground. Three & 1/2 years after inoculation, accumulated yields of dried mushrooms totalled 8571.29 grams or approximately 27504.7 grams by fresh weight for the 176 logs. Dried mushroom yields were highest on red oak inoculated with the Korean strain, averaging 69.21 grams per log. The bur oak--Taiwan strain combination produced 57.80 grams per log, the red oak--Taiwan strain 47.56 grams per log, and bur oak inoculated with the Korean strain produced 32.76 grams per log. The mushrooms were then graded using cap diameter and other morphological criteria adapted from proposed grading standards for dried shiitake.

## BUSINESS AND MANAGEMENT CONTRIBUTED PAPERS

A PERFORMANCE EVALUATION OF FIRST LEVEL MANAGERS IN RETAILING COMPARED TO ACADMIC PREPARTATION. John C. Cerrito, Dept. of BSN.ADM. & ECON., Augsburg College, Minneapolis, Minnesota.

The focus of the study was to determine if a relationship existed between the academic preparation of graduates from a vocational fashion merchandising program and graduates from four year colleges in terms of performance of task responsibilities in similar job situations (entry level managers) in the fashion merchandising industry (retailing). Achievement or mastery level of entry level management responsibilities in retailing was determined by a task analysis rating evaluation instrument for personnel in that job postion in that industry. The performance rating on the performance responsibility inventory was conducted by the direct supervisor of the entry level manager, in selected retail speciality store businesses. The data analysis section compares the mean and T-test showing little statistical difference between groups in 18 out of 19 performance areas.

ARE BIGGER RAILROADS MORE EFFICIENT. P. Dion, University of Minnesota, Duluth and P. Dorin, University of Minnesota, Duluth.

This research examined the relationship between railroad organization size, expressed in terms of track mileage, freight density and average haul miles and financial operating ratios for 86 Class I railroads for the period 1928-1977. The best predictor of operating efficiency was the ratio of average haul distance to track mileage. Larger railroads were found to be significantly inferior to small ones in terms of operating efficiency.

CONTROL STRUCTURES IN ORGANIZATIONS, W. Ammentorp, Univ. of Minn., *Tom Morgan, Augsburg College, Minneapolis, Minn.

Theories of organizational control have been severely limited by the shortcomings of traditional information and communication systems. Modern telecommunications technology when coupled with developments in artificial intelligence has resulted in significant breakthroughs in the control sciences. The automated factory is an example of the degree to which these technologies support an evolving science of organizational control.

This paper explores the possible future directions of organization control and its potential applications to less well-determined problems. Computer simulations are offered to illustrate the behavior of typical organizational information networks. Examples from the human services are used to suggest directions for future research. These examples show how control principles are applied to organization operations.

THE DEVELOPMENT OF SHORT LINE RAILROADS IN THE UPPER MIDWEST. E.J. Dooley, Dept. of Bus. Adm., Moorhead State Univ., Moorhead, MN 56560.

The overall objective of this paper is to review the growth of the short line railroad industry. Most shortline railroads established since 1970 are a result of a restructuring or abandonment by a Class I railroad. The short line may be able to profitably operate on former Class I rail lines because of lower labor costs, the availability of government funding for capital improvements, and higher service levels to local shippers which in turn generates more traffic. The research method is to develop operating cost and revenue estimates for a particular branch line operated as an independent shortline and a Class I branchline. Preliminary analysis suggests that a shortline has a lower breakeven point than a Class I railroad. However, depending upon shipper loyalty a shortline will not necessarily be profitable.

KOREAN ECONOMIC DEVELOPMENT: WHY KOREA DEVELOPED SO MUCH AND SO FAST? S.M. Kahng, Economics Dept., University of Minnesota, Morris, Morris, MN.

During the three decades of Japanese domination, the Korean economy, in terms of per capita output, grew less than 11% per decade. However, Korea's post-1946 growth rate exceeded 72% per decade, raising per capita GNP to $2000 from less than $300. Why did Korea develop so much and so fast? The foremost important factor was that Korean people were freed from the foreign bondage and they could satisfy their educational, entrepreneurial, as well as other nation building aspirations. Now, Korea is one of the most educated nations in the world. The elected national government protected infant domestic industries during the crucial period of growth. The timely opening of trade opportunities, the influx of foreign investments together with the highly educated labor force tremendously boosted the speed of development. What is the future outlook? There are many favorable factors for the continued rapid development. However, there are some ominous dark clouds hanging over an otherwise promising future. One is the potential resumption of hostility between the two divided halves and the other is the decay of political democracy in the selection of the national leadership.

NONSURVEY INPUT-OUTPUT ESTIMATION METHODS: THE IMPORTANCE OF THE HOUSEHOLD SECTOR. Robert Garhart, Department of Economics, College of St. Thomas, St. Paul, MN.

Previous work has found that errors in measuring the activities of the household sector (labor inputs and consumption) of regional input-output (I/O) models contribute greatly to errors in multipliers derived from those models, particularly when the model is closed with respect to households. The purpose of this study is to isolate the characteristics of the model which have the greatest effect on multiplier accuracy in order to aid practitioners in collecting limited survey data. Random I/O models are generated, starting with the interindustry and interregional flows. Zero elements are systematically introduced to the interindustry flow matrix to determine the effect of matrix density on multiplier error. Next, the household row and column are scaled (individually and jointly) to determine the effect of the relative size of the household sector on multiplier error. On the basis of the results, recommendations are made on the desirable amount of survey information.

MOTIVATION FOR MEMBERSHIP IN A COMMUNITY SERVICE ORGANIZATION. R. C. Sielaff, School of Business and Economics, U. of Minnesota Duluth.

Recently, women have petitioned to be admitted to membership in several community service organizations, including the Rotary Club and the Kiwanis Club, but membership was denied.

This has raised a question as to the reasons why men join service organizations and why they prefer not to admit women.

This is a pilot study of one service organization. The questionnaire was answered by all active members of the club, and this is a census of their responses.

The major question was, "What was your major reason for joining this organization?"

Some gave one reason, and some gave more than one. A total of 55.8% joined for reasons of friendship and fellowship; 28.1% joined to participate in community activities; 19.9% joined for business reasons; and less than 10% joined for other reasons. Detailed information is in the paper. It appears that many men prefer fellowship with other men rather than with women.

A QUANTAL RESPONSE STUDY OF QUALITY OF LIFE INDICATORS. J. L. Kreitzer* and C. S. Marcott, Dept. of Economics, Coll. of St. Thomas, St. Paul, MN.

In traditional approaches to quality of life measurement, a researcher forms an index number (quality of life score) for a geographical region by assigning weights to various environmental, cultural and socioeconomic variables. Although the resulting quality of life scores can be used to rank geographical regions, the rankings are meaningful only to the extent that one accepts as appropriate the weights assigned to the measured variables. The present methodology differs in that the weights assigned in forming the index are determined by the choices of people in the region. Specifically, a quantal response model is used to predict the probability that an individual with a particular set of characteristics (e.g., sex, income, age, occupation, etc.) will rank the quality of his or her life as "high" or "low." The data used in the study are taken from three samples of the Minnesota Measure, a quarterly

telephone survey of 1000 state residents compiled by the Economic and Business Research Center of the College of St. Thomas. Results of the study indicate: (1) tests of statistical significance of the Logit and Probit models (asymptotic *t*-tests) correspond closely to tests of statistical significance of the Crosstabulations (chi-squared tests); (2) while some of the dependent variables remain significant in all three samples, others do not.

## SCIENCE EDUCATION/MINNESOTA SCIENCE TEACHERS ASSOCIATION CONTRIBUTED PAPERS

AN ASSESSMENT OF TEACHER INSERVICE IN MINNESOTA UNDER THE TITLE II, EDUCATION FOR ECONOMIC SECURITY ACT POSTSECONDARY GRANTS. N.B. Walters, Minnesota Higher Education Coordinating Board, St. Paul, MN.

On August 11, 1984 the Education for Economic Security Act, P.L. 98-377, was signed into law. Title II of the Act provides financial assistance to states to improve the skills of teachers and instruction in mathematics, science, foreign languages and computer learning. Impetus for this legislation came from the National Commission on Excellence in Education 1983 report, "A Nation at Risk, the Imperative for Educational Reform." Through funding this legislation, the federal government provides resources to improve the quality and number of mathematics and science teachers. Title II requires that 30% of the funds available to each state be administered through postsecondary programs. By the end of the third year of Title II, the Minnesota's postsecondary community will receive over $1,000,000 for teacher training activities. In this paper, the teacher training needs in mathematics and science and the successes of the postsecondary training are discussed. The major impacts of two years of postsecondary grants are summarized. I conclude with projections on future mathematics and science teacher needs.

CORRELATIONS OF MINNESOTA COUNTY EDUCATIONAL STATISTICS. E.G. Soroka*, C.L. Nelson, Dept. of Earth Sciences, St. Cloud State Univ., and L.L. Lamwers, Dept. of Psychology, St. Cloud State University, St. Cloud, MN.

Linear least square regression fits were applied to Minnesota County Educational Statistics provided by the Minnesota Dept. of Education for the years 1982-83 and PSAT scores for the years 1981-1985. Relationships between 1) total students in the county, 2) total educational staff, 3) pupil per staff ratios, 4) graduation rates, 5) federal funds as a percent of revenue, 6) expenditures per pupil, 7) combined (weighted) PSAT scores, and 8) combined (weighted) PSAT math scores, were determined. Pupil per staff ratio was significantly correlated with total students in the county ($r$ = .372), federal funds as a percent of revenue ($r$ = -.435), expenditures per pupil ($r$ = -.308). When metro areas were excluded the total students also correlated with expenditures per pupil ($r$ = -.349).

**THE CREATIONIST AGENDA.** R. T. Arndts, Dept. of Chem., St. Cloud State Univ., St. Cloud, MN.

For nearly three decades scientifically trained creationists have been challenging evolutionary theory. In the last ten years creationists have insisted that their viewpoint be included in public school curricula.

Early creationist efforts requested that creation be included with evolution. In this era such terms as "equal time" and "balanced treatment" were common. These requests were met with a storm of protests, with objections such as that creation was religious and unscientific, thus teaching it was unconstitutional.

Currently creationists propose that the focus of the public school curricula be shifted from the discussion of any specific prehistory to a discussion of the data and rationale used as evidence for prehistorical beliefs. There should be no objection to the analysis of the data relating to origins. The assurance that students will be given the weaknesses as well as the strengths of evolutionary theory will please those who happen to favor the creation view of origins.

USE OF PIAGETIAN CONCRETE-OPERATIONAL LEARNING STRATEGIES TO FACILITATE HUMAN GENETICS CONCEPT ACQUISITION AND GROWTH IN INTELLECTUAL DEVELOPMENT. S.M. Beison, Dept. of Biol. Sci., St. Cloud State University, St. Cloud, Minnesota.

Ninety-seven college honors students enrolled in an introductory human genetics/bioethics course served as the research population to determine whether human genetics concepts could be attained at an appropriate level via instruction by lecture or Piagetian concrete-operational learning strategies. The population was divided into control and experimental groups receiving instruction via lecture or concrete learning strategies, respectively. A Piagetian Task Instrument was used to assess the intellectual developmental level of the research population and to determine the growth in intellectual development of those students who comprised the experimental group. Human genetics concept acquisition improved significantly in both groups indicating lecture and learning strategies are effective modes of instruction in a human genetics honors course. Experimental group students demonstrated growth in intellectual development, thus learning strategies are useful in improving intellectual development.

WRITING AS A MEANS OF LEARNING IN A SCIENCE CLASS FOR DEVELOPMENTAL COLLEGE STUDENTS. *E.T. Hatch & C. Miller, General College, University of Minnesota, Minneapolis, MN.

Developmental writing students used three integrated writing activities designed to help them develop informed opinions about environmental issues. These activities included weekly 1-2 paragraph entries in a "Writer's Notebook," 2) biweekly 2-page essays which integrated and expanded several of the notebook entries, and 3) two essay examinations, which were based on the notebook entries and essays. The principle of multiple drafting was applied throughout the course, and the writing tasks themselves advanced from narrative form to analytical form as the course progressed. The major drawback of this approach was that 30% of the subject matter normally covered in this class had to be omitted. This omission was a direct result of using more class time for interactive feedback on notebook entries. However, the sacrifice of a small amount of content is probably worth the gain in overall facility in the critical thinking and expression process.

**GRADUATE CONTRIBUTED PAPERS (WINCHELL COMPETITION)**

BORATE RODS AS AN ON-SITE REMEDIAL TREATMENT FOR CONTROL OF FUNGAL DECAY IN A RECREATIONAL DECK. M.DIETZ* and E.SCHMIDT, Dept. of For.Prod., Univ. of MN, St. Paul, MN.

A conventional wood recreational deck constructed with Spruce-Pine-Fir decking was sampled for active growth of wood decay fungi before and 10 months after remedial preservative treatment with fused disodium octaborate rods (IMPEL)® at boric acid levels from 1.5-10 $kg/m^3$. Extent of boron distribution was observed with a color indicator dye at the 10 month exposure period. Remedial treatment with boron rods was nearly 100% effective with active decay cultures from treated material found only in samples obtained from boards treated at the inhibition dosage level (1.5 $kg/m^3$) of boric acid. Suggested lethal dosages (>3.0 $kg/m^3$) were effective in all cases as indicated by failure to culture any decay fungi. In contrast, the numbers of active decay cultures from control boards increased over the exposure period. Curcumin tests for diffusion indicated excellent distribution of boric acid in wood material where moisture contents exceeded 25%.

COMPARATIVE PHYSIOLOGY OF SODIUM REGULATION IN THREE CRICETID RODENTS. Tom Manning, Dept. of Biology, Univ. of MN, Duluth.

Specialized herbivores in some ecosystems face potential $Na^+$ depletion because of spatial and/or seasonal inavailability of $Na^+$, and because high dietary $K^+$ intake resulting from consumption of succulent spring vegetation may cause increased rates of urinary $Na^+$ loss. Herbivores appear to rely heavily on physiological conservation to insure $Na^+$ homeostasis; this pattern may be especially pronounced in small-bodied herbivores with limited mobility. It is reasonable to expect that these animals would possess better-developed physiological abilities to reduce $Na^+$ loss than would related species that consume $Na^+$-rich insects. This study tested that hypothesis by examining $Na^+$ regulation in the meadow vole (Rodentia:Microtus pennsylvanicus), a specialized herbivore, and in two cofamiliar rodents, the omnivore Peromyscus leucopus and the insectivorous Onychomys leucogaster. Diet experiments in metabolic chambers indicated that M. pennsylvanicus showed no greater capability to maintain total $Na^+$ balance nor to restrict either fecal or urinary $Na^+$ loss than did the other two species.

EVALUATING THE QUALITY OF RING NECKED PHEASANT (PHASIANUS COLCHICUS) BROOD REARING HABITAT ON MANAGED GRASSLANDS *Donald R. Nelson and Merrill Fryderdall, Dept. of Biol., Mankato State University, Mankato, MN and Richard O. Kimmel, Minn. Dept. of Nat. Resour., Madelia, MN.

Long-term declines in ring-necked pheasant populations have been attributed in part to the loss of brood rearing habitat. Quality brood habitat is characterized by areas with little obstruction to movement, good protective cover and abundant insect populations. This study attempts to evaluate the insect availability and protective cover of brood habitat provided by roadsides and native warm season grass plantings. Four different covertypes were evaluated; (1) roadsides dominated by smooth brome (Bromus inermis), (2) roadsides with a mixture of smooth brome and forage legumes, (3) warm season grass plantings dominated by switchgrass (Panicum virgatum) and (4) plantings with a mixture of warm season grasses. Vegetation was sampled bi-weekly during June and July using a 10 point frame and Robel pole. A sweep net was used to sample insects. Insect samples were identified to order, dried for 24 hrs at 70°C and weighed. Insect biomass was highest in brome-legume roadsides and lowest in switchgrass dominated plantings.

KARYOTYPIC EXAMINATION OF FATHEAD MINNOWS SUBJECTED TO pH STRESS. Margaret Thomas* and Stephen Hedman, Department of Biology; Univ. of MN; Duluth, MN 55812

Reproductive failure of the fathead minnow (Pimephales promelas) in acid environments has been reported in the literature. This research explored the hypothesis that such failure may be associated with changes in the normal chromosome karyotype of this species. Chromosomes were obtained from in vitro cultured lymphocytes and from various tissues following in vivo injection of colcemid. The two methods will be compared with respect to chromosome yields and ease of technique. Under acid stress of pH 4.5 or 5.6 for periods up to seven weeks, various chromosomal abnormalities were noted, primarily aneuploidy, fragmentation, breaks, and ring formation. (This work was supported by grants from the Minnesota Zoological Society and the University of Minnesota Graduate School.)

MACROINVERTEBRATE DISTRIBUTIONS BY LAND USE IN A SOUTHEASTERN MINNESOTA STREAM. T.V. Hovey, Dept. of Forest Resources, Univ. of MN, St. Paul, MN.

A study was performed on Hay Creek, a third order, spring fed, trout stream in S.E. Minnesota. The two land use types that were sampled monthly for one year include a forest area with shaded stream reaches and a pasture area with no canopy shading the stream. Samples of the invertebrates were collected using a Hess type stream bottom sampler. Two replicate riffles were sampled in each land use to increase statistical significance in hypotheses testing. The hypotheses tested were that: the benthic macroinvertebrate distributions will be different between land uses, and relative rates of change for densities and biomass over a year will be different between land uses. Densities and biomass were shown to be much higher at the pasture site. This corresponds to a larger food resource for the fish in the stream. The pasture site also had a considerably larger aquatic macrophyte component than the forested site.

MARKING THE BAIT LEECH (NEPHELOPSIS OBSCURA) FOR MARK RECAPTURE ANALYSIS. J.W. Erickson, Dept. of Biol. Sci., University of Minnesota-Duluth, Duluth, MN.

Estimating the size of bait leech populations has been limited to the trap-out technique. In this study bait leeches were sprayed with fluorescent pigments by means of compressed air. The fluorescent marks were only detectable when the leeches were observed under black light. Controlled experiments have shown that leeches marked in this manner maintained visible marks for more than one month with a mortality of less than one percent. In a month long experiment, three models (trap-out technique, Kelker's method, and Petersen's method) for estimating the number of leeches in a small pond were compared daily. The estimate obtained by Kelker's method stabilized in the fewest number of trapping days, followed closely be the Petersen estimate, while

the trap-out estimate continued to fluctuate for the duration of the experiment, suggesting that catch per unit effort was not constant for the entire month of trapping.

PHOSPHORUS PUMPING BY AQUATIC PLANTS. K.W. Sargent, Dept. of Biology, Univ. of Minnesota-Duluth, Duluth, MN.

Phosphorus transfer from sediments to overlying water could affect the trophic status of many aquatic systems. Depletion of phosphorus in sediments near plants would support the theory that aquatic plants can transport significant amounts of phosphorus from the sediments to the overlying waters. The root biomass of Potamogeton natans as well as several phosphorus fractions were measured from cores taken among P. natans beds and from plant-free sites. The root biomass of P. natans peaks near the surface and at 8-10 cm. The easily exchangeable phosphorus fraction was depleted in the top 10 cm of the sediments supporting plants. This fraction correlated negatively with the root biomass, suggesting that P. natans can transport significant amounts of phosphorus from the sediments to the overlying water. Less mobile phosphorus fractions were not significantly affected by the presence of aquatic plants.

USE OF WETLANDS BY EARED GREBES IN MINNESOTA. J.S. BOE. Zool. Dept., North Dakota State Univ., Fargo, ND.

Summer 1986 was the first year of a three year study of colony site and nest site selection by eared grebes in Minnesota. The objective was to determine what factors are important in the choice of particular lakes as colony sites. Lakes listed as active or recently active colony sites by the Nongame Wildlife Program (MNDNR) and a stratified random sample of lakes in the same type range (III-V) and vegetation zones (Kuchler's Bluestem Prairie and Oak Savanna) were visited and habitat variables recorded. Limited vegetation mapping was done to aid in the interpretation of ASCS aerial slides of the study lakes. Only preliminary data analysis has been completed, but it appears that eared grebes in Minnesota prefer shallow lakes larger than 80 acres with abundant submergent vegetation and little human disturbance.

**UNDERGRADUATE CONTRIBUTED PAPERS (WINCHELL COMPETITION)**

COMPUTERIZED ANALYSES OF FATHEAD MINNOW CHROMOSOMES. Bernard Erickson* , Glenn Andreas, and Stephen Hedman, Dept. of Biology; U. of MN; Duluth, MN 55812

Relatively little has been reported in the literature regarding the chromosomes from the fathead minnow (Pimephales promelas). This study was initiated in order to gain basic karyotypic information on this species. Chromosomes were obtained from various tissues (gill, kidney, liver, stomach, spleen) following in vivo injection of colcemid. Whole stained (Giemsa) chromosomes as well as G-banded and C-banded chromosomes were examined. In order to analyze these chromosomes, digitized images of photomicrographs were first created using an Apple Macintosh computer. Software was written whereby chromosomal measurements could be directly made on these images and transferred to a spreadsheet program. This approach has resulted in the establishment of a standard karyotype for this species. (This work was supported by grants from the University of Minnesota as part of Project MinneMac and the Undergraduate Research Opportunity Program.)

ECOLOGICAL DETERMINANTS OF FRUIT MATURATION IN Bursera simaruba, a COSTA RICAN TREE. J. M. Schwantes* and G. C. Stevens, Dept. Biology, Gustavus Adolphus College, St. Peter, MN.

Bursera simaruba is a dioecious tree that makes up to 60,000 fruit each year. The number of fruit depends largely on the size of the tree, but the amount of bee visitation, flower abortion rates, and the nutritional status of the tree also play a role. To see if these factors also influence the timing of fruit maturation, comparisions were made between the flower scars and terminal twigs of early and late maturing fruit crops. The onset of fruit maturation was found to be advanced in trees with low stem elongation. Early fruit maturation was also associated with small fruit crops. Flower abortion rates did not appear to differ between early and late ripening fruit crops. Given the assumed competition between trees for dispersal agents, the early maturation time of trees with small crops may act as a means of compensation for their competitive disadvantage (due to their small fruit display) relative to trees with larger fruit crops.

THE EFFECT OF TISSUE CULTURE ON THE CLASS II POSITIVE CELL POPULATION IN THE ISLETS OF LANGERHANS. * K. Brasel, Macalester College, Dr. J.R. Serie, Dept. of Biol., Macalester College, St. Paul, MN.

Dendritic cells, which bear Class II major histocompatibility antigens, have been shown to be the primary stimulators in the mixed leukocyte reaction. It has been hypothesized that these cells are the primary antigen presenters in vivo, and as such play a primary role in graft rejection. This hypothesis is supported by evidence that elimination of Class II positive cells from allografts prolongs their survival. One method used to eliminate these cells has been tissue culturing 7-20 days before transplant. We have shown that if rat islet allografts are cultured 10 days before transplant they survive indefinitely across many different major genetic barriers. In order to better determine that this is the result of elimination of Class II positive cells, we have analyzed this cell population in normal rat pancreas and in cultured islets using immunohistochemical methods.

EXCHANGE OF AGRICULTURAL TECHNIQUES BETWEEN GUATEMALAN PEASANT FARMERS. E. Myers* and G. C. Stevens, Dept. Biology, Gustavus Adolphus College St. Peter, MN.

To study the transfer of agricultural innovations from research institutions to farmers in developing countries, the farming practices of a small community of farmers in Guatemala was studied in detail. Interviews and work experience with farmers in their fields were used to build an understanding of the agricultural practices. The yields of poor farmers were below those attainable with present technology in Guatemala. This submaximal productivity is partly an outcome of poverty, but can also be traced to the lack of communication of new methods to peasants. There is little opportunity for innovations to spread as nearly all agricultural information is passed from father to son without outside influence.

MODELING OF A SPRING-PENDULUM SYSTEM. M.E. Moline, Dept. of Mathematics, Bethel College, St. Paul, MN.

A pendulum on a spring is modeled by four first order differential equations in polar coordinates. The derived equations are apparently not solvable in closed form. A Runge-Kutta numerical method together with a UN*X graphics package is therefore used to plot the solutions. These solutions show very little effect of error propagation.

THE LIFE HISTORY OF TWO POPULATIONS OF IOWA DARTERS (ETHEOSTOMA EXILE) IN LAKE ITASCA, AND THE HEADWATERS OF THE MISSISSIPPI. *J.D. Johnson & J.T. Hatch, College of Education & General College, Univ. of Minnesota, Mpls., MN

Over 500 Iowa darters collected in 1984-86 from Lake Itasca and the headwaters of the Mississippi River were analyzed to provide information about reproduction, growth, and food habits. In the lake, Iowa darters spawned from mid-April to mid-June, while in the river they spawned from late April through May. On average, Iowa darters reached about 40-42 mm total length in their first year, 50-55 mm in their second year, and about 60 mm in their third year. Females grew faster and lived longer than males in both populations. Both sexes reached maturity at 11-12 months. Although a few darters completed a third growing season, most died shortly after their second spawning at about 23-25 months of age. River darters were shorter than equivalent age lake darters, but had higher condition factors. Lake darters ate mostly immature midges, amphipods and crustacean zooplankton, while river darters ate a variety of immature midges, blackflies, caddisflies, and mayflies.

REPRODUCTIVE CAPACITY AND BODY SIZE IN DARTERS (PERCIDAE: ETHEOSTOMATINI). *A. Price & J.T. Hatch, College of Biological Science & General College, Univ. of Minnesota, Minneapolis, MN.

The purpose of this research was to test the hypothesis that larger body size results in disproportionally greater energy investment in egg production by darters. Ripe females of 6 species of darters (Etheostoma exile, E. microperca, E. nigrum, Percina caprodes, P. evides, and P. maculata), representing three reproductive guilds, were analyzed for several relationships between body size and fecundity, as estimated by direct ova counts and ovarian weights. All species except P. maculata showed strong, positive correlations between body size and fecundity estimates. However, correlations of body size and weighted fecundity (i.e., total ova/body weight) were not significant, except in two cases for E. exile. Our study suggests that darters in all three reproductive guilds produce more eggs as they increase in body size, but do so only in direct proportion to their body size increase. We conclude that on a per gram body weight basis, larger sized individuals do not invest more energy in egg production than smaller individuals.

ROLE OF AN IN VITRO ISOLATION METHOD ON ISLET GRAFT SURVIVAL. M. Bardack*, J.R. Serie. Dept. of Biology, Macalester College, St. Paul, MN.

The transplatation of the islets of Langerhans, the insulin producing cells of the pancreas, has been effective in reversing diabetes in laboratory animals. However, graft rejection continues to be one of the major unsolved problems in islet transplantation. It has been shown that, if islets are cultured before transplant, their survival across major genetic barriers is enhanced. Evidence suggests that this is due to the loss of antigen-presenting cells during the culture process. We have investigated the mechanism whereby a novel in-vitro islet isolation processes produces islets which survive indefinitely across multiple genetic barriers.

SEED SURVIVAL RATES AFTER CONSUMPTION BY COSTA RICAN VERTEBRATES. R. T. Merideth* and G. C. Stevens, Dept. Biology, Gustavus Adolphus College, St. Peter, MN.

In the deciduous forests of NW Costa Rica, vertebrate dispersed plants have a highly unpredictable fate. Not only can they be consumed by one of several species of animals (monkeys, birds, ctenosaurs, peccaries), but the microhabitat of defecation is also highly variable (bare rock surfaces to deep forest litter, shade to direct sunlight). To study the influence of this variability on seed survival, fecal samples were collected from different areas and the survival of the seeds compared to seeds found in undispersed fruit. Seeds of Manilkara (Sapotaceae), Ficus (Moraceae), Chomelia (Rubiaceae), Trichilia (Meliaceae), and Muntingia (Eleocarpaceae) were all found in dung, but had variable levels of survival. An indepth study of the acid and temperature tolerance of Manilkara and Chomelia seeds in the laboratory revealed a range of tolerance in the two species. Apparently natural selection has favored the evolution of broad ecological tolerances in these vertebrate-dispersed seeds.

THE VALUE OF AN UNDERGRADUATE ASSISTANT TEACHER IN PRINCIPLES OF ECONOMICS. Larry Buron, Undergraduate Student, Department of Economics, College of St. Thomas, St. Paul, MN.

The author is a senior economics major acting as an assistant teacher in a Principles of Microeconomics course. His duties include leading small group discussions, critiquing student writing assignments, assisting students carrying out research, and preparing in-class assignments. In addition, the assistant occasionally lectures to half the class, and the instructor to the other half. Each group is taught a different application of a concept, which they are then required to teach to members of the other group. This paper examines the benefits to the student assistant, the instructor, and the pupils in the class. The assistant gains a deeper understanding of economic principles and an opportunity to explore teaching as a career. The instructor is able to try more innovative teaching techniques. Students receive more individual attention and have the opportunity to teach one another, which enhances their learning of basic concepts.