JOURNAL OF THE TENNESSEE ACADEMY OF SCIENCE

Volume 62, Number 2, April, 1987

PROCEEDINGS OF THE TENNESSEE ACADEMY OF SCIENCE 1986

Diane R. Nelson, Secretary TAS

East Tennessee State University

EXECUTIVE COMMITTEE MEETING

April 18, 1986

The Executive Committee Meeting of the Tennessee Academy of Science was called to order by President David Yarbrough at 7:00 p.m. CST in Room 320, Tennessee State University Building, Nashville, on April 18, 1986. Members present were David Yarbrough, President; William H. Ellis, Past-President; Gus Tomlinson, President-Elect; Diane R. Nelson, Secretary; A. Floyd Scott, Treasurer; Libby Workman, *JOURNAL* Editor; Richard J. Raridon, Director of the Collegiate Division; William N. Pafford, Director of the Junior Academy; Bernard W. Benson, Director of the Visiting Scientist Program; Ernest Blythe and David Fields, Members-at-Large; Geraldine Farmer, State Department of Education; and David Driskill, Belmont College, Local Arrangements Chairperson.

The minutes of the November 1985 Executive Committee Meeting and the Annual Business Meeting were published in the April 1986 issue of the *JOURNAL* and copies were distributed to the Executive Committee by mail. The minutes were approved as printed by a motion passed unanimously.

The Treasurer's report was published in the April 1986 issue of the *JOURNAL*. Discussion was postponed until the budget proposal was considered under New Business. The editor of the *JOURNAL*, Libby Workman, reported that the former editor, Gus Tomlinson, had transferred all materials to her, and she expressed her appreciation for his assistance during the transition. Dr. Tomlinson edited the January and April issues; Ms. Workman, July and October. Efforts were being made to find a local printer in Chattanooga. The Editor's report was accepted.

The Director of the Visiting Scientist Program, Bernard Benson, presented the following report:

"There has been a substantial increase in the number of students and teachers contacted by the Visiting Scientist Program this year as well as in the number of visits completed (See **Table 1**).

Table 1. Comparison of 1984-85 and 1985-86 Program Activity

	1984–85	1985–86 (April)	Percentage of Increase
Visits Requested	73	112	53%
Visits Completed	48	61	27%
Students Contacted	5698	7169	25%
Teachers Contacted	112	187	67%
Classes Contacted	96	179	86%

There has been more participation in the Visiting Scientist Program during the 1985-86 school year than during any previous year. **Table 2** shows the steady trend of increased usage of the Visiting Scientist Program over the last five years.

Table 2. Five Year Overview of the Visiting Scientist Program

	81–82	82–83	83–84	84–85	85–86
Visits Requested	58	39	80	73	112
Visits Completed	44	27	48	54	61
Visits Declined	12	10	25	13	12
Visits Cancelled	2	2	7	6	7
Students Contacted	3058	1775	5430	5698	7169
Teachers Contacted	101	37	107	112	187
Classes Contacted	15	52	120	96	179

Ongoing evaluation of the program this year indicated that four areas of improvement were in order—restructuring of operating procedures, the revision of program forms, the reorganization of the filing system, and the development of procedures and forms for assimilating the data base.

In January, the program's operating procedures were analyzed and modifications were made in the sequence of events involved in the planning of a visit. A new checklist was developed and the program's forms were revised reflecting these modifications.

Next, the program's filing system was evaluated and it was determined that five file management needs existed. A "Pending Visit" file was implemented to hold the folders containing information pertinent to visits which are currently being processed. A "Completed Visit" file was established to hold the files of visits which have already been completed this school year. A "Documents/Correspondence" file and a "Scientist" file have been outlined which will contain longitudinal evaluative data regarding each scientist's and each school system's participation in the program over the years.

Procedures and forms for gathering and analyzing the program's data have been outlined. When the data is assimilated and analyzed, it will be possible to make data-based decisions regarding the maintenance and expansion of the program. During the present semester, data pertaining to this school year is being gathered.

The 1986-87 Roster for the Tennessee Visiting Scientist Program is currently under development. Scientists who participated in the VSP this past year have been invited to continue their partricipation in the program and additional scientists are being invited to join for the coming year. Current figures indicate that the VSP Roster will be expanded from the current 100 participating scientists to 125 or more scientists who will contribute to the improvement of science and mathematics education in the Tennessee schools during the 1986-87 school year. The new roster is being reformatted in order to make it easier to use."

The Director's report was accepted.

The Director of the Junior Academy, William Pafford, presented the following report:

"The 1986 spring meeting is scheduled for Friday, April 18, at West End Middle School in Nashville. A total of twenty-one students have been invited to present their research papers.

We have received fifty-four papers this year. They were submitted from nine different schools. Since forty-one papers were received last year, our total represents an increase of over 30 percent.

A representative of the Tennessee Department of Education is scheduled to be with us at the April 18 meeting. At that time certificates will be presented to an outstanding science teacher from each of the three grand divisions of the state."

The Director's report was accepted.

The Director of the Collegiate Division, Richard J. Raridon, reported that the spring meetings were underway. At the fall meeting, the Collegiate Division papers will be presented in appropriate sectional meetings rather than being held separately on Saturday morning. The director's report was accepted.

As delegate to the Association of Academies of Science of AAAS, Richard J. Raridon reported that he will attend the 1986 meeting of AAAS in Philadelphia and will give his report to TAS in November.

Geraldine Farmer, the representative of the State Department of Education, presented a report on "Greenbook Outcomes" discussed at the January meeting of the Board of Regents. Curriculum guidelines have been established for high school teachers to follow to assist students to achieve the required outcomes. TAS is invited by the State Department of Education to participate in evaluations of the guidelines.

Dr. Gus Tomlinson, president-elect and program chairman, presented the subcommittee report on the proposed format change and program for the 1986 annual meeting. All major meeting events will occur in a single day. The morning General Session will be followed by a luncheon (instead of the evening banquet) and business meeting; sectional meetings, including the Collegiate Division, will be held in the afternoon. The proposal was accepted by a motion passed unanimously.

Dr. David Driskill, chairman of the Local Arrangements Committee, discussed the plans for the annual meeting at Belmont College. The possibility of a spouse's program was also discussed.

OLD BUSINESS

Dr. Bernard Benson recognized four of the Visiting Scientists for their service to the Academy.

To publish in the TAS *JOURNAL,* at least one of the authors on a paper must be a member of the Academy. The editor will verify the membership with the treasurer before publication of the paper. A motion was passed to include this information in the Notice to Authors in the *JOURNAL.*

A motion was passed to award the three best collegiate papers a one year membership in the Academy. Each regional director will select a winner and inform Dr. Raridon, who will notify the treasurer.

Dr. Ellis reported that the constitutional revision needs further study.

Dr. Floyd Scott discussed the need for membership recruiting. A reminder should be sent to libraries on renewing subscriptions. Dr. Scott prepared a letter to send members who are delinquent on paying dues. A followup letter will be sent six months after the first dues notice if the member is delinquent. The member's name will be dropped if dues are not paid after the second notice.

Invitations for future meetings have been accepted from Jackson State Community College in 1987, Tennessee Technological University in 1988, and Tennessee State University in 1989. A formal invitation will be solicited from UT-Chattanooga for 1990.

NEW BUSINESS

Dr. Bernard Benson submitted his resignation as director of the Visiting Scientist Program, and recommended that Dr. Wayne Stevenson be appointed director of VSP at the beginning of the fiscal year. Dr. Stevenson is director of "Project Strive", a program funded by NSF for Oak Ridge Associated Universities. The Visiting Scientist Program will continue to be funded by TAS and will remain a program of the Academy. A motion was passed to accept Dr. Benson's resignation with regret and also with the condition that the president of TAS will confirm with Dr. Stevenson, in writing, that VSP will remain a TAS program.

The treasurer's report and the following budget for 1986-87 were adopted.

CASH BALANCE — JULY 1, 1986	19,940.05
RECEIPTS	
STATE OF TENNESSEE	9,000.00
MEMBERSHIP DUES	5,662.00
LIBRARY SUBSCRIPTIONS	1,845.00
INTEREST EARNED	982.85
JOURNAL PAGE CHARGES	1,795.00
CONTRIBUTIONS	403.00
REGISTRATION AND BANQUET FEES	1,056.00
EXHIBITOR'S FEES	300.00
TOTAL RECEIPTS	31,043.85
TOTAL CASH AVAILABLE	50,983.90
DISBURSEMENTS	
JOURNAL PRINTING COSTS	3,437.64
VISITING SCIENTIST PROGRAM	2,078.31
TENNESSEE JR. ACADEMY SCIENCE	1,284.83
ANNUAL MEETING	1,018.32
BOARD MEETING EXPENSES	712.52
TREASURER'S EXPENSES	1,003.11
PRESIDENT'S EXPENSES	62.55
STUDENT RESEARCH GRANTS	1,000.00
COLLEGIATE DIVISION EXPENSES	400.00
SECRETARY'S EXPENSES	339.80
TOTAL DISBURSEMENTS	21,337.08
CASH BALANCE — APRIL 15,1986	29,646.82
RECEIPTS	31,043.85
DISBURSEMENTS	21,337.08
CASH INCREASE	9,706.77
CASH BALANCE — JULY 1, 1985	19,940.05
CASH BALANCE — APRIL 15, 1986	29,646.82
BREAKDOWN OF HOLDINGS	
APSU ACCOUNT	203.53
PRIMARY CHECKING ACCT, 1ST FEDERAL	2,913.33
SAVINGS ACCOUNT, 1ST FEDERAL	26,407.72
TOTAL HOLDINGS AS OF APRIL 15, 1986*	*29,524.58
PROJECTED DISBURSEMENTS 1985-1986	
PRESIDENT'S OFFICE	100.00
SECRETARY'S OFFICE	400.00
TREASURER'S OFFICE	1,600.00
JR. ACADEMY OF SCIENCE	3,600.00
VISITING SCIENTIST PROGRAM	4,500.00
JOURNAL	16,000.00
RESEARCH GRANT (AAAS)	1,000.00
ANNUAL MEETING	1,500.00
COLLEGIATE DIVISION	1,000.00
BOARD MEETING EXPENSES	1,200.00
AAAS	300.00
TOTAL BUDGET	31,200.00

The meeting was adjourned at 9:35 p.m.

TENNESSEE ACADEMY OF SCIENCE EXECUTIVE COMMITTEE MEETING

November 20, 1986

The Executive Committee Meeting of the Tennessee Academy of Science was called to order at 7:00 p.m. C.S.T. by President David Yarbrough in the Private Dining Room, Gebhart Student Center, Belmont College, Nashville. Present were David Yarbrough, president; Gus Tomlinson, president-elect; Floyd Scott, treasurer; Diane R. Nelson, secretary; Libby Workman, editor; Richard J. Raridon, director of the Collegiate Division; William Pafford, director of the Junior Academy; Benjamin P. Stone, David Fields, and Ernest Blythe,

members-at-large; Geraldine Farmer, State Department of Education representative; and David Driskill, local arrangements chairman.

The secretary, Diane R. Nelson, had mailed printed copies of the minutes of the April 1986 Executive Committee Meeting. A motion to accept the minutes was accepted unanimously.

Dr. David Driskill, local arrangements chairman, reported on the arrangements for the meeting. He and his committee members were thanked for their efforts on behalf of the Academy.

The treasurer, Floyd Scott, presented his audited report, which appears elsewhere in these proceedings along with the report of the auditor. Both reports were accepted by a motion passed unanimously.

The editor, Libby Workman, reported that two papers were in review, twenty were under author revision, and eight were typeset for the January issue. Members should be encouraged to submit manuscripts for publication. The editor's report was accepted.

The director of the Collegiate Division, Richard J. Raridon, presented the following report:

"Three regional meetings were held during April, 1986. The Eastern Regional Meeting was held at the University of Tennessee at Chattanooga. Nine papers were presented by students representing two schools. The Middle Regional Meeting was held at Austin Peay State University. Sixteen papers were presented, including nine psychology papers, by students from four schools. The Western Regional Meeting was held at Union University. Twenty five papers were presented by students from six schools. The programs were organized by the regional sponsors: Dr. Robert G. Ziegler, Lincoln Memorial University; Dr. James X. Corgan, Austin Peay State University; and Dr. Charles J. Biggers, Memphis State University.

I would like to propose the following statement be included in the Call for Papers next year:

Collegiate:

Papers by undergraduates may be presented in any of the sections listed above. Please submit a title to the appropriate chairperson. Any papers received after September 26 can still be presented but will not be listed in the program. The abstract will be published later. Undergraduates needing financial assistance to attend the meeting should contact the Collegiate sponsor: Dr. Richard Raridon, 111 Columbia, Oak Ridge, Tennessee 37830."

The director's report was accepted.

The director of the Junior Academy, William N. Pafford, presented the following report:

"During 1985–1986, total expenditures were approximately $3,000. This amount includes the cost of the Handbook, office supplies, envelopes for mailing, and postage.

The 1986 spring meeting was held at West End Middle School in Nashville on April 18, 1986. A total of fifty-four papers were submitted by students across the state, and twenty-one of these students were invited to present their papers at the annual meeting.

Abstracts of all papers presented at the annual meeting have been published in the Handbook, with the top five being edited and published in their entirety. The two highest-ranked presenters were Ms. Michelle Bettler, Dickson County High School, and Glenn Douglas, University School of Johnson City. They will receive a year's subscription to *SCIENCE*.

Three outstanding science teachers were recognized at the annual meeting. They were Ms. Shirley A. Cox, Raleigh-Egypt High School, Memphis (West Tennessee); Dr. Eva M. Wike, Hillsboro High School, Nashville (Middle Tennessee); and Ms. Marsha P. Ottem, Greeneville High School (East Tennessee). A representative from the commissioner's office presented certificates to each of the three teachers so honored.

The 1987 spring meeting will be held at Pearl-Cohn Comprehensive High School, Nashville on April 24, 1987."

The director's report was accepted.

As delegate to the National Association of Academies of Science and to Section Y of AAAS, Richard J. Raridon presented the following report:

"I represented the Academy at the Annual Meeting of the National Association of Academies of Science and the Section X Meeting of AAAS which were held in Philadelphia May 25-30, 1986. The members of Section X recently voted to change the name of the section to 'Societal Impacts of Science and Engineering.' At the request of a number of state academies, the AAAS Council approved the formation of a new section, Section Y, called 'General Interest in Science and Engineering.' TAS has now transferred its enrollment to this new section which is scheduled to meet at the next AAAS meeting, February 14-18, 1987, in Chicago."

The director's report was accepted.

President Yarbrough presented standing committee reports from the respective chairpersons as follows:

Auditing Committee. The chairman, Eugene A. Kline, submitted the following letter from the auditor, James F. McKinnie:

"I have examined the receipts and disbursements records of the Tennessee Academy of Science for the fiscal year ended June 30, 1986. The entire accounting system appears to be well maintained. However, I do think that the Academy should consider a fidelity bond for its treasurer of $10,000.00. With only one person recording the receipts, writing the checks, and maintaining the records, it is not possible to have a good system of cash control. Because it is not feasible to divide the duties among several people, a bond would seem to be the only alternative. I do wish to emphasize that I do not view the lack of a bond as a problem due to the integrity of the persons who normally serve as treasurer.

I also prepared a Return of Organization Exempt From Income Tax, including a Schedule A. This Form 990 must be filed with the Internal Revenue Service no later than November 15, 1986."

A motion was passed unanimously to accept the recommendation to obtain a fidelity bond of $10,000.00 for the treasurer, provided the cost does not exceed $100.

Fellows Committee. The chairman, Hal DeSelm, sent six names for nominations for Fellows. A seventh name was submitted by a member of the Executive Committee.The individuals are as follows: Edward T. Browne, Roy Clark, Thomas Hemmerly, Philip Mathis, Joe Middlebrooks, George Murphy, and Ralph Sharp.

A motion was passed to approve all seven nominees as Fellows of the Academy and to present their names to the membership at the Annual Business Meeting for approval. Dr. Tomlinson will inform the committee next year to limit the number of nominees from any one school.

Membership Committee. The chairwoman, Sue Ann Barnes, sent the following report:

"The treasurer of the Academy, Dr. Floyd Scott, provided a current membership list which indicates that from November 13, 1985, to November 19, 1986, 83 persons have joined the Academy. The current membership roll includes 483 members of which 45 are students, 35 are retired, and 48 reside outside of Tennessee. The roll also includes 146 libraries: 41 instate, 90 out of state and 15 foreign. Life memberships are held by 24 of our members."

The committee's report was accepted.

Discussion was held on the need for recruitment of new members. This year's list of new members will be presented for acceptance by the membership at the Annual Business Meeting.

Necrology Committee. The chairman, Albert L. Myers, reported the death of Dr. Floyd Ford, Biology Department, Austin Peay State University.

The committee's report was accepted.

Nominating Committee. The chairman, William H. Ellis, sent the following proposed slate of officers for next year:

President:	Dr. Gus Tomlinson Tennessee State University
President-Elect:	Dr. David Fields Oak Ridge National Laboratory
Secretary:	Dr. Diane R. Nelson East Tennessee State University
Treasurer:	Dr. Floyd Scott Austin Peay State University

The proposed slate of officers was approved unanimously and will be presented to TAS members at the Annual Business Meeting.

Research Committee. The chairman, Prem Kahlon, will submit a report at the Annual Business Meeting.

Resolutions Committee. The chairwoman, Betty C. Davis, will present the resolutions at the Annual Business Meeting.

NEW BUSINESS

The secretary, Diane R. Nelson, advised the Executive Committee of the necessity of appointing a "Meeting Coordinator," as an assistant to the secretary and the president in organizing the annual meeting. David Fields agreed to act as the coordinator for 1987, in addition to serving as president-elect (program chairman). The Executive Committee agreed to identify and appoint a person to fill the position and to attend future Executive Committee meetings. A line will be added to the budget to cover the expenses involved.

Suggestions were made to increase the membership in the Academy, as follows:

(A) Chairpersons of science, mathematics and psychology departments will be encouraged to meet with the Academy to discuss common problems, including increasing faculty participation in the Academy.

(B) The Academy will interact with other professional societies that have chapters within the state.

(C) Section chairpersons will be encouraged to recruit new members by soliciting papers for the annual meeting.

(D) The president, Gus Tomlinson, was authorized to spend up to $500 for a recruiting brochure.

Dr. James Corgan, APSU, was authorized to investigate finding official state archives for deposition of important Academy papers, at zero or nominal cost. The Executive Committee also authorized reimbursing Dr. Corgan for postage and supplies used in constructing historical summaries for the various sections of the Academy.

The Academy will meet at Jackson State Community College in 1987, Tennessee Tech in 1988, Tennessee State in 1989, and UT Chattanooga in 1990 (the 100th meeting of the Academy).

A motion was passed that the Executive Committee will nominate individuals who have made significant contributions to science to write an autobiographical article for the Journal, describing their philosophy and experiences in science. The issue of the Journal would be dedicated to that person. The editor of the Journal will invite the person to write the article after the nomination and approval by the Executive Committee.

Section chairpersons will be asked to nominate and to invite nominations for regional and/or national editors for the *JOURNAL*, pending approval of the constitutional amendment at the Annual Business Meeting.

The meeting was adjourned at 10:00 p.m. C.S.T.

THE NINETY-SIXTH MEETING OF THE TENNESSEE ACADEMY OF SCIENCE
November 20–21, 1986
Belmont College

The annual meeting of the Tennessee Academy of Science, Inc., was held November 20–21, 1986, at Belmont College, Nashville. Dr. David Driskill was chairman of local arrangements. Dr. Gus Tomlinson, Tennessee State University, was program chairman. Approximately 200 individuals registered for the meeting with 73% attending the luncheon.

A new format was instituted for the meeting, with all activities occurring on Friday. The General Session was held in Massey Auditorium beginning at 9:00 a.m., with Dr. Gus Tomlinson presiding. The Academy was welcomed by Dr. James C. Stamper, vice president for Academic Affairs, Belmont College. The speakers were as follows: Dr. William Schaffner, "AIDS: Current Status and Future Prospects;" Mr. William David, Jr., "Information Security;" and Dr. David E. Fields, "Experimental Investigation of Nuclear Winter Parameters."

The Annual Luncheon was held in the White Dining Hall, Gebhart Student Center, beginning at 11:45 a.m. on Friday. President David Yarbrough presided. Dr. Charles Chappell, NASA Space Center Laboratory, was the speaker. The title of his address was "Science Aboard the Space Shuttle." The Annual Business Meeting followed the luncheon at 1:00 p.m. Section meetings were held Friday afternoon in the Hitch Science Building, beginning at 2:00 p.m.; 93 papers were presented as listed in the program. Collegiate division papers were presented in the appropriate sectional meetings.

ANNUAL BUSINESS MEETING
November 21, 1986

The Annual Business Meeting of the Tennessee Academy of Science, Inc., was called to order by President David Yarbrough at 1:00 p..m. C.S.T. in the White Dining Hall, Gebhard Student Center, Belmont College, Nashville, on November 21, 1986. The president determined a quorum was present.

The reports of the secretary, treasurer, editor, and directors of the three educational programs were similar to those presented the previous evening at the Executive Committee Meeting. The reports were approved and will be recorded in the minutes.

The secretary, Diane R. Nelson, read the report of the Auditing Committee, chaired by Eugene Kline. The secretary read the names of the Fellows nominees, approved by the Executive Committee upon recommendation of the Fellows Committee, chaired by Hal DeSelm. A motion was passed that Dr. Edward T. Browne, Dr. Roy W. Clark, Dr. Thomas E. Hemmerly, Dr. Philip M. Mathis, Dr. E. Joe Middlebrooks, Dr. George G. Murphy, and Dr. Ralph E. Sharp be elected Fellows of the Academy. The secretary read the report of the Membership Committee, chaired by Sue Ann Barnes. The treasurer handed out a list of individuals who had applied for membership in the Academy in 1985–86; a motion to accept the new members was accepted.

The chairman of the Necrology Committee, Albert Myers, reported the death on October 31, 1986, of Dr. Floyd Ford, Biology Department, Austin Peay State University. Dr. Ford had served on the faculty since 1952, retiring on September 1, 1986. Dr. Myers asked the audience to stand for a moment of silence in tribute to Dr. Ford.

Dr. Prem Kahlon, Research Committee chairman, presented the following report:

"The Research Committee submitted a proposal requesting $1000 from AAAS for the 1986–87 school year. In response to this request the Academy received a sum of $900 for this purpose from AAAS. In addition to this amount, the Academy had set aside a sum of $1000 from its own resources for the purpose of encouraging secondary school students' science projects.

Unfortunately we could not announce the availability of these funds in the Academy Journal this year; however, announcements regarding the availability of funds were sent to all the science teachers who had sought funds in previous years and also to the science fair coordinators.

The deadline for receiving the applications was November 14, 1986. The committee received ten (10) applications from four schools requesting $5,828.43. Nine of the applicants are recommended for a total of $1,741. The committee recommends that the remaining funds (from the $1900) be kept for possible future awards until January 15, 1987, for those whose applications may come late. If these funds are not used by January 15, 1987, then these funds can be utilized by the Academy for other needs. The committee is recommending the expansion of this committee to include a representative from the Department of Education from the state whose current duties involve contacts with high school principals or science teachers. Hopefully this expansion will increase the pool of applicants. The following students received awards:

Student Name	School	Request	Award
David Curry	Camden	$171.10	$172
Chris Taylor	Westview	4,482.50	487
Chris Brown	Stewart Co	51.50	52
Carl Hoff	Stewart Co	550.00	530
Bronson Gibbs	Stewart Co	142.50	142
Kristy Grizzard	Stewart Co	32.83	33
Marc Touchton	Stewart Co	100.00	100
Matthew Evans	Haywood	100.00	100
Linda Korn	Haywood	125.00	125
		$5,828.43	$1,741

The president presented the report of the Nominating Committee and asked for further nominations from the floor; there were none. A motion was passed to accept the nominees, and the secretary was instructed to cast one vote which would represent the unanimous

election of Gus Tomlinson as president, David Fields as president-elect, Diane R. Nelson, secretary, and Floyd Scott as treasurer.

Ms. Betty C. Davis, chairwoman of the Resolutions Committee, presented the following resolutions, which were accepted:

RESOLUTION OF APPRECIATION

"WHEREAS, the Tennessee Academy of Science, including the Collegiate Division is enjoying a most pleasant, profitable, and well-organized series of meetings at Belmont College, and

WHEREAS, the success of these meetings has resulted mainly from the efforts of the officers of the respective sections; the Local Arrangements Committee representing Belmont College, composed of David Hill, Robert Magruder, Otis McCowan, Donald Ramage and Dr. David Driskill, chairman; the program chairman, Dr. Gus Tomlinson; from the recognition given the meetings by the press, television, and radio stations; and from the generous hospitality of the host institution, Belmont College and its president, William E. Troutt,

BE IT RESOLVED, therefore, that the Tennessee Academy of Science expresses its sincere appreciation to these and all others who have contributed to the success of these meetings."

RESOLUTION IN SUPPORT OF SCIENTIFIC STUDIES OF REELFOOT LAKE

"WHEREAS, the Tennessee Academy of Science acknowledges the increasing importance of preserving the natural resources located in the State of Tennessee, and

WHEREAS, the Academy recognizes that Reelfoot Lake is a valuable natural resource with unique geologic and biologic features, and

WHEREAS, the Academy perceives that the most effective preservation of Reelfoot Lake would occur with direct involvement of the scientific community of Tennessee, and

WHEREAS, the Academy expresses enthusiastic support of the development of effective monitoring programs of all biotic and abiotic facets of the Reelfoot Lake environment,

BE IT RESOLVED, therefore, that the Tennessee Academy of Science encourages its involvement in the planning stages for the future direction of management and monitoring of Reelfoot Lake as well as in research and educational usage of the area.

BE IT FURTHER RESOLVED, that this resolution be included in the minutes of the Tennessee Academy of Science and published as a part of the Proceedings of this meeting, and that a copy be sent to Paul B. Hamel, Ecological Services Division of the Tennessee Department of Conservation, and to Dr. Winfred Smith, Professor of Biology, UT Martin."

RESOLUTION OF CONGRATULATIONS

"WHEREAS, Dr. Stanley Cohen of the Department of Biochemistry at Vanderbilt University Medical Center was recently awarded the 1986 Nobel Prize in Medicine and Physiology for recognition of his research on the isolation of Epidermal Growth Factor, and

WHEREAS, Dr. Cohen has also received the prestigious Lasker Award,

BE IT RESOLVED, therefore, that the Tennessee Academy of Science extends its congratulations to Dr. Stanley Cohen for his outstanding accomplishments."

NEW BUSINESS

The following constitutional amendment was approved by the membership:

ARTICLE III, Section 6

FORMER READING:

Section 6. — The editor shall edit and manage the Journal of the Tennessee Academy of Science and such other publications as the Academy may from time to time publish. He shall be assisted by an Editorial Board consisting of one editor elected by each section, by an editor of the News of Tennessee Science, and by an editor of a section devoted to the High School Science Teacher, both of the latter to be approved by the Executive Committee.

NEW APPROVED READING:

Section 6. — The editor shall edit and manage the Journal of the Tennessee Academy of Science and such other publications as the Academy may from time to time publish. The editor shall be assisted by an Editorial Board consisting of three editors per section, one of whom is elected by each section, and two editors, recognized regionally and/or nationally for their professional expertise, who are recommended by the editor. All editors shall be approved by the Executive Committee.

The Executive Committee will identify and appoint a person to serve as "Meeting Coordinator," as an assistant to the secretary and the president in organizing the annual meeting. Members may volunteer or submit nominations for the position.

The Academy will meet at Jackson State Community College in 1987, Tennessee Tech in 1988, Tennessee State in 1989 and UT Chattanooga in 1990 (the 100th meeting of the Academy).

The meeting was adjourned at 1:45 p.m. C.S.T.

TENNESSEE ACADEMY OF SCIENCE
TREASURER'S REPORT
November 21, 1986

A. Floyd Scott, *Treasurer*

CASH BALANCE — JULY 1, 1986	27,270.64
RECEIPTS	
STATE OF TENNESSEE	19,000.00
MEMBERSHIP DUES	3,580.00
LIBRARY SUBSCRIPTIONS	1,575.00
INTEREST EARNED	594.02
JOURNAL PAGE CHARGES	465.00
CONTRIBUTIONS	422.00
REGISTRATION AND LUNCHEON FEES	860.00
EXHIBITORS' FEES	250.00
AAAS AWARD	900.00
TOTAL RECEIPTS	27,646.02
TOTAL CASH AVAILABLE	54,916.66
DISBURSEMENTS	
JOURNAL PRINTING COSTS	7,463.67
VISITING SCIENTIST PROGRAM	4,998.55
TENN. JR. ACADEMY OF SCIENCE	420.59
ANNUAL MEETING	259.90
BOARD MEETING EXPENSES	0.0
TREASURER'S EXPENSES	1,056.66
PRESIDENT'S EXPENSES	330.00
STUDENT RESEARCH GRANTS	0.00
COLLEGIATE DIVISION EXPENSES	0.00
SECRETARY'S EXPENSES	176.84
TOTAL DISBURSEMENTS	14,706.21
CASH BALANCE — NOVEMBER 20, 1986	40,210.45
RECEIPTS	27,646.02
DISBURSEMENTS	14,706.21
CASH INCREASE	12,936.81
CASH BALANCE — JULY 1, 1986	27,270.64
CASH BALANCE — NOVEMBER 20, 1986	40,210.45
BREAKDOWN OF HOLDINGS	
APSU ACCOUNT	122.75
PRIMARY CHECKING ACCOUNT, 1ST FEDERAL	4,713.23
SAVINGS ACCOUNT, 1ST FEDERAL	35,374.47
TOTAL HOLDINGS AS OF NOVEMBER 20, 1986	40,210.45

Tennessee Academy of Science New Members 1986–1987

Charles F. Baes, Jr.	Oak Ridge	Martha E. Hunter	Nashville	Abu K. Sarwar	Clarksville
Anita Bailey	Gainesboro	Albert F. Iglar	Johnson City	Diane L. Simmons	Clarksville
R. Keith Barrett	Murfreesboro	James A. Johnson	Memphis	Sivaram Srinivasan	Memphis
Dr. Daniel W. Bath	Clarksville	Claude E. Jones	Clarksville	Douglas Stephens	Whitley City, KY
Richard E. Bergenback	Chattanooga	Dr. Padgett Kelly	Dickson	Dr. Wayne L. Stevenson	Oak Ridge
Marvin B. Berwind	Nashville	Judy A. King	Johnson City	Dr. Arthur B. Straughr	Memphis
Jean L. Bledsoe	Oak Ridge	Kenneth F. Kirschner	Antioch	Eugene Strobel	Murfreesboro
John L. Butler	Clarksville	Teresa A. Lane	Murfreesboro	James C. Stroh	Memphis
Dr. Alex Bykat	Chattanooga	Jefferson G. Lebkuecher	Cookeville	Jeff Tassin	Sewanee
Greg Clement	Jackson	Library Dept Transport	Nashville	Michael J. Thrasher	Allons
Dr. J. William Cliburn	Hattiesburg,MS	Jeremiah J. Maclaren	Murfreesboro	Norman H. Tolk	Nashville
Ralph C. Daniel	Nashville	Robert H. Magruder III	Nashville	William R. Trentham	Cookeville
Michael D. Daugherty	Cleveland	John R. Manning	Murfreesboro	Lisa D. Turner	Gallatin
Russell R. Duggan	Murfreesboro	Dr. Jacqueline Martin	Nashville	Ellen M. Twombley	Woodlawn
Glenn Steven Edwards	Nashville	Andrew S. Methven	Knoxville	Marie L. Twombley	Woodlawn
Edgar Emeric	Cleveland	Harold Miller	Asheville, NC	David H. Wagner, Jr.	Johnson City
Lydia O. Enzor	Murfreesboro	James D. Milloway	Cookeville	Walter D. Ward	Chattanooga
Dr. Mary Eubanks	Nashville	Karen S. Moore	Antioch	Charles N. Watson, Jr.	Johnson City
Elaine Foust	Clarksville	Martha S. Morehead	Cleveland	Dr. George W. Wheeler	Knoxville
Ann K. Fuqua	Nashville	George Musil	Johnson City	Dean P. Whittier	Nashville
Joe Galetovic	Knoxville	Elbert Lewis Myles	Nashville	John P. Wikswo, Jr.	Nashville
Darlene A. Gasperson	Nashville	Dr. Robert F. Newkirk	Nashville	Barbara B. Wilbur	Clarksville
Robert T. Grammer	Nashville	Robert H. O'Bannon	Cleveland	John C. Wilson	Cleveland
Gregory J. Grant	Chattanooga	J. Gerald Parchment	Murfreesboro	Jeffrey A. Winfree	Lebanon
David K. Hackett	Knoxville	Joyce J. Pinkston	Memphis	Arnold Gene Woodward	Knoxville
Richard F. Haglund, Jr.	Nashville	Adrienne N. Pou	Nashville	Libby L. Workman	Hixson
Craig T. Harston	Chattanooga	Wayne J. Price	Murfreesboro	M. Guven Yalcintas	Oak Ridge
Lisa J. Hight	Clarksville	Hugh W. Quigley	Fairfield Glade		

JOURNAL OF THE TENNESSEE ACADEMY OF SCIENCE

Volume 62, Number 2, April, 1987

ABSTRACTS PRESENTED AT THE ANNUAL MEETING

BOTANY SECTION

Kurt E. Blum, *presiding*

A Cytological Study of Heterochromatic Regions in Zea Hybrids, M. Eubanks, Vanderbilt University.

Dark staining hererochromatic regions on the chromosomes of maize appear like beads on a string and are called knobs. It is established dogma in maize cytogenetics that knobs are heritable, stable markers just as mutant genes. The findings of research on the inheritance of knob patterns in hybrids between maize and its close relative teosinte, however, indicate that knobs can move from terminal to internal positions as a result of interspecific hybridization. Evidence for the phenomenon of knob transposition will be presented.

A History of the Botany Section, 1934–1985, James X. Corgan, Austin Peay State University.

Oral presentations are a guide to the history of the Botany Section. Counts of papers show six statistically distinct phases in 52 years. Phase I (1934–1937) had a mean of 14 papers and drew very diverse support. Phase II (1938–1945), with an average of 7.38 papers, was a time of decline. Decline was probably caused both by World War II and by the emergence of competing organizations. Phase III (1946–1952), a post-war boom, averaged 11.86 papers. Phase IV (1953–1962), with a mean of 8.70 papers, was influenced by increasing specialization within botany, which lessened interest in general organizations. Phase V (1963–1980), with 11.11 papers, reflected a state-wide strengthening of collegiate science offerings and the spread of graduate work to regional schools. Phase VI (1981–Present) has the lowest mean number of oral presentations in the history of the section, 6.80. Causes of this decline ar not clear. It may be significant that fewer institutions are represented in sectional programs. Since 1934 the relative success and failure of the Botany Section seems to be statistically independent of easily measured geographic influences and, while there are similarities, the history of the Botany Section does not correlate in detail with the history of any other section.

Changes in the Persistent Marshes of Reelfoot Lake, J.W. Henson, The University of Tennessee at Martin.

Giant cutgrass *(Zizaniopsis miliacea)* formerly dominated persistent marshes of Reelfoot Lake (1933–1963). Since 1963, this species has been largely replaced by others more typical of swamps. Distribution of giant cutgrass today mainly occurs along reservoir edges. Abundant species of persistent marshes are: swamp loosestrife *(Decodon verticillatus)*, common cattail *(Typha latifolia)*, rose mallows *(Hibiscus lasiocarpus* and *H. militaris)*, buttonbush *(Cephalanthus occidentalis)*, false indigo *(Amorpha fruticosa)*, swamp rose *(Rosa palustris)*, climbing hempweed *(Mikania scandens)*, groundnut *(Apios americana)*, and immature baldcypress *(Taxodium distichum)*, red maple *(Acer rubrum)*, silver maple *(A. saccharum)* and black willow *(Salix nigra)*. Most persistent areas represent marsh-to-swamp successional stages. Southern smartweed *(Polygonum densiflorum)* aggressively competes with other species along marsh margins and in ditches and sloughs. Expansion of giant cutgrass has been retarded because of species competition and elevated, average water levels which limit its growth.

Decline of Submersed Macrophytes of Reelfoot Lake Following Introduction of the White Amur, W.A. Sliger and J. Wesley Henson, The University of Tennessee at Martin.

A quantitative study of problem submersed aquatic macrophytes of Reelfoot Lake showed a precipitous decline in all submersed

vegetation following the introduction of White Amur, *Ctenopharyngodon idella*. Within two years of stocking with five fish per vegetated acre, the quantity of all submersed macrophytes declined drastically at all sites sampled. Curlyleaf Pondweed, *Potomogeton crispus*, and Coontail, *Ceratophyllum demersum*, dominated all sampling areas prior to White Amur introduction. After two years, these plants were reduced to the point of being non-problem species in the lake. Asexual buds (turions) of Curlyleaf were present two years after fish introduction but their numbers were significantly reduced. The number of Curlyleaf Pondweed turions may provide a good indicator for determining future stockings of White Amur into Reelfoot Lake.

Nutrient Capital Sequestration in Pioneer Plant Communities on Surface-mine Spoil, G.L. Wade, U.S. Forest Service, Berea, Kentucky.

Sequestration of nutrient capital in biomass after disturbance is an important ecosystem recovery mechanism that may also be important to new ecosystems on surface mines. Four pioneer community types, a reclamation mix of grasses and lespedeza, native species from a forest topsoil seed bank, a native species plus reclamation mix, and a *Chenopodium*-dominated community, were established in microplots to determine differences in ability to sequester nutrients in biomass. The four communities produced different amounts of aboveground biomass and sequestered different amounts of the initial nutrient capital at the end of the first growing season. Community content of nine elements was not strictly proportional to biomass. Nutrient uptake characteristics of the dominant species as well as biomass determined pioneer community nutrient capital sequestration. Community N, K, Mg and Zn contents were most strongly correlated with biomass; Ca, Mn and Fe contents were least correlated with biomass.

The Distribution of an Endangered Mint, Scutellaria montana., Joseph L. Collins and Charles P. Nicholson, Tennessee Valley Authority.

Scutellaria montana (Lamiaceae) is a federally endangered species known historically from the vicinity of Rome, Georgia, and Chattanooga, Tennessee. Field searches resulted in the discovery of six new populations in 1981. Other botanists discovered two additional populations in 1984. TVA botanical surveys along Chickamauga Reservoir in 1986 revealed 10 additional populations north of the previous range. Although *S. montana* is restricted in range, a current evaluation of its status indicates it is not as rare as previously believed.

A Baseline Population Survey of Pityopsis ruthii along the Hiwassee River, Joseph L. Collins, Tennessee Valley Authority, and Scott C. Gunn, Tennessee Department of Conservation.

Pityopsis ruthii (Asteraceae) is a federally endangered species occurring only along the Hiwassee and Ocoee Rivers in southeast Tennessee. Numbers of plants have not been recorded previously, and population trends have been subject to conjecture. A baseline study, including permanent plots, is now in progress. Data from 10 by 10 m plots and 1 by 1 m quadrats in the Hiwassee population are reported. Information on habitat, plant vigor, reproduction, and associate species is presented. An estimate is given for the total number of *P. ruthii* plants and total seed production.

Plant Communities of Collins Gulf, Tennessee, J.G. Lebkuecher, G.E. Hunter, Tennessee Technological University.

Ten wooded stands in Collins Gulf, sampled using the point-centered quarter method, include a variety of forest types, hemlock, chestnut oak, oak-hickory, red maple and mixed mesophytic, similar to those found in adjacent Savage Gulf, Tennessee.

The Effects of Ultraviolet Radiation on Saccharomyces uvarum metabolism, Juan Z. Luciano, Cathy Hix, Tennessee Technological University.

The objective of this study was to measure the effect of UV radiation on the metabolism of *Saccharomyces uvarum* in wort used in beer production. Pure yeast cultures were exposed to a Westinghouse G8T5 germicidal lamp for 10, 20, 30 and 40 minutes and added to fresh wort. The cultures were allowed to ferment for 96 hours at 130 C and fermentation products were assayed at 24 hour intervals and analyzed on a SCABA BEER ANALYZER.

Metabolic parameters measured were balling, alcohol and cell count. Percent alcohol (V/V %) increased significantly at all exposures, but as the UV dosage increased, alcohol levels showed a significant decline with longer exposures.

The assimilation of sugars or balling levels dropped at each exposure level among samples. The ability for the yeast to assimilate sugars decreased as UV exposure was increased although pitching rates fluctuated. (Pitching rates are the cell count readings at inoculation). None of the samples showed a logarithmic growth pattern, except for the controls which did not exhibit a lag phase. All other samples decreased cell counts as exposure levels increased, without peaks.

Substrate availability was not a factor in the metabolism of *Saccharomyces uvarum.* Cell count levels at each exposure could have possibly affected the metabolic parameters because of excessive cell killing. Viabilities at the exposure levels studied show that the number of live cells available for nutrient uptake was lower at each level. However, the peak levels of the parameters measured were very close to the controls. Although the availability of cells was low, metabolic rates could have been altered by the UV light.

Protoplast Production for Fern Gametophytes and Sporophytes, J.D. Caponetti, The University of Tennessee, Knoxville.

Proptoplast cultures have been obtained from gametophytes of *Ceratipteris richardii* and two of its mutants. The best results were obtained by placing whole gametophytes from sterile culture in a sterile solution of cellulase and pectinase with 0.6 M mannitol at pH 5.8. Cultures were agitated gently on a rotary shaker for two hours. Pre-treatment of the gametophytes with liquid fern medium containing 0.6 M mannitol at pH 5.8 for one-half hour yielded better protoplast cultures at the time of enzyme treatment than without pre-treatment. The same procedure with the substitution of Driselase enzyme mixture yielded satisfactory results. The techniques used on gametophytes were applied to sporophyte pinnae of several cultivars of Boston Fern. Some success was obtained with pinnae of Fishtail Fern, *Nephrolepis falcata* cultivar 'furcans.' The fern protoplast culture technique shows promise for propagating the standard ornamental cultivars via sterile tissue culture, and for the development of new cultivars and hybrids.

Effects of Selected Growth Regulators on Leaf and Cotyledonary Explants of Simmondsia chinensis, M.A. Bailey, T.M. All, and S.K. Ballal.

Jojoba is a desert shrub endemic to the Sonoran Desert of the American Southwest and Mexico. This plant is receiving increased attention due to the high quality oil contained in its seeds. Plant tissue culture is one method by which potential crops such as jojoba may be propagated. Several attempts have been made to establish transplantable jojoba plantlets in tissue culture, but no practical regime has yet been established. Many micropropagation regimes through tissue culture require a preliminary callusing phase. Selected growth regulators have ben used in this study to observe growth rates, quantities, persistence of callus, and, subsequently to find the optimum regulator concentrations for the production of callus. The regulators used in this study include NAA, 2,4-D, IAA and kinetin.

Cytological studies were conducted on callus derived from leaf and cotyledon explants. A comparison of chromosome number based upon the type of auxin (2,4-D, IAA and NAA) and cytokinin (kinetin) used was made. These results were compared with chromosome counts made on tissues derived from excised embryos germinated on a basal MS medium.

In Vitro Culture of Brassica Oleracea L. Var. Italica, S. M. Bhatti and P.S. Kahlon, Tennessee State University.

The objective of this experiment was to study the effect of various factors on callus induction and differentiation of broccoli *(Brassica Oleracea* L. Var. *Italica).* Hypocotyl and cotyledonary sections were excised from one week old seedlings of cultivars Green Valiant, Green Mountain, Emperor, Shogun and Green Duke and placed on media modified with different combinations of

hormones. At the end of an eight-week period, cultivars Green Valiant and Emperor showed considerable difference in the amount of callus formed from cotyledons and hypocotyls. Cotyledonary sections formed more callus than hypocotyls. Genotypic differences were also observed in the cultivars in their response to the various media modifications. Shoot formation from callus was observed in Green Duke after being subcultured on media supplemented with 2 mg/l Napthalene acetic acid and 2 mg/l Benzyladenine whereas Emperor required .5 mg/l Napthalene acetic acid. 1 mg/l Benzyladenine, 0.25 gms/l casein hydrolysate and 0.25 gm/l Glutamine for shoot formation. (Supported by USDA/CSRS grant 7903-1-PS2).

The Analysis of Zeins in Normal and Mutant Zea mays Kernels During Endosperm Development, T.L. Hogg, A. Kriz and B. Larkins, Purdue University.

In order to analyze gene expressions in the kernels of *Zea mays*, we have analyzed the zeins proteins in both normal and mutant seeds. We have attempted to accomplish this task using both quantitative and qualitative methods. Zeins are alcohol-soluble proteins that are stored in the endosperm of maize kernels. These proteins account for the majority of the protein found in the maize endosperm. We have analyzed the zein kernels by three methods. The first method was by sodium didecylsulfate–polyacrylamide gel electrophoresis (SDS-PAGE). The second method was an immunological assay called ELISA (enzyme-linked immunoadsorbent assay). The third method was the analysis of radioactive kernels which had been labelled with tritiated (^{3}H) amino acids. Zeins were extracted from these kernels and subjected to SDS-PAGE followed by fluorography. The results of these *in vivo* labelling experiments allow for evaluation of zein gene expression as a function of amino acid incorporation into zein polypeptides.

The Effect of Different Strains of Verticillium daliae on Phytoalexin Formation in Gossypium arboreum Cell Suspension Cultures, P. M. Tucker and P.F. Heinstein, Purdue University.

Phytoalexins are chemical compounds which are synthesized by plants as a defense response to physical, chemical, or biological stress, such as invasion by microorganisms. In this experiment, phytopathogenic fungi are used to stimulate the increase of hemigossypol and gossypol derivatives, the natural defense compounds present in the pigment glands of *Gossypium arboreum,* a species of wild cotton. Phytoalexin production by the cotton cells is induced by elicitors which are believed to be found within the fungal cell wall and activated when the pathogen is introduced to the host.

Cell suspension cultures of *Gossypium arboreum* were inoculated with heat denatured cell wall fragments of seven *Verticillium dahliae* strains with varying degrees of virulence. The inoculated Gossypium cell suspension cultures were incubated for a period of 120 hours after which the cell dry weights were obtained to determine the amount of cell death after inoculation, and to find a possible correlation between virulence, cell death, and phytoalexin accumulation. The data indicated that there was a significant increase in the amount of phytoalexins after inoculation with the fungal fractions, and the strains with the lowest virulence index induced the highest amounts of phytoalexins.

CHEMISTRY SECTION

George E. Walden, *presiding*

Ion Exchange Column Modeling: Equilibrium- Controlled and Mass Transport-Controlled Models for Univalent-Divalent Exchange, David J. Wilson, Vanderbilt University.

The operation of ion exchange columns exchanging univalent for divalent ions is modeled by numerical integration. Both equilibrium-controlled and mass transport-controlled regimes are modeled, the last by means of a time constant approach. The time constant is estimated as the smallest non-zero eigenvalue of a suitably chosen diffusion problem. Numerical dispersion is reduced by the use of upwing asymmetrical algorithms for the advection term. The effects of salt concentration in the eluting liquid and of the time constant for mass transport are presented.

Reactions of 4,5-Dihydropyrene, 4,5,9,10-Tetrahydropyrene, 1,4-Dihydronaphthalene, and 9,10-Dihydroanthracene with 1,1'-Binaphthyl, Eugene A. Kline, Nai-Syun Roy Chuang, and Timothy H. Morris, Tennessee Technological University.

1,1'-Binaphthyl has been shown to react with various H-donors used in coal liquefaction at a high temperature (470°C) to form perylene in various amounts. This study involved syntheses and isolation of two model H-donors 4,5-dihydropyrene and 4,5,9,10-tetrahydropyrene. Reactions involved 1,1'-binaphthyl and these two H-donors as well as two other commercial H-donors 1,4-dihydronaphthalene and 9,10-dihydroanthracene. Reactions were run for 1,2,3,and 5 hours at 470°C and gas chromatographic analyses were used to study the kinetics. A gradual increase in perylene occurred at different rates depending on the H-donor used.

Deuterated PNA's were reacted with 1,1'-binaphthyl and H-donor. The mixtures were then analyzed by 200 MHz ^{1}H NMR which gave unique adsorptions for each kind of hydrogen present. The results showed the method effective and a mechanism most consistent with a bimolecular reaction between a low concentration reactive hydroaromatic and binaphthyl with exchanges of varying extents of the hydrogens of all the aromatic compounds.

A History of the Chemistry Section, 1940-1986, James X. Corgan, Austin Peay State University.

There are two statistically distinct phases in the history of the Chemistry Section. In Phase I (1940–1967) typical meetings involved six or seven papers. In Phase II (1968–Present) they involve 10 or 11 papers. Quantitative approaches to the identification of causes for this two-part history are limited by a lack of numerical data on anything other than the number of oral presentations. Examining these data suggests that easily quantified aspects of geography do not influence sectional programs. The major cause of a two-phase history seems to be change in the community of chemists served by the section. While there are similarities, there is no detailed correlation with the history of any other academy section.

Preparative Gas Chromatography: Nonlinear Isotherms, Mass Transfer Kinetics, and Solute-Solute Interactions, David J. Wilson, Vanderbilt University.

The effects of nonlinear isotherms, mass transfer kinetics, and solute-solute interactions in proparative gas chromatography are modeled by numerical integration of the differential equations describing solute movement. Numerical dispersion is greatly reduced by the use of asymmetrical upwind algorithms for advection. A time constant approach is used for mass transfer rate effects. A number of solute-solute interactions are modeled and found to produce extreme distortion of band shapes.

Removals of Trace Levels of Phenols From Aqueous Solution by Foam Flotation, G.A. Nyssen, G.S. Lovell, A.A. Simon, J.G. Smith, and B.D. Tolar, Trevecca Nazarene College, and D.J. Wilson, Vanderbilt University.

Pentachlorophenol (PCP) was removed from water by foam flotation with the cationic surfactant cetyltrimethylammonium bromide (CTAB). With initial PCP concentrations of 20 ppm or less, residual PCP concentrations of less than 0.1 ppm were obtained after five minutes of flotation. The CTAB concentration and flotation time are directly related to the amount of PCP removed. PCP removal is most efficient at neutral to basic pH values and at low ionic strength. PCP removal is less effective with sodium dodecyl sulfate (SDS). As much as 80% of the CTAB can be replaced by dodecylamine without inhibiting PCP removal. Alcohols up to 10% by volume do not effect PCP removal. Other phenols can also be removed equally well by foam flotation if the phenol is predominately in the anionic form during flotation. The phenol removal is explained by an ion-pair attraction and an ion-dipole attraction between the phenol and the surfactant ion.

The Forensic Analysis of Human Skin Oils, Linda A. Wilson, A.E. Woods, Gale J. Clark, Middle Tennessee State University.

Capillary gas-chromatographic profile analysis has been applied to the study of human skin oils. Human skin oils are a complex mixture of lipids which can yield chromatogram of up to 150 peaks. Facial skin oils from 23 volunteers were analyzed to see whether each would produce a unique pattern. Forensic applications will be discussed.

Electrical Aspects of Adsorbing Colloid Flotation: Flotation with Mixed Surfactants, Matilal Sarker, Michelle Bettler, and David J. Wilson, Vanderbilt University.

The effect of a number of alcohols in reducing the critical micelle concentration (cmc) of sodium dodecylsulfate (SDS) was measured conductivetrically; alcohols reduce the cmc quite substantially. This suggested the use of these alcohols as low-cost surfactant extenders in precipitate and adsorbing colloid flotation separations. Octanoic acid, n-butanol, n-hexanol, and n-octanol markedly reduce the quantity of SDS needed for the flotation of ferric hydroxide and for the adsorbing colloid flotation of Cu(II) with ferric hydroxide.

^{1}H and ^{13}C NMR Studies of Pentachlorocyclopentadienyl (2,4,6-tri-tert-butylphenyl) Mercury, William H. Ilsley, Kevin Benner, Middle Tennessee State University, and Ole Mels, William L. Wurster , John P. Oliver, Wayne State University.

Pentachlorocyclopentadienyl (2,4,6-tri-tert-butylphenyl) mercury, *1,* has been prepared by reacting equimolar amounts of bis (2,4,6-tri-tert-butylphenyl) mercury, *2,* and bis (pentachlorocyclepentadienyl) mercury, *3,* in methylene chloride. The formation of *1* by this simple exchange reaction was rather surprising, since examination of solid state structure of *2* had suggested that this molecule ought to be too sterically hindered to react via simple exchange, especially in methylene chloride.

Compound *1* is of interest because of the C_5Cl_5 ligand might be expected to exhibit fluxional behavior (i.e., 1,2-sigmatropic rearrangement) both in solution and in the solid state. Preliminary ^{35}Cl-NQR data (N. Weiden and G. Wulfsbert, unpublished results) has confirmed fluxionality in the solid state and suggests an activation energy on the order of 23 kJ/mole for the rearrangement. Solution ^{13}C-NMR data will be presented that also confirms fluxionality of the C_5Cl_5 group in solution. Preten, ^{199}Hg and solid state ^{13}C-NMR data on *1* will also be discussed.

Absolute Configuration of (S)-(–)-*p-Bromo-α-phenethylamine,* Martin V. Stewart, Middle Tennessee State University.

An X-ray crystal-structure determination of the dextrorotatory salt formed from (S)-(–)-p-bromo-α-phenethylamine and (S)p-(+)-1,6-methano[10]annulene-2-carboxylic acid established the absolute configuration of the planar chiral carboxylic acid without recourse to anomalous dispersion measurements by virtue of the internal-reference chiral center provided by the cationic moiety. Previous workers have suggested an (S)-(–) configuration for the precursor amine based on ORD data. We desired a more substantial proof for the absolute configuration of the internal reference center of our crystallographic sample and accomplished an unequivocal chemical correlation of (S)-(–)-α-phenethylamine with its p-bromo derivative.

Effects of Helium Upon Flame Characteristics, Harvey F. Blanck, Austin Peay State University.

The presence of an unreactive gas mixed with reactants lowers a flame's temperature. The effect is related to the heat capacity of these gases. In an attempt to demonstrate this in a visual fashion, a match was held tip end up by a hosecock clamp and placed in the bottom of a bell jar. In a mixture of 20% O_2 and 80% N_2 the match burns just as in room air. The results using 20% O_2 and 80% He which were expected to visually demonstrate a higher flame temperature by producing a more rapid combustion, were surprising. The flame went out! Hot gases are carried upward by convection and cooler gases flow molecules to conduct thermal energy away from surface depends upon the heat capacity and the frequency of collision. The higher collision frequency of helium more than compensates for its lower heat capacity and under these conditions extinguishes the flame. An attempt to develop an adiabatic flame temperature demonstration resulted in a gas chromatography thermal conductivity detector demonstration.

Porphyrin Mediated Photodynamic Damage in DNA. Thermal Denaturation Studies, James C. Howard and J. Richard Manning, Middle Tennessee State University.

Calf thymus DNA was irradiated with visible light in the presence of *meso* tetra(4-N-methylpyridyl)porphine, a DNA-binding porphyrin, and the possibility of photodynamically induced crosslinks analyzed spectrophotometrically using thermal denaturation and renaturation experiments. No evidence for crosslinks was found.

ENGINEERING SECTION

George R. Buchanan, *presiding*

The Engineering Section of the Tennessee Academy of Science from 1955 to 1986, James X. Corgan, Austin Peay State University; David W. Yarbrough, Tennessee Technological University.

The first plans for the Engineering Section of the Tennessee Academy of Science were made in 1954 with the initiation of a feasibility study. The section met during the years 1955 to 1960 and then became relatively dormant until 1977. Analysis of Academy records provides an identification of three distinct phases of the section's history. Statistical information about the section will be presented.

An Environmental Option to Copper Cleaning, J. T. Mason, Tennessee Technological University.

Although expensive, copper is one of the choice materials for construction of certain mechanical apparatus. During construction, oxidation can be formed on the surface and must be removed for some applications.

A primary copper cleaning technique uses nitric acid to further oxidize and remove the surface. This technique provides considerable waste that must be disposed of carefully.

One technique currently used for etching copper circuit boards involves use of a proprietary stabilizing agent with sulfuric acid and hydrogen peroxide. Waste from this process is copper sulfate crystals. The technique has not been previously tested on material with unique geometries.

Research has been done to investigate the applicability of this to copper parts with unique geometries. With proper time and agitation, the technique works exceptionally well and could be applied to numerous processes.

A Comparative Study of Metal Removal by Vermiculites, Perlite, Sulfide Precipitation, Ion Exchange Resin, and Hydroxide Precipitation, by Paul J. Whalen, John S. Gifford, William P. Bonner, Suda Bunduwongse, Narendaran Ramachandran, Tennessee Technological University.

A metal preparation process in a large manufacturing company located in Middle Tennessee produces a waste stream high in zinc, nickel and in smaller concentrations, copper. The plant's effluent permit allows only very small concentrations of the three metals in discharge water. Four methods were evaluated to determine an effective and feasible treatment scheme for the company's waste stream. The methods examined were, vermiculite/perlite, sulfide precipitation, ion exchange resin, and hydroxide precipitation.

Metal removal was successfully achieved from the four treatment schemes. However, each process evaluated required unique treatment considerations such as waste pre-treatment or pH adjustment and increased coagulant doses to improve precipitation. A comparison of treatment processes was performed to evaluate method feasibilities and select the best treatment scheme.

R & D Needs in the Pen and Pencil Industry, Victor Ebolum, Faber-Castell Corporation, David W. Yarbrough, Tennessee Technological University.

The development and improvement of techniques for manufacturing pens and pencils require physical property data that are not

commonly available. Two manufacturing processes needing new property data will be described. Non-Newtonian fluids for which basic data are needed are encountered in many manufacturing steps. Diffusion data for waxes in porous media are needed for process improvement calculations. Research topics on properties of materials will be suggested.

A Dye Survey of Sensitizing Agents for the Photooxidation of Bromacil, Talbert N. Eisenberg, E. Joe Middlebrooks, V. Dean Adams, Tennessee Technological University.

Laboratory scale studies were conducted to determine the degradation potential of sensitized photooxidation of the refractory herbicide bromacil. The effects of sensitizer (69 textile, biological, and chemical dyes, stains and indicators), pH value (4, 7, and 10) and dissolved oxygen (saturated and anoxic) on bromacil degradation were evaluated. The rate of reaction was found to be dependent on percent ionization of bromacil, pH value, dissolved oxygen, and sensitizer. Little or no degradation was observed at pH 4. An increase in reaction rates and percent ionization was seen at pH 7, and reaction rates and percent ionization were highest at pH 10 with no bromacil detected at 4 min for phloxine B, 8 min for rose bengal, methylene blue, and eosin Y, and 16 min for Wright's stain. Reaction rates under anoxic conditions were generally 1 to 2 orders of magnitude less than reaction rates under aerobic conditions. Thiazine, azine, and xanthene dyes were the most effective sensitizers.

On the Galerkin Approach to Nonlinear Dispersive Wave Propagation, Asghar Googerdy, Barber-Scotia College, Concord, NC, John Peddieson, Jr., Tennessee Technological University.

The Galerkin method is applied to the model nonlinear one-dimensional dispersive wave-propagation problem

$$\partial_t^2 u = \partial_x^2 u + \varepsilon(\partial_x u \partial_x^2 u + \delta \partial_x^2 \partial_t^2 u) = 0; \quad \varepsilon << 1 \qquad (1)$$

$$u(0,t) = 0,\ u(\pi,t) = 0,\ u(x,0) = \sin(x),\ \partial_t u(x,0) = 0$$

which arises, among other places, in the approximate continuum description of longitudinal wave propagation in a chain of identical masses connected by quadratically nonlinear springs. This is a useful test case for two reasons. First, the ordinary differential equations governing the time dependent modal amplitudes associated with the Galerkin method can be derived in closed form. Second, it is known that solutions of (1) should exhibit the Fermi, Pasta, Ulam (FPU) recurrence phenomenon. The ability of the Galerkin method to predict this can be regarded as a measure of the method's success.

The ordinary differential equations governing the modal amplitudes are first simplified for $\varepsilon << 1$ by the two-variable perturbation method and then solved numerically. It is found that eight to ten modes are necessary to obtain qualitatively correct results.

An Evaluation of a Domestic Wastewater Package Treatment Plant, Paul J. Whalen, V. Dean Adams, E.J. Middlebrooks, Jeffry G. Curtis, Susan K. Burns, Center for the Management, Utilization and Protection of Water Resources, Tennessee Technological University.

Great emphasis has been placed on the use of innovative and alternative technologies for wastewater treatment by the USEPA. Often, the construction and maintenance of a central municipal wastewater treatment plant is not feasible for rural and small communities. Septic tank systems are the most common methods for onsite wastewater treatment. However, septic tank systems may not be suitable for sites with inadequate soil properties or shallow soil depth above restricting formations. The karst topography regions of Tennessee may also be examples of sites inadequate for septic tank systems. A feasible alternative may be a prefabricated, self-contained package treatment.

A package wastewater treatment plant, utilizing fixed-film growth and extended aeration processes, was operated for approximately 18 months at three flow rates of 360, 600, 960 gpd. Influent and effluent composite samples were periodically analyzed for BOD, COD, TSS, VSS, and nitrogen species. Measurements were performed to determine solids build-up. Build-up was evident after extended operation.

The plant evaluation consisted of comparing treatment efficiency under varying hydraulic and organic loadings. Results showed the package treatment plant, designed to treat 400 gpd, achieved effluent requirements for the removal of BOD and TSS within each hydraulic loading rate.

Analysis of Piezoelectric Effects in Gallium Arsenide, George R. Buchanan and Mohamad Sallah, Tennessee Technological University.

A three-dimensional model of the zinc-blende crystal structure is formulated using a 27 node isoparametric element. A variational principle is presented and used to derive the corresponding finite element equations. Results for coupled three-dimensional piezoelectric behavior are compared to uncoupled two-dimensional plane strain solutions. The extension to other crystal structures is discussed.

GEOLOGY AND GEOGRAPHY SECTION

David N. Lumsden, *presiding*

Devonian-Mississippian Clastic Sedimentation in Northern Tennessee, Richard E. Bergenback, Habte G. Churnet, The University of Tennessee at Chattanooga.

Oil and gas wells have penetrated a subsurface Devonian-Mississippian sedimentary package in the Northern Cumberland Plateau of Tennessee. The Devonian Chattanooga Shale and the Mississippian Pennington Formation are the lowermost and uppermost stratigraphic units of this unconformity-bounded sedimentary package and are composed dominantly of fine-grained siliciclastic rocks.

Hundreds of gamma ray logs from four contiguous quadrangles in three adjoining counties (Fentress, Morgan and Scott) have been selected to construct isopach, net shale and structure contour maps.

The net shale map of the Pennington indicates that these green, maroon and red intertidal shales were deposited in west-trending channels. The overall thickness of the Pennington is variable in that it ranges from 140 to 330 feet thick, and this variation is largely a function of erosion on top of this unit.

Structure contour maps drawn on top of the Chattanooga and Pennington show circular to elliptical depressions and knobs as well as linear ridges and depressions. The depressions and knobs tend to abound within a narrow, NE-SW trending zone. These features appear to be related to karst topographies developed on platformal carbonates which were subaerially exposed at forebulges inboard of the Chattanooga foredeep, and of the Lower Pennsylvanian foreland. Presumably the forebulges were NE-SW trending linear features.

Contrasting Saprolites Formed on Two Rock Types, Southern Appalachian Piedmont, Michael K. Burton, R.W. Deininger, Memphis State University.

Mineralogy, chemistry and textures of saprolites developed on an amphibolite in Heard County, Georgia, and a felsic gneiss in Elmore County, Alabama, show significant differences. Clay in the Heard County saprolite is dominated by chlorite but in the Elmore County saprolite only kaolinite was detected. Assuming immobility of alumina, the Elmore County saprolite shows expectable upward decreases in MgO, MnO, CaO, K_2O and Na_2O, with FeO* and SiO_2 remaining nearly constant. Data from Heard County are noisy, but indicate upward increases in CaO, K_2O and Na_2O, and decreases in FeO*, MgO and MnO. Evidence is seen in both saprolites for alumina mobility, at least near the top of the profile. Dissolution features developed in the Heard County saprolite appear much more strongly controlled by dislocations than in the Elmore County Saprolite.

Sedimentary Structures and Facies of the Hartselle Formation in the Buck Mountain Area of Tennessee, G.B. Parnell, D.K. Maxwell, F.W. Stapor, Jr.

The Hartselle Formation in the Buck Mountain area is a Mississippian age unit. Its lower contact is with the Monteagle Limestone, the upper contact is with the Bangor Limestone. The thickness of the Hartselle averages approximately eight meters.

The contact between the Hartselle and the underlying Monteagle is sharp and erosional, with as much as 30 cm of local erosional relief on the Monteagle.

There are four major facies within the Hartselle Formation, designated A, B, C, and D. They are arranged into the following shoaling-upward sequence; A→B→C→D. A is a coarsening upward shale, commonly found with interbedded silts and sands. The sand and silt layers are made up of current ripples. B consists primarily of thin- to medium-bedded orthoquartzites. These are mostly swaley cross-stratified, with some hummocky cross-stratification present. The beds were deposited by storm waves below fairweather base. C is composed of medium- to thickly-bedded planar tabular and trough cross-bedded orthoquartzites. They were deposited by wave and tidal currents above fairweather base within the upper shoreface. D comprises thin-bedded planar laminated orthoquartzites deposited within the swash zone.

These four facies in the Buck Mountain area represent the progradation of a wave-dominant marine delta. Based on the locations of the facies within the study area, and regional stratigraphic relationships, the delta front is oriented from northeast to southwest and progradation occurred from northwest to southeast.

Source Area of the Big Clifty (Hartselle) Sandstone (Mississippian) of Tennessee, D.N. Lumsden, L.A. Thomas, Memphis State University.

Field investigations, isopachous maps, and examination of thin sections from samples collected at ll locations in east central Tennessee defined eight lithofacies (three sandstone, four limestone and shale) in this unit. Thickness variations and the distribution of the lithologies suggest deposition as a portion of a delta system that prograded from the Illinois Basin, across the Cumberland Saddle, and into Tennessee. Upon abandonment the distal portions of the delta were reworked by longshore processes. The name Big Clifty is used for the stratigraphically equivalent unit in the Illinois and Indiana area whereas Hartselle is used in Alabama and Mississippi. On the basis of this study and similar investigations to the south we suggest that the name Big Clifty be used in Tennessee in preference to the currently used term Hartselle.

The History and Development of the Oil and Gas Industry in Tennessee, Marvin B. Berwind, Tennessee Division of Geology.

The discovery of oil in Tennessee was a result of pioneers drilling for salt, and predates the Civil War. The first commercial production of oil in Tennessee was in 1866 from the Spring Creek field in southwestern Overton County. Minor oil and gas production has continued through the years from several rock formations of Ordovician through Pennsylvanian ages. The primary producing zones in Tennessee historically are the Monteagle limestone and the Fort Payne limestone, both Mississippian in age.

Following the sizable increase in drilling activity during the 1980–1981 period and the subsequent change in the world-wide energy situation, the oil and gas industry in Tennessee had dwindled to a point of near non-existence.

The First Fifty Years of the Geology and Geography Section, 1937–1986, James X. Corgan, Austin Peay State University.

The Geology and Geography Section has a complex history as indicated by a fifty year record of oral presentations, the only known numerical data on sectional history. Phase I (1937–1944) averaged 8.9 presentations per year because the enthusiasm of the section's founders and the expansion of mineral industries during World War II encouraged strong Academy programs. Phase II (1945–1951) was a post-war decline that averaged 3.7 papers. Phase III (1952–1958, 7.7 papers), Phase IV (1959–1969, 5.6 papers), and Phase V (1970–1986, 7.7 papers) are statistically well-defined but difficult to interpret. They seem to reflect both changes in governmental geological agencies and changes in the colleges of Tennessee. The history of the Geology and Geography Section seems to be independent of the histories of other Academy sections and little influenced by easily quantified external factors, such as the site of meetings. From 1937 through 1974 most section chairs were government geologists and all chairs from Academia represented large, prestigious schools. Since 1975 all chairs have been professors from regional universities. This reorientation is the most significant recent change within the section.

Depositional Setting of Lower Pennsylvanian Sandstones, Northern Cumberland Plateau, M.F. Miller, E.A. Bargar, S.R. Jackson, R.G. Stearns, Vanderbilt University.

Lower Pennsylvanian rocks of the Rockcastle Conglomerate and Crooked Fork Group of the northern Cumberland Plateau were deposited in fluvial (Rockcastle Conglomerate) and deltaic environments (Crooked Fork Group). Facies associations within the Rockcastle, unimodal paleocurrent directions to the southwest which parallel isoliths, and the diversity and abundance of biogenic structures indicate a low sinuosity fluvial depositional setting for the Rockcastle Conglomerate. Based on sandstone geometry, subsurface isolith patterns, paleocurrent directions and associations of sedimentary structures, sandstones of the Crooked Fork Group are interpreted as deposited as distributary mouth bars (Crossville Ss) and interdistributary bay fills (Coalfield Ss) and possibly in upper delta plain fluvial environments (Wartburg Ss). Trace fossils with marine affinities are common. The overall picture for the Early Pennsylvanian is of a coastal area typically marine influenced (e.g. during much of Fentress and Crooked Fork deposition), but with occasional influxes of sand delivered by sediment-choked coastal braided streams (Rockcastle Conglomerate). Nearly uniform sandstone composition throughout the sequence suggests that the source remained the same or similar throughout the Early Pennsylvanian and that depositional environment did not strongly affect sandstone composition.

The Cumberland Dome, An Isostatically Suppressed Appalachian Border Structure, Arthur L. Reesman, Richard G. Stearns, Vanderbilt University.

Isostatic adjustments on the Chattanooga show the emergence of an isostatically suppressed dome under the topographically high, but structurally low Cumberland Plateau. The elongate "Cumberland dome" borders the Appalachian thrusts of east Tennessee and may represent a flexual foreland bulge that is related to the loading of the thrusts. Alternatively, this dome may have been a topographic high in late Devonian through early Mississippian time as is suggested by the distribution of oil-producing and mud mounds in the Ft. Payne Formation which overlies the Chattanooga. The Hohenwald Platform (an island in Chattanooga Time ?) occurs on the western end of a minor isotatic high.

Iron Industry in Cumberland Furnace, Dickson County, Tennessee, Ruth E. Adams, D.M.S. Bhatia, Austin Peay State University.

The iron industry in Tennessee dates from the 1790's, when pig iron was produced on a very small scale. In Cumberland Furnace, Dickson County, Tennessee, the iron industry started around 1793 or 1795 and spanned nearly 100 years. This paper discusses the history of the industry, the mining, processing, transportation of the iron ore, and how the iron industry affected the establishment of Cumberland Furnace as we know it today.

MATHEMATICS AND COMPUTER SCIENCES SECTION

David E. Fields, *presiding*

*TRICYCLE: A New Mathematical Model For Tritium at the Global Scale,** George G. Killough, David C. Kocher, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831-6383.

TRICYCLE (for TRItium CYCLE) is a new linear dynamic compartment model that has been successful in reproducing environmental time-series data that show levels of tritium from nuclear weapons testing. Based on the global hydrologic cycle and other geophysical data, TRICYCLE includes (1) separate stratosphere compartments for the northern and southern hemispheres, (2) disaggregation of the troposphere and ocean surface waters into eight latitude zones each, (3) consideration of the different concentrations of tritium in atmospheric water vapor over land and over the ocean (the concentration over land exceeds that over the ocean by a factor of 3–4), and (4) a box-diffusion model for vertical transport in the ocean. We have used the model to simulate tritium in precipitation, ocean surface waters, and surface fresh waters (rivers and lakes). When we assume that 50% of the tritium from

atmospheric weapons testing was injected directly into the northern stratosphere, the model gives good representations of tritium in the ocean surface waters and the rivers and lakes of the northern hemisphere; moreover, it estimates reasonable approximations to time-series measurements of tritium in marine precipitation taken at specific latitudes; and over the full range of latitudes, its representation of the high-to-low latitude gradient of tritium in marine precipitation is remarkable. Apart from their intrinsic geophysical interest, such models are useful in assessing the collective radiation dose to populations from tritium that is reeased at a particular latitude.

* Research sponsored by the U.S. Department of Energy under Contract DE-AC05-84OR21400 with Martin Marietta Energy Systems Inc.

Simulation of Kr-85 Transport at Savannah River, Sherri J. Cotter, David E. Fields, Charles W. Miller, Oak Ridge National Laboratory.

The AIRDOS-EPA computer code uses a modified Gaussian plume equation to estimate air concentrations from the release of up to 36 radionuclides and couples these results with the terrestrial model developed in U S Nuclear Regulatory Commission Regulatory Guide 1.109 to estimate the annual dose to the general public. One year of weekly average ^{85}Kr concentrations observed at 13 sampling stations around the Savannah River Plant have been used to validate the atmospheric transport portion of AIRDOS-EPA. The predicted annual average concentration at each station exceeded the observed value in every case. The average overprediction factor was 2.4 (range 1.4 to 3.4). Pearson's correlation between pairs of logarithms of annualized observed and predicted values was r = 0.93. As the averaging time of the prediction decreases, however, the uncertainty in the prediction increases. For example, the monthly values show more scatter than do annual or seasonal values. When seasonal observed and predicted values were compared, we found increasing agreement as we compared spring, summer, fall and winter values.

Determination of Radionuclide Concentrations of U and Th in Unprocessed Soil Samples, Edward N. Lazo, Oak Ridge Associated Universities, M. Guven Yalcintas, Berry Berven, Oak Ridge National Laboratory.

The assay of inhomogeneous distributions of U and Th in moist soil samples is being pursued as a Ph.D. dissertation project. Gamma rays from Co-57 are used to induce x-ray fluorescence. The K-alpha-1 photopeaks of U and Th are measured, using a hyper pure germanium planar detector, and the areas are accurately determined by least squares fitting the spectra to Voigt profiles. The soil sample is treated, mathematically, as a set of small point sources. By mathematically summing the x-ray contributions of each of these point sources, using techniques similar to those used in Computerized Tomographic (CT) imaging, the inhomogeneous nature of the soil sample can be taken into account. Gamma transmission measurements are made to determine the soil moisture content and mass attenuation coefficients for use in the above mentioned summing.

The Effects of Fallout From Chernobyl on Neighboring Countries, M. Guven Yalcintas, Oak Ridge National Laboratory.

On April 26, 1986, a fire started in the number 4 reactor at the Chernobyl power center. The reactor's core was damaged, and the plume containing radioactive gases went up into the atmosphere about 1500 m. The distribution of the radioactive cloud was in the direction of the Baltic countries immediately following the accident. After April 27, the radioactive cloud followed a direction that included some of the other European countries. Most of the radioactive materials released to the atmosphere were short half-life noble gases, and the total activity is estimated to be about 12 million Ci. On the following days this activity was reduced; there was an estimated 2 million Ci on the fifth day after the accident. The fallout from the radioactive cloud on the northern and western part of Turkey will be discussed in this paper. Some of the results will be presented and its effects on the population will be described.

The Academy's Mathematicians, 1940-1986, James X. Corgan, Austin Peay State University.

In 46 years, the Academy section that serves mathematicians has passed through six historical phases, as evidenced by changes in the number of papers presented each year. These are the only available quantitative data on sectional activities. In Phase I (1940-1942) the enthusiasm of founders produced a mean of 7.33 papers but World War II soon resulted in a decline to 3.40 papers during Phase II (1943-1947). Phase III (1948-1952) saw a postwar return to 7.20 papers. Phase IV (1953-1971) was an extended time of depressed participation, with a mean of 4.53 papers. In these years, Tennessee's mathematicians turned away from the Academy to devote more energy to other locally oriented professional groups and to NSF institutes. Phase V (1972-1981) saw a return to the Academy, with a mean of 6.0 papers. This slight increase may have been related to the emergence of computer science as a field of instructional expertise for mathematicians. In 1982, the section ceased to function. It was soon reorganized as the Mathematics and Computer Science Section. Collapse and reorganizations form Phase VI in the history of Academy organizations for mathematicians. At present there are not enough data to characterize Phase VI. Thus far in sectional history the geography of the meeting site has no apparent influence on the number of papers presented and there is no close correlation with success and failure in other sections. Above average and below average programs seem to be largely due to interaction within the section and within the world of mathematicians.

Correlation of Meteorite Impacts and Lifeform Extinctions, David K. Hackett, Aztech Services.

The recent evidence and theories of meteorite impacts causing repeated lifeform extinctions has sparked much controversy and speculation. Some researchers have claimed a regular periodicity. A careful statistical analysis of the data upholds the view of a regular, rather than random periodicity, and gives warning of recurrence. The strong correlations also suggest that the known major impacts indeed played a significant role in the extinctions, despite the fact most impacts occurred without leaving astroblemes as evidence. In contrast, the smaller events are more random, with hundred-megaton events occurring on average every 20,000 years, and ten-megaton events occurring every century or so.

*Initial Investigation of a Carbonaceous Component of the K/T Boundary Clay,** J. Michael Crenshaw, David E. Fields, Oak Ridge National Laboratory.

Samples of clay from the K/T boundary layer have been obtained, and a carbonaceous fraction has been extracted. This component has been examined using electron microscopy, LASER-flow cytometry, RAMAN spectroscopy, and X-ray diffraction. The particle size distribution and morphologies have been determined. The physical and optical properties of these particles are being studied to determine residence times and assess past possible climatic effects.

* Research sponsored by the U.S. Department of Energy under contract DE-AC05-840R21400 with the Martin Marietta Energy Systems, Inc.

Computers, Robots and Thingamajigs, Harold Miller, Ph.D., Asheville Country Day School.

Using an apprenticeship approach, students as young as 10 years old have built sophisticated electronic devices and, in the process, learned how to learn from each other, cooperate, improve their concentration and think more logically.

Last summer three groups of gifted elementary and high school students spent 2-3 weeks designing, building and programming their own computer-controlled robots. The most capable students apprenticed themselves to the teacher, and they in turn took on their own apprentices. Competition took a back seat to camaraderie, as everyone shared in each other's success.

In this session we will have an opportunity to see some of the students' projects. We will also discuss the how-to's of the apprenticeship approach, the benefits it conveys and ways to apply it to other areas.

Some Aspects of An Intelligent Operating System Consultant and Teacher, Alex Bykat, The University of Tennessee at Chattanooga.

In this paper we discuss some aspects of design of OSCAT, as knowledge based system capable of acting as an intelligent Operating System Consultant and Teacher. OSCAT can be perceived as a system which offers intelligent features for control of the underlying hardware system, as well as facilities for effective training of personnel in the use of such as hardware. OSCAT's natural language interface produces an internal representation of the dialogue semantics using expectation based parsing. The internal representation of the dialogue semantics is utilized in creation of the models constructed by OSCAT: the user model, the user's machine model and the dialogue model. These models together with appropriate metrics guide the consulting/teaching process and support the choice of correct level of responses. A PROLOG prototype of OSCAT is under construction for VM/CMS system operating on an IBM 4381 computer.

The Swanflow Finite Element Model for Water, Air, and Nonaqueous Phase Flow, J.L. Bledsoe, D.E. Fields, Oak Ridge National Laboratory.

SWANFLOW (Simultaneous Water Air and Nonaqueous Phase FLOW) is a two-dimensional finite-difference code which simulates the flow of water and an immiscible nonaqueous phase liquid (NAPL) within and below the vadose zone, that region in the earth above permanent groundwater level. The model is based on a modified formulation of conventional three-phase flow equations used in the petroleum industry for evaluation of black oil reservoirs. This model has possible application in such areas as the study of hazardous waste, groundwater restoration, and fuel spills and leaks.

dBASE III Applied to a Physician's Radiation Therapy Database, Anthony Z. Cole, Alan McMurray, East Tennessee State University.

dBase III was used to establish a tumor registry database for hospital use. Demographic information was obtained from the patients and placed in the database. Statistical information can be analyzed to assist the physician in providing the best possible health care.

An application generator was used to develop the program at the elementary stages of the project. This is a fourth generation program that produces code in the dBase III language. Normal programming techniques were used after a certain level of code complexity was reached. The tumor registrar who keeps the written histories was involved in development of the presentation screens; this made the program more user-friendly.

This project is significant in that: 1) it is not cost effective for a community hospital to purchase an available commercial program and dBase is affordable, 2) it is more efficient to have a computer maintained record system than a manual record keeping system, 3) it provides for rapid statistical analysis and enhances the physician's analysis capabilities.

Pattern Matching With PROLOG, Craig Harston, The University of Tennessee at Chattanooga.

PROLOG is a high level computer language which uses facts and rules to substantiate or not substantiate relationships found in data. In a sense, PROLOG logically finds patterns within data. If geometric data can be represented as a series of facts, and patterns depicted as rules, then PROLOG should be able to pick out patterns among diverse geometric data.

The object of this exercise was to find a series of vectors which would fit into a pattern we call a dashed line. Individual vectors or lines were represented by numeric data defining the attributes such as start and stop points, dimension, and length. For example `line (1,2,0)` described a line from point 1 to point 2 along the $Y = 0$ dimension. A set of rules were defined which described the pattern of a dashed line. These rules defined a group of lines with the same length and the same space between them along the same Y dimension. This algorithm was recursive so it executed over and over until it could not find any more lines which fit into the pattern.

When executed this program reported failure to find a pattern. However when the program was traced we found that this algorithm worked. That is, it found lines which fit into a pattern of equal lines with equal spaces along one dimension. It concluded that it had failed because it had not found an infinite number of lines which fit into the pattern. Techniques used to report successful searches will be reviewed.

While this algorithm is limited to simple lines, the concept can be applied to numerous problems, For example, plans are now made to find patterns among neuronal cell populations of the brain stem. PROLOG may prove too slow to process large sets of data resulting from nerve cell counts. To resolve this objection, it is suggested using this algorithm and related concepts with parallel processors.

Cellular Recognition of Digital Images, Sivaram Srinivasan, Memphis State University.

Conventional methods, such as FFT/DFFT and Hankel transforms, use a square kernel to digitally filter an image, either by convolution in the spatial domain or by multiplication in the frequency domain, which leads to phase shifts beyond cut off frequency. Moreover, these transforms being doubly periodic, expect the digitized image to be highly symmetric in signal strength. By contrast, cellular automata pass absolutely no signal beyond the cut off frequency. All output frequencies appear with the same phase as the corresponding input frequencies at constant phase and the exact cut off frequency achieved does not depend on the span of the kernel.

The paper describes a cellular algorithm that correctly recognizes the image of the numeral. The local dynamics operates on the Moore neighbourhood and successively applies transition functions for self reproduction, thresholding and skeletonization.

MEDICAL SCIENCES SECTION

R. Dean Blevins, *presiding*

Mutagenic Activity in Extracts of Fish Muscle Taken in Upper-East Tennessee, Raymond Dean Blevins, Charles Douglas Mohr, East Tennessee State University, Oscar C. Pancorbo, The University of Georgia.

This study was designed to establish if there was an accumulation of mutagens and/or promutagens in fish muscle using the Ames *Salmonella* /mammalian microsome assay. The fish were taken from four different collection sites in the Upper-East Tennessee area: Watauga Lake, Boone Lake, the Nolichucky River, and the Holston River.

Extracts of fish muscle were screened for mutagenicity using the standard plate incorporation test, a quantitative form of the *Salmonella* /microsome test. The plate incorporation test used the bacterial *Salmonella typhimurium* tester strains TA97, TA98, TA100, and TA102. Only two samples tested showed signs of mutagenicity (i.e., mutagenicity ratio of >2.5), one from Boone Lake and the other from the Nolichucky River. These two samples were retested at several doses. Results indicated that only the sample from the Nolichucky River was mutagenic (i.e., displayed a dose response) using strains TA97 and TA98 with microsomal activation. These results indicated that the sample contained a promutagen which was activated by the addition of the S-9 mix.

The Effect of Exposure of Human Blood to Sunlight Upon Automated Serological Analyses, R.H. O'Bannon, E. Emeric, J.C. Wilson, and M.W. Riley, Lee College.

Past studies have demonstrated serum chemistries to be altered by improper storage. In this study, three blood samples were drawn from each of 12 students and stored for five hours under normal laboratory conditions, in styrofoam containers in sunlight, and in test-tube racks in sunlight. Serum analyzed by a Technicon SMA II showed controls to be normal on all 16 parameters tested. BUN, creatinine, uric acid, cholesterol, total protein and albumen levels were unaltered by storage regime. Glucose dropped from 112 mg/dL in controls to 67 and 79 mg/dL in styrofoam and sunlight groups. Bilirubins of 0.6 mg/dL in controls were reduced to 0.5 and 0.2 mg/dL in styrofoam and sunlight groups. Ca^{+} and Cl^{-} were

unchanged. CO_2 levels were minimally affected. Inorganic P levels increased from controls of 3.8 mg/dL to 5.0 mg/dL and 6.8 mg/dL in styrofoam and sunlight groups. Normal Na^+ levels of 141 and 142 meq/L in the control and styrofoam groups declined to 130 meq/L when unprotected from the sunlight. Marked differences were seen in K^+ levels due to sunlight-induced hemolysis of red cells. Control samples had K^+ levels of 4.0 meq/L and samples protected by styrofoam had levels of 5.0, but the samples hemolyzed by sunlight were >10.0 meq/L. Serum enzymes LDH and SGOT were both elevated by exposure to sunlight with control, styrofoam, and sunlight groups yielding 167, 332, and 438 U/L respectively. Alkaline phosphatase activities declined from 92 U/L and 91 U/L in control and styrofoam groups to 8 U/L in the sunlight group. GGT declined from 13 U/L and 12 U/L in control and styrofoam storage to 10 U/L when exposed to sunlight. These results demonstrate the necessity of proper storage of blood drawn away from laboratory settings.

The Effect of Exposure of Human Blood to Sunlight Upon Automated Hematological Laboratory Analyses, R.H. O'Bannon, M.S. Morehead, M.D. Daugherty, and M.W. Riley, Lee College.

Preliminary studies of oxalated blood exposed to sunlight for four hours suggested that some parameters of the complete blood count were altered sufficiently to prevent accurate measurements by modern automated hemoanalyzers. Blood from nine students was drawn and placed in three different storage regimes: normal laboratory conditions, in styrofoam containers placed in sunlight, and in wire test-tube racks placed in sunlight. A CBC was run on each sample at 0, 2, and 5 hours. Red cell numbers, hemoglobins, hematocrits, and red cell indices were not significantly different between treatments or time of analysis. Platelet and white cell numbers remained unchanged at two hours in all groups but were significantly elevated ($P > 0.01$) in the samples unprotected from sunlight for five hours. Platelet numbers/μL at five hours for the control, styrofoam, and sunlight groups were 271, 267, and 485 $\times 10^3$ respectively.

White cells numbered 6.6, 5.9, and 28.3 $\times 10^3$/μL respectively. Microscopic examination of blood smears showed these not to be true increases but alterations in red cells, white cells, platelets and serum proteins, producing fragments and/or coagulated proteins which were recognized as platelets or white cells by both Ortho ELT-8 and Technicon H-1 hemoanalyzers. Erythrocyte Sedimentation Rates were 7.4, 8.0, and 9.1 mm/hr. for the control, styrofoam, and sunlight groups after two hours of storage and 7.5, 7.1, and 0.7 mm/hr. after four hours of storage. Results of this study demonstrate a need for careful storage of blood samples drawn away from laboratory settings.

Need For Hearing Conservation Evaluated in a University Woodworking Laboratory, Burton Ogle, Albert F. Iglar, Monroe T. Morgan, Charles H. Story, East Tennessee State University.

This study was designed to determine noise levels in an industrial education woodworking laboratory, in order to evaluate the need for a hearing conservation program. Sound levels were measured for each woodworking machine in the laboratory on two occasions. An integrating sound level meter was used to develop data on ambient noise level (dbA), equivalent noise level (Leq) and peak noise level (Lmax). A second instrument was used to also provide an octave band analysis for each woodworking machine.

Results were transformed into dose using guidelines of the Occupational Safety and Health Administration. It was concluded that plausible use of the laboratory could cause exposure to noise in excess of standards. A program was recommended, including additional monitoring, use of hearing protection devices, education, audiometric testing, and measures to limit noise generation by the machinery.

Fate of Mutagenic Activity During Conventional Treatment of Wastewater, O.C. Pancorbo, University of Georgia, D.D. Davison, R.D. Blevins, East Tennessee State University.

The mutagenic activity of wastewater was followed during conventional, activated sludge treatment at a municipal plant. Raw wastewater (combined industrial and domestic) was initially screened for mutagenic potential using the Ames *Salmonella* /mammalian microsomal test, and employing tester strains TA97, TA98, TA100, TA102 and TA1535. The wastewater was extracted using mixed-bed macroreticular resins, or methylene chloride at basic, neutral and acidic pHs. The combined raw wastewater was found to produce dose-related mutagenic responses with TA98 and TA100 in the presence of S9 metabolic activation. In contrast, the raw wastewater from domestic sources alone was not mutagenic. Specific mutagenic activities ranging from 690 to 1950 net revertants per mg of residue were measured using the most sensitive strain, TA98 (+S9), in the combined raw wastewater extracted at acidic or neutral pHs (either methylene chloride or resin extracted). Using TA98 (+S9), and methylene chloride extraction, the mutagenic activity of the wastewater was observed throughout the treatment process. The primary effluent displayed similar specific mutagenic activity (780 net revertants mg^{-1}), in a pH 2 extract, as the combined raw wastewater. Moreover, the secondary effluent (activated sludge) prior to chlorination contained the highest specific mutagenic activity (25,900 net revertants mg^{-1}) measured in this study, when extracted at pH 11. Chlorination of the secondary effluent decreased the specific mutagenic activity in the pH 11 extract (8570 net revertants mg^{-1}). Soxhlet extracts of the primary (150 net revertants mg^{-1}) and secondary (285 net revertants mg^{-1}) sludges were also mutagenic with TA98 (+S9). This study demonstrated that the mutagenic activity in municipal wastewater containing industrial discharges is not removed by conventional treatment processes and can be enhanced by activated sludge treatment.

The Traditional Tribal Medicine of Masai in East Africa, Denise I. Pav, East Tennessee State University.

At a biologically oriented safari in Kenya during the summer of 1986, visits were made to Masai villages, and representative Masai, those living in traditional tribal settings and in the cities, were interviewed. Tribal records were studied in the Nairobi Institute of Anthropology, some oral traditions were recorded and written sources acquired.

This is a preliminary rather than a comprehensive study with some observations, impressions and photographs of the remnants of the once powerful, colorful and well adjusted nomadic Masai tribe whose physiognomy and diet are, and healing practices appear to be, distinct from other East African tribes. Three aspects of Masai traditional medicine, namely the disease prevention, rational treatment of trauma and use of powerful psychological factors are discussed in this presentation.

The Medical Sciences Section, 1960–1985, James X. Corgan, Austin Peay State University.

In 26 years the Medical Sciences Section has passed through three historical phases, as indicated by statistics on oral presentations at annual meetings. These are the only known quantitative data on sectional activities. In Phase I (1960–1966), meetings averaged seven presentations, with little variation from the mean. Phase II (1967–1978) brought greater variability and an increase in the mean to 10.25. Phase III (1978–1985) saw a retention of the variability of Phase II and a mean of 7.14. Phase III cannot be distinguished statistically from Phase I. Attempts to use tools such as Chi^2 to explain historic phases in terms of easily quantified aspects of the sections external environment, such as the geography of the meeting place, seemingly never yield positive results. Each historic phase probably reflects a fundamental change in the population of specialists served by the section. Causes of these changes merit further study.

Meiotic Investigations of Human Female and Male Cytogenetics, E.L. Myles, Tennessee State University.

Chromosomal analysis using the air dry technique was initially used to study somatic cells and is now being used to study meiotic cells. In this study a cytological analysis was completed on 11 sterile males and three female feti (19–21 weeks gestation) using the air dry technique. Histological analysis of the 11 males revealed that three were in spermatogenic arrest whereas the remaining eight males had normal production of spermatozoa. Cytological analysis revealed that one of the three males was an asynaptic and another possessed a heterogeneous population of meiotic cells in that some

cells contained what appeared to be a supernumerary. The third male had no observable chromosomal abnormality. This study showed that the air dry technique can be more useful in making chromosome analysis in sterile human males. Cytological analysis of the three female feti revealed that all had Down's Syndrome. The data showed that 78 percent of the cells had normal bivalent pairing plus a univalent. Thirteen percent of the analysable cells had a loosely paired trivalent and in nine percent, no univalent or trivalent was detected.

PHYSICS SECTION

Roy W. Clark, *presiding*

The First Fifty Years of the Physics and Astronomy Section, 1937-1986, James X. Corgan, Austin Peay State University.

Since it was founded in 1937 the Academy section that serves physicists and astronomers has had a more discontinuous history than any other Academy section. From 1937 through 1939, a Physics Section met regularly but some members were displeased with the meeting schedule. From 1940 through 1949 no meetings were held. When the group reorganized as the Physics and Astronomy Section in 1950, it entered its third historical phase. From 1950 through 1959 the section met regularly, averaging 10.6 papers per year. From 1960 through 1985 meetings averaged 5.5 papers and no meeting drew as many papers as the average for the 1950-1959 era. Sectional programs have always fluctuated widely about the mean. Apparently this is primarily a result of conflicts with meetings of other organizations that serve physicists and astronomers. Easily quantified aspects of the section's external environment, such as the size of the host city, do not seem to influence the success of meetings.

A Possible Subgrouping in the Monoceros OB2 Stellar Association, A.M. Heiser, Vanderbilt University.

The Monoceros OB2 stellar association is located along the galactic equator at a galactic longitude of around 205°. The cluster, NGC 2244, is the central feature of the association but there are a number of other loose groupings of early type stars within a couple of arc degrees of this cluster. One of these groupings is located in the vicinity of HD 46966, an 08.5 V star, which, together with two other nearby O-type stars, was once thought to be the primary excitation source for a part of the Monoceros Loop Nebula. Photoelectric *UBV* observations for about 25 stars in this region have been obtained at the Kitt Peak National Observatory. The color-magnitude array for these stars supports the likelihood that many of them do belong to a group at a common distance with a similar amount of interstellar absorption. The subgroup's distance, a rough determination of the subgroup's age and its relation to the whole Monoceros OB2 association will be discussed.

Variable Brightness of Nova T Coronae Borealis After Its Outburst, James R. Bruton, Douglas S. Hall, Vanderbilt University.

We have analyzed 1982–1983 UBV photoelectric photometry of Helen C. and Richard D. Lines and 1981–1983 VRI photometry of Thomas G. McFaul, covering the entire 227-day orbital period of this recurrent nova (outbursts in 1866 and 1946) during its quiescent state. It is clearly variable, showing two maxima and two minima per cycle, which we presume is predominantly the ellipticity effect. Least squares fits to a sinusoidal curve yielded six times of minimum: McFaul 1982 in VRI and Lines 1983 in UBV. These six times, six much earlier times derived by Peel (J.A.A.V.S.O. *14,* 8, 1985) and one time of conjunction derived spectroscopically by Paczynski (Acta Astr. *15,* 197, 1965) were fit by linear least squares to derive the following improved ephemeris:

$$\begin{array}{lrcrl} \text{JD (hel.)} & 2{,}435{,}688.4 & + & 227.68 & n\,, \\ & \pm 1.2 & & \pm .02 & \end{array}$$

where the initial epoch is a time of conjunction.

Electronic Interactions of Ions, Photons, and Electrons With Surfaces, N.H. Tolk, Royal Albridge, Alan Barnes, R.F. Haglund, Jr., M.H. Mendenhall, Vanderbilt University.

The underlying physical mechanisms associated with electronically stimulated desorption, bond breaking, nuclear spin depolarization, ionization, neutralization, and excitation of atoms and molecules on or near solid surfaces remain a matter of vigorous controversy. Knowledge of these processes is important in many areas, including first wall interactions in CTR research, evolution of planetary atmospheres, catalysis, and quantitative surface analysis using electron, photon, and ion-beam spectroscopies. Recent measurements of (a) optical radiation from electron and photon stimulated desorption (ESD and PSD) of neutral species using laser induced fluorescence techniques[1], (b) nuclear spin depolarization at surfaces, and (c) coherently excited states of hydrogen formed by grazing incidence at surfaces, will be discussed. Emphasis in this talk will be placed on fundamental studies of hydrogen near surfaces.

1 G.M. Loubriel, T.A. Green, P.M.Richards, R.G. Albridge, D.W. Cherry, R.K. Cole, R.F. Haglund, Jr., L.T. Hudson, M.H. Mendenhall, D.M. Newns, P.M. Savundararaj, K.J. Snowdon, N.H. Tolk, Physical Review Letters *57,* 1781 (Oct., 1986).

Infrared Spectroscopy of DNA, Proteins, and Lipids, G.S. Edwards, Vanderbilt University.

The dynamics of biopolymers may be investigated with several spectroscopic techniques. Whereas higher frequency techniques (>300 cm^{-1}) probe normal modes that involve a subset of the macromolecule, lower frequency techniques (< 300 cm^{-1}) probe those normal modes that exhibit in-phase motion over the entire macromolecule. Such low frequency normal modes are observed in DNA and proteins that are in either dilute solution or the solid state. The long lifetime of these modes (at least hundreds of picoseconds) has resulted in a new physical model of polymer-solvent interactions that emphasizes surface effects. These vibrations extend over several microns; this requires a reconsideration of the role of mechanical vibrations in bioenergetics.

A Model For Conduction Velocity Distributions In Nerves, R.S. Wijesinghe, J.P. Wikswo, Jr., Vanderbilt University.

A nerve bundle consists of thousands of small nerve fibers that propagate an electrical impulse when stimulated. We can use toroidal coils and electrodes to make magnetic and electric measurements of the compound signals that represent the summation of the individual contributions. Since the individual signals have different shapes and propagation velocities, the compound signals change in shape as they propagate down the nerve. We have devised a numerical method to calculate the number of fibers in the nerve bundle using these compound signals and calculated or measured individual signals. We used electric, magnetic and histological data to determine independently the number of fibers in the frog sciatic nerve bundle, and were able to assess the relative sensitivities of the electric and magnetic techniques to various nerve and model parameters.

Bessel Transform Model for the Cardiac Apex, Wei-qiang Guo, John P. Wikswo Jr., Vanderbilt University.

We found that the spiraling fiber geometry at the apex of the heart requires two 3 by 3 conductivity tensors to describe the anisotropic, bidomain electrical conductivity of the intra- and extracellular spaces of cardiac tissue. Theoretically, the off-diagonal tensor components associated with the spiraling fibers yield electrically-silent magnetic fields, i.e., these components appear in the equation for B but not for E, implying that new information about the electrical conductivities of the tissue can be gained from measuring its magnetic field. The Bessel transformation formalism for the potentials and magnetic field components arises from the cylindrical symmetry. Far from the apex, the magnetic dipole behavior of the electric-silent magnetic fields allows them to dominate over the non-electrically silent magnetic fields, which fall off faster with distance.

The Magnetic Field of a Single Axon, Bradley, J. Roth, John P. Wikswo, Jr.

A propagating action potential in a nerve axon produces a magnetic field, which we have measured by threading the axon through a wire-wound ferrite-core toroid. The toroid functions as a transformer, inductively coupling the biological current to the toroid windings. We also measured the potential across the axon membrane using a microelectrode. We have developed a model to calculate the magnetic field from the transmembrane potential, and have found that the calculated and measured magnetic fields agree very closely. Simultaneous magnetic measurements of current and electrical measurement of potential allow us to determine the resistance per unit length of the nerve axon to within 10%. This technique may have significant applications in both basic electrophysiological research and in medicine.

Magnetic Fields of Multicellular Systems, J.P. Wikswo, Jr., Vanderbilt University.

We have developed room-temperature amplifiers for magnetic recordings from peripheral nerves, and are now evaluating them for use during neurosurgical repair of damaged peripheral nerves in humans. While magnetic measurements are quite new as compared to electric ones, the ease with which the magnetic field can be recorded from nerve and cardiac tissue and the ability of magnetic techniques to detect steady ionic currents suggest that magnetometry may have broad applications to basic research and clinical medicine. We are studying the theoretical and experimental relationship between bioelectric and biomagnetic signals, particularly at the cellular level. High-resolution SQUID magnetometers with coil diameters of only several millimeters and a similar coil-to-animal spacing could localize two and three-dimensional current sources to better than 1 mm. We are conducting model studies to determine the capabilities and limitations of this instrument for magnetic measurements at the surface of the exposed heart and brain.

On the Physics of Geysers, Roy W. Clark, Middle Tennessee State University.

The dramatic change of physical state which makes possible the action of a geyser is susceptible to analysis by simple physics principles. Studies of natural geysers around the world have shown that many factors besides the superheating of water are involved in the still unpredictable behavior of these awe-inspiring natural spectacles. Times between eruptions are influenced by earthquakes, rainfall, and barometric pressure variations. Natural geysers can be altered by human intervention, but this is never allowed in our National Parks. Cold water geysers work on a different principle than do hot water geysers. Geyser demonstrations in the classroom are possible.

SCIENCE AND MATHEMATICS TEACHERS SECTION

Philip M. Mathis, *presiding*

Enrichment of the Science and Mathematics Curriculum: An Industry-Centered, Cooperative Education Approach, Philip M. Mathis, F. Curtis Mason, Middle Tennessee State University.

Twenty-seven teachers of science and mathematics participated in a federally sponsored curriculum development project during the spring and summer, 1986. Through cooperative agreements with industries, teachers were given the opportunity to study and observe state-of-the-art technology during a carefully planned forty-hour visitation period at one of eight industrial sites in middle Tennessee.

Teacher visits to industries were used as a basis for developing twenty-seven instructional modules during a follow-up workshop. The modules appear in a project publication entitled: *Applications of Science and Mathematics in Business and Industry: Instructional Modules for Teachers (Grades 7–12).* Evaluation results suggest that an industry-centered, cooperative education approach to curriculum development can be an effective way of: (1) enriching science and mathematics instruction, and (2) building important channels of communication between the schools and local industry.

Memphis City Schools Science Improvement Program, Joyce J. Pinkston, Memphis City Schools.

The Memphis City Schools' Science Improvement Program is a multiphase plan for upgrading science education in grades 1–12 throughout the school district. The plan focuses on teacher training, curriculum development, facilities and equipment. College course work in the earth, biological and physical sciences combined with the on-site assistance of a science specialist provides the foundation of the teacher training program. The goals of this component are to enable teachers to gain knowledge, skills and confidence to give leadership to a viable laboratory program. The curriculum component is developing a conceptually based, process-oriented 1–12 program. Schools targeted for improvement during each phase receive fully equipped laboratories. This comprehensive plan for improvement in science education can provide a model for other districts seeking ways to enhance their science program. Grades 1–12.

Chemistry and Physics for the Anti-Science Student, Judith M. Bonicamp, Middle Tennessee State University.

The Department of Chemistry and Physics offers the one-semester course Topics in Physical Science to nonscience majors as part of the general studies curriculum. A goal of the course is to develop scientifically literate citizens with a sufficient understanding of chemistry, physics, astronomy, and geology for effective participation in 20th and 21st century life. Scientists agree that prospective chemists and physicists need a sound background in practical and theoretical science for job success, but the question of what of chemistry and physics a citizen should know, and how one can convey that essential part of science hasn't a simple answer. A scientist confronted with teaching physical science must face additional problems: how to integrate the four fields, how to handle the math anxiety of anti-science students, and how to cover the four areas of physical science in one brief semester. The paper will address these issues and will present student reactions to the chemistry and physics sections of the physical science course.

Digital Sums and the Multiplication Table, Alvin Tirman, Barbara Malone, East Tennessee State University.

Digital sums are applied to the multiplication table enabling the investigator to note and to study the various group structures that are developed.

The First Quarter-Century of the Science and Mathematics Teachers Section, 1962–1986, James A. Crouch, James X. Corgan, Austin Peay State University.

In a twenty-five year history, the Science and Mathematics Teachers Section of the Tennessee Academy of Science has passed through three statistically distinct historical phases. During Phase I (1962–1965) leadership was dominated by secondary school science teachers and sectional programs tended to stress informal, round table discussion. Phase II (1966–1969) was a time of dormancy, followed by the modern Phase III (1970–Present). Phase III is characterized by collegiate leadership, by structured oral programs, and by an extreme variation in the number of papers presented at annual meetings.

The Geographic Education National Implementation Project (GENIP), Byron J. Webb, Austin Peay State University.

In response to much evidence indicating poor understanding of geography by students and inadequate training on the part of many geography teachers, a number of professional organizations, in alliance with the National Geographic Society, have joined forces in the Geographic Education National Implementation Project (GENIP). By means of national, state, and local workshops for teachers, enhanced learning resources for students, and curriculum changes GENIP is attempting to address geographic education deficiencies in the nation's schools.

ZOOLOGY SECTION

George G. Murphy, *presiding*

Electron Microscopic Observations of the Tardigrade Macrobiotus tonollii, Diane R. Nelson, George Musil, East Tennessee State University.

Macrobiotus tonollii Ramazzotti 1956 is a cosmopolitan tardigrade frequently found in mosses growing on the bark of live trees. Specimens were collected from this habitat on the grounds of the Veterans Administration, Mountain Home, Tennessee, and were prepared for observation with transmission and scanning electron microscopy. A modified technique was developed for transmission electron microscopy. Species identifications of extended anoxic (inactive) animals were verified with a light microscope. Reviving animals were cut, and the specimens were fixed in OsO_4 and embedded in Spurr's epoxy resin. Thick sections (1 μm) were stained with toluidine blue for light microscopy. Thin sections were stained with uranyl acetate and lead citrate and examined with a Phillips 201 transmission electron microscope. Observations were made primarily on the fine structure of the digestive system, nervous system, muscular system, and the cuticle. Standard SEM procedures for tardigrades were followed, and the external anatomy of adult specimens and eggs were examined with an ETEC Autoscan scanning electron microscope.

Preliminary Report on Tardigrada from Southern Chile, Diane R. Nelson, East Tennessee State University, Rudolph Prins, Western Kentucky University, Robert O. Schuster, University of California–Davis.

Few studies of the tardigrade fauna of South America have been reported in the literature. To survey the tardigrade species of Southern Chile, samples of mosses and lichens were collected by Rudolph Prins while on a sabbatical at the University Austral de Chile, January–June 1984 and June 1985. More than 100 collections were made in a large geographical area from Temuco to the Straits of Magellan (over 1500 miles). The samples were processed, and tardigrades and eggs were extracted and mounted on slides for identification. Preliminary examination of specimens revealed 14 species (excluding those in the genus *Macrobiotus).* The following genera were represented in the collection: *Echiniscus* (one species), *Pseudechiniscus* (one species), *Mopsechiniscus* (one species), *Hypsibius* (three species), *Isohypsibius* (three species), *Diphascon* (four species), and *Milnesium* (one species). New distributions will be recorded and the new species will be described. Support for this project was received from the Research Development Committee, East Tennessee State University.

History of the Zoology Section, 1944–1986, John L. Butler, James X. Corgan, Austin Peay State University.

Counts of talks presented to the Zoology Section show six statistically distinct historical phases: 1944–1946, 1947–1950, 1951–1958, 1959–1965, 1966–1979, and 1980–Present. War influenced several phases. All phases reflect the changing interests of zoologists and the expansion of Tennessee's universities. Of some 542 papers presented, 65% treated vertebrates and 35% treated invertebrates with mammals, fish, and insects the dominant groups studied. Fifty-one percent of papers were in field disciplines with ecology and distribution accounting for half of them, and 49% were laboratory based with physiology and development the predominant disciplines. The locations of field studies in Tennessee grouped around universities or Great Smokey National Park. Thirty-five counties were represented.

Growth Characteristics of Walleye, Sauger, and Their Hybrids from Selected Tennessee Reservoirs, Arnold G. Woodward, J. Larry Wilson, The University of Tennessee, and James D. Little, Tennessee Wildlife Resources Agency.

Age and growth characteristics of 369 walleye *(Stizostedion vitreum),* 172 sauger *(S. canadense),* and 162 sauger x walleye hybrids were compared. Length at age, sex ratio, and relative condition were determined for all three groups. Walleye and saugeye exhibited similar growth (292.0 and 295.7 mm at Age 1, and 441.6 and 442.0 at Age 2, respectively), while sauger growth for a similar period was somewhat less. Results of these comparisons indicate that hybrids may be a successful introduction in selected Tennessee reservoirs.

Relationship of Body-Weight and Chest-Girth Circumference in White-Tailed Deer, F.W. Weckerly, P.L. Leberg, R.A. Van Den Bussche, Memphis State University.

Relationships of body-weight and chest-girth circumference were evaluated among age-sex groups, seasons, and sites in 384 white-tailed deer *(Odocoileus virginianus)* from Tennessee. Weights were recorded in kilograms and chest-girth measurement varied among age-sex groups, seasons (fall, winter), and sites. Use of regression equations from areas not previously examined may give biased results.

How Important is Hemipteran Predation Upon Freshwater Pulmonate Snails? David H. Kesler, Wayne R. Munns, Jr., Rhodes College.

Population densities and size distributions of the dominant pulmonate gastropod species, *Pseudosuccinea columella* and *Physa vernalis,* were monitored for three years in a small New England pond. Densities of both snails decreased with the appearance of the hemipteran, *Belostoma flumineum.* Predation rates by *Belostoma* upon snails were determined using two methods: 1) *Belostoma* densities in the pond were multiplied by laboratory-derived consumption rates, and 2) enclosures containing *Belostoma* and natural assemblages of prey were placed in the pond. These derived predation rates were sufficient to explain snail mortality rates seen in the pond as well as the observed number of empty shells. *Belostoma* generally selected larger snails in the laboratory experiments, though no preferences were displayed between *Pseudosuccinea* and *Physa vernalis,* or between *Pseudosuccinea* and a surrogate species *(Physa hererostropha)* used in two experiments. Size distributions of *Physa* in the pond reflected local densities of *Belostoma.* This is the first reported quantitative investigation of the influence of hemipteran predation upon a freshwater snail species in North America.

Genetic Variability in the Texas Mouse (Peromyscus attwateri) from Arkansas, Derrick W. Sugg, Michael L. Kennedy, Memphis State University, Gary A. Heidt, University of Arkansas at Little Rock.

Horizontal starch gel electrophoresis was utilized to examine amounts of protein variation and interlocality genetic differentiation in the Texas mouse, *Peromyscus attwateri.* Two hundred and forty-seven specimens from 13 localities (within two physiographic regions) were assessed for 36 loci. Twenty of the loci were found to be polymorphic with the remaining 16 loci being fixed for the same allele in all populations. Mean heterozygosity for all localities was 7.8%. Levels of genetic variability were consistently higher than previously reported for this species. The patterns of genetic variability differed among localities and showed subdivision within each physiographic region with little differentiation between regions.

Microhabitat Preference of Four Species of Rodents in West-Central Kansas, James C. Stroh, Memphis State University, Eugene D. Fleharty, Fort Hays State University.

Four species of rodents were studied with respect to microhabitat utilization in a relict grassland in Ellis County, Kansas. Principal component analysis and correlation coefficients suggested noticeable habitat preferences by each species. *Peromyscus maniculatus* was associated with big and little bluestem communities and negatively correlated to litter depth. *Microtus ochrogaster* and *Reithrodontomys megalotis* preferred western wheatgrass-Japanese brome communities and exhibited a positive correlation to litter depth. *Perognathus hispidus* was associated with little bluestem-grama grass communities and negatively correlated to litter depth. *P. maniculatus* and *R. megalotis* had the most dissimilar microhabitat usage.

Age Specific Feeding Preferences of Raccoons, John P. Nelson, Jr., Memphis State University.

Raccoons were collected in September and October 1985, during the annual hunt at the Reelfoot National Wildlife Refuge. Stomach samples were analyzed from 195 individuals from four age classes (based on tooth-wear). There were no significant differences

found between sexes within a single age class. Based on preliminary analysis, the youngest animals showed a preference toward a limited variety of foods, while the oldest animals used the greatest variety of food types. These results have potential management implications for a species that has great economic and recreational importance.

Home Range of the Coyote in Western Tennessee, Jeffrey G. Babb, Michael L. Kennedy, Memphis State University.

Home range of the coyote *(Canis latrans)* was studied from December 1985 to September 1986 on the Milan Army Ammunition Plant in Gibson and Carroll counties in Western Tennessee. Four males and one female were equipped with radio transmitters and monitored using a tracking receiver. The female home range was larger than that recorded for males. Home range size recorded for all individuals was within the range previously reported for the species.

Dose-Response Studies With Ethylene Dibromide, Curtis O. Herring, James A. Adams, Tennessee State University.

This study represents the first of a series of Descriptive-Reproductive-Toxicology Studies currently underway in our laboratory. Ethylene Dibromide (EDB) is suspected of causing infertility (especially in males), carcinogenesis, mutagenesis, and possibly teratogenesis. Coupling the suspected undesirable effects of EDB exposure with the fact that the chemical has broad utility (soil fumigant, fruit and grain fumigant, gasoline additive, etc.), EDB is an important agricultural and industrial toxin.

In this study *Hydra oligactis* are exposed to EDB in an attempt to determine the acute toxicity of the chemical. Since *Hydra* is organized at the tissue level only, the toxin can be applied as a component of an artificial pond water (APW) medium. The EDB stock solution is 19:1; Acetone (emulsifier): EDB. Direct dilutions are made and exposures are continuous. The medium is exchanged daily after feeding.

The LC50 at 48 hours incubation with EDB is 70 mgL^{-1}. Compared to the LC50's for two common commercial PCB mixtures, Aroclors 1254 and 1016, EDB is shown to be a highly toxic chemical. The respective LC50's for the PCB's are 20 mgL^{-1} (Aroclor 1254) and 5 mgL^{-1} (Aroclor 1016) at 72 hrs. Sublethal EDB toxicity is currently being studied.

Immuno-Electron Microscopy of Junctional Feet in Isolated Skeletal Muscle Vesicles, Edward P. Ager, Tennessee State University.

Junctional feet are identified as small structures which bridge the gap between terminal aslenae (T.C.) and transverse tubule (t-tubule). Spanning protein, a constituent of junctional feet, has been isolated from the sarcospiralis muscle of rabbits. In this study two protocols were used employing a polyclonal antibody which is specific to the 300K dalton spanning protein.

In evaluating results of electron microscopy, greatest staining was seen on the cytoplasmic side of the membrane of the T.C./triads. a substantial amount of gold was seen in the trypsin and the antibody treated samples which indicated either incomplete digestion of the feet and/or inaccessibility of antibody to the feet in protocol 1. Controls not treated with primary antibody showed no staining. Tannic acid allowed greater resolution of the T.C./triad junctions. Preparation of triads using protocol 2, however, was preferred because post-fixation treatment of samples with primary and secondary antibody allowed access of gold-label to the cytoplasmic and luminal sides of the sectioned organelles as an indicator of antigenic sites.

Biochemical Taxonomy and Genetic Variability on the Crayfish Genus Orconectes, John W. Harris, Albert Korgi, Tennessee Technological University.

Electrophoretic analysis of 16 biochemical loci was used to investigate the taxonomic relationship between the Nashville crayfish, *Orconectes shoupi* Hobbs, and an undescribed species of *Orconectes (O. sp.)* found in Mill Creek, Nashville, Tennessee. A mean Nei's coefficient of genetic identity *(I)* value of 0.839 was obtained upon comparison of all samples of *O. shoupi* with all samples of *O. sp.,* indicating that they belong to two separate, but closely related, species. Mean heterozygosity *(H)* values of 0.129 and 0.109 were calculated for *O. shoupi* and *O sp.,* respectively. These values are significantly higher than those previously reported for decapod crustaceans and may reflect environmental instability. Adaptation to the heterogeneous conditions found in Mill Creek may require increased genetic variation.