

PROCEEDINGS OF THE TENNESSEE ACADEMY OF SCIENCE 1983

East Tennessee State University

EXECUTIVE COMMITTEE MEETING
APRIL 22, 1983

The meeting was called to order at 7:20 P.M. by President Gordon Morris in Room 320 of the Tennessee State University downtown campus. Present were Gordon Morris, President; Robert Wilson, President-Elect; S. K. Ballal, Past-President; R. K. Fletcher, Treasurer; Gus Tomlinson, Journal Editor; Bernard Benson, Director of the Visiting Scientist Program; Richard Raridon, Director of the Collegiate Division; William Pafford, Director of the Junior Academy; John Bennett, State Department Representative; and David Yarbrough, Member-at-Large. In the absence of the secretary, William Pafford recorded the minutes.

John Bennett reported on a meeting which was held with Commissioner McElrath. The Commissioner expressed support for the Academy, but stated that financial conditions prohibited an increase in the amount of funding. The money will be handled through John Bennett's office this year, however, which will make it easier for the funds to be utilized by the Academy programs. Funding will be provided in the amount of \$4,000.00 next year; \$2,000.00 for each of the public school programs.

Since the Better Schools Program was not funded, less money will be available for science education. John Bennett pointed out that qualified teachers in math and science are urgently needed, especially in view of the increased high school requirements for graduation in these fields. Support of the Academy for the Better Schools Program would be welcomed by the Commissioner and might help the program to pass next year, a development which would significantly improve funding for science and mathematics education.

John Bennett is sending out a memorandum to Tennessee teachers on May 15. If information is available regarding any science organization, he will be glad to disseminate this information. He is also soliciting names of outstanding science teachers throughout the state.

Minutes of the last meeting were distributed and approved as written.

R. K. Fletcher presented the following treasurer's report, which was approved unanimously:

TREASURER'S REPORT FOR TENNESSEE ACADEMY OF SCIENCE

APRIL 22, 1983

Deposits	Expenditures	Subaccount			Charged Vis Sci	Journal	St Rsch & Other Interest	
		Treasurer	TN	JR AC				
12387.00	60.64			60.64				
	30.00			30.00				
37.54	200.00	200.00						37.54
	204.00						204.00	
	75.00						75.00	
269.00	125.00						125.00	
	53.00						53.00	
	43.00						43.00	
	32.50			32.50				
	24.00						24.00	
	39.10				39.10			
	39.08				39.08			
	36.49				36.49			
	8.16				8.16			
	41.31				41.31			
	25.50				25.50			
45.00	40.47						40.47	
61.33	30.00			30.00				61.33
144.00	4.00			4.00				
	2365.23					2365.23		
150.00	332.00	332.00						
57.05	29.14	29.14						57.05
	30.00			30.00				
	24.30			24.30				
	216.92			216.92				
	95.36					95.36		
274.00	49.50			49.50				
13424.92	4253.70	561.14	477.86	189.64	2460.59	564.47	155.92	
TTL	TL	TTL	TTL	TTL	TTL	TTL	TTL	
DEP	WITHD	TREAS	JR A	V S	JOUR	RSCH	INT	

Balance on hand as of April 22, 1983 9275.94

This report reflects only the funds transferred to me. Also, a balance of \$104.72 is in the acct. at Tenn. Tech. This is reflected in the balance noted above.

Gus Tomlinson presented the following Editor's report which was approved unanimously:

"A complete report on 1982 activities, including a list of manuscripts received, published and rejected for the year, was given at the November meeting and published in the JTAS April 1983. These data will not be repeated in this report. Instead, this is an update of what has happened since November.

The decision by the Executive Committee to go to two issues per year due to the current financial restrictions has meant that the January and April issues are combined and published during April 1983. It has been kept to a regular issue size in order to help hold down academy expenses.

The April 1983 issue includes sections on the new president of TAS, annual proceedings from the November meeting, new member lists for 1982, abstracts of research reports which were given at the annual meeting, plus regular manuscripts in zoology, botany, physical sciences and mathematics. Individuals who have made special contributions to TAS in terms of time and/or financial contributions were cited in the journal this year.

Thirteen new manuscripts have been received since the November report was made. Two were rejected on the basis that they were thesis-like in format and too long to justify publication under the present restricted circumstances. Even so, a backlog of manuscripts is beginning to accrue and will undoubtedly become very large if two issues per year continues to be the case. This is especially true since a major portion of one issue each year must be devoted to annual proceedings. This leaves only one issue for regular manuscripts per year under the current publication schedule.

In conclusion, I would like to reiterate a point which I have made previously to the Executive Committee. If the current two issues per year or anything less is to become the rule for JTAS, we need to notify libraries and others with whom we have contractual obligations of our plans. Also, we should honor manuscripts which we accept for publication and not simply stop publishing the journal without regard to contributors. Simply stated, that means that the editor needs a year of "lead time" on major changes in the publication schedule."

Bernie Benson presented the Visiting Scientist's report. These was discussion regarding mileage costs and honoraria. It was moved to raise the mileage to 20¢ per mile for next year. The motion passed unanimously. No honoraria will be paid next year, however. His report was approved unanimously:

"The following represents a summary of VSP activities for the 1982-83 academic year and recommendations for the 1983-84 academic year:

- 1) A data summary for the 1982-83 academic year is attached.
- 2) A complete revision of the Visiting Scientist Program Roster is currently in progress. This revision consists of two parts. In the first part the visiting scientists currently involved in the program are being asked to reaffirm their interest in participating in the program and to revise their specific program. In the second part a request is being sent to all members of the Academy residing in Tennessee asking that they participate as visiting scientists in the program. Copies of the materials sent to both groups will be available at the meeting for review.
- 3) The major expenditure in addition to visiting scientist travel expenses for the current year will be in the revision of the roster. A budget summary for this year cannot be prepared until this roster revision is complete.
- 4) As stated in the fall report, as soon as the new roster is prepared for printing it will be sent to Mr. John Bennett, Science Consultant for the State of Tennessee, who has indicated that the State will provide for printing costs. This too would further decrease the Visiting Scientist Program's expenditures for the year.
- 5) Matters requiring discussion at the board meeting include:
 - A. the reinstatement of a VSP honorarium,
 - B. a mechanism for approving the roster,
 - C. continued support arrangements.

SUMMARY DATE

	1982-83
1. Number of visits requested	39
2. Number of visits declined	10
3. Number of visits completed	24
4. Number of visits outstanding	5
5. Number of students contacted	1660
6. Number of classes contacted	48
7. Number of teachers and principals contacted	34

Zoology.....	8
Botany.....	2
General Science.....	2
Chemistry.....	2
Computer Science.....	1
Geology-Geography.....	1
Medical Sciences.....	1
Environmental Sciences.....	1
TOTAL	18

Dick Raridon reported that no formal meeting was held last year, so no report was filed for the Collegiate Division. He stated, however, that there seems to be a good turnout for the spring meetings. A good press release resulted from the meeting at Southwestern, which was circulated to the committee. The Directors report was approved unanimously.

William Pafford submitted the following report of the Junior Academy which was approved unanimously:

"Arrangements are now being finalized for the spring meeting of the Junior Academy, which is scheduled for April 22 at Glencliff High School in Nashville. All members of the Tennessee Academy of Science are invited to attend. Papers will be presented during the periods 9:00-11:30 a.m. and 1:00-3:00 p.m. We are indebted to the Nashville Metro School System for allowing us to meet at Glencliff. Special thanks are due Mr. Bob Bryson and Mr. Tony Beasley for helping with local arrangements.

A total of 54 papers were received from talented high school students in Tennessee. This compares with 50 papers last year. Fifteen teachers from thirteen schools sponsored students this year."

Dick Raridon reported as the delegate to Section X of AAAS. He stated that he will attend the meeting this year.

Bob Wilson discussed plans for the fall meeting. The theme will be computers in education. Governor Alexander has been invited to speak at the meeting.

R. K. Fletcher asked whether or not he should contact members who have not paid dues this year. He stated that he has a list of 562 active members, but several have not paid dues recently. The Committee asked him to forward a reminder to these individuals.

Gordon Morris discussed a letter received from AEL. He also discussed correspondence received from Prem Kahlon regarding funds for high school students' research projects.

The possibility of establishing a committee to maintain contact with legislators was discussed. It was decided that a formal committee for this purpose might not be appropriate.

A person at each state university has agreed to serve as a contact person and will attempt to stimulate membership in TAS.

The meeting was adjourned at 9:48 P.M.

EXECUTIVE COMMITTEE MEETING

November 17, 1983

The Executive Committee Meeting of the Tennessee Academy of Science was called to order at 7:05 p.m. by President Gordon Morris in the President's Dining Room of the Campus Center at Volunteer State Community College, Gallatin. Present were Gordon Morris, President; Robert L. Wilson, President-Elect; S. K. Ballal, Past-President; R. K. Fletcher, Treasurer; Diane R. Nelson, Secretary; Gus Tomlinson, Journal Editor; William N. Pafford, Director of the Junior Academy; Bernard W. Benson, Director of the Visiting Scientists Program; Richard J. Raridon, Director of the Collegiate Division; John Bennett, State Department of Education; Thomas E. Byrne, James X. Corgan, David W. Yarbrough, Member-at-Large; and Joe Watlington and Tom Miller, Local Arrangements Committee.

The Secretary, Diane R. Nelson, had mailed printed copies of the Minutes of the April 1982 Executive Committee Meeting. A motion to accept the minutes as printed was accepted unanimously.

The Treasurer, R. K. Fletcher, 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, Gus Tomlinson, presented the following report:

"Since the annual meeting in November of 1982, two issues of JTAS have been prepared. The January issue was combined with the April issue and the July issue was combined with the October issue. In addition to the regular inclusions such as proceedings, abstracts, new members, news events, etc., 18 regular manuscripts were published. The breakdown by subject area for the 1983 published articles is as follows:

Twenty-eight new manuscripts were received during the past year as compared with thirty three last year. Two manuscripts were rejected, 11 are in sectional review, 8 in author revision and 7 have been published. With carry over from 1982, a total of 20 manuscripts are now in accepted for publication status. Ten of these are scheduled for the next issue of the journal.

In compliance with 1982 approval, the author revision file was purged of manuscripts which had not been re-submitted within a year. Such file copies were returned to their authors with a letter of explanation and an invitation for the data to be updated and re-submitted as a new manuscript.

In order to hold down costs at the Printer, most of the proofreading, cutting and pasting of dummy format, special changes requested by authors, etc., are being done in the editor's office. The net cost of a 32 page issue of TAS is currently about \$2800 if one does not consider Journal subscriptions through the Treasurer's office. That is, it costs about \$3500 (\$2120 page costs, \$810 Editor's costs, \$500 photocuts and \$70 mailing) to prepare and mail an issue with about \$700 reimbursement from authors via page and photocut costs that are billed to them upon publication. Thus, \$3500 minus \$700=\$2800. The Treasurer's report on income from subscriptions will further reduce the apparent net cost of an issue of JTAS.

Using such budget data, the Executive Committee will be able to consider how many issues the Academy can afford to print in view of its overall income and projected costs of other programs such as the Junior Academy and Visiting Scientist Program. In the Editor's view, the options for JTAS range from a return to quarterly issues as in the past to three issues or two issues per year. The decision should be made by the Executive Committee and announced to the general membership and libraries to whom we have contractual obligations to publish."

The Editor's report was accepted.

The Editor also reported that the invoice for page charges is mailed to the author with page proofs. The Treasurer is responsible for rebilling. The Journal will not publish a second article by an author if the charges for the previous article are not paid.

The Editor requested the Executive Committee to consider modification of the Journal's policy of not publishing acknowledgments in the abstracts presented at the annual meeting. After discussion, Dr. Nelson made a motion that one sentence may be added to the abstract to acknowledge financial support; the statement must be included in the 150 word maximum. Dr. Tomlinson seconded the motion, which passed unanimously. This information will be included in the "Call for Papers" in the future. A motion was passed that abstracts previously published without acknowledgments will not be republished in order to include the acknowledgments.

The Editor had included in the last issue of the Journal a request for a Computer Science Section. Interest was expressed in expanding the scientific areas included in the Academy. Because of the decline in the math section and the increase in interest in computer science, a motion was passed to change the Mathematics Section to the Math and Computer Science Section with David Fields as the section chairman.

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

"The following represents a summary of the 1982-83 fiscal year and a progress report on the 1983-84 fiscal year:

- 1) A data summary for the 1982-83 academic year is attached. This profile also contains data for the two previous years as a basis for comparison. To date, 46 visits have been requested for the 1983-84 academic year.
- 2) The Academy received funding from the State of Tennessee to support the Visiting Scientist Program for the 1982-83 academic year. This funding was not received in time to complete an update of the Visiting Scientist Roster. Correspondingly, all schools were sent notification early in September, 1982, that the Visiting Scientist Program would be operational during that school year. Rosters were sent only upon request. A new roster was sent to all high schools in Tennessee in September, 1983. The roster was financed with funds carried forward from the 1982-83 fiscal year.
- 3) The 1983-85 roster contains a total of 77 visiting scientists compared to 73 visiting scientists in the 1981-83 roster. During the spring of 1983 two mailings were sent—to the 1981-83 visiting scientists and to all residents of Tennessee listed on the Tennessee Academy of Science membership

list. Eight of the 1981-83 roster participants either declined an invitation to continue supporting the program or were reported as deceased. There were 14 visiting scientists who did not respond. Their names were deleted from the roster. This process recruited 26 new participants. A second mailing to those not responding to the first mailing is forthcoming. An addendum will be added to the roster before the second printing. Since the process resulted in a net gain of only five new participants, alternative methods of recruiting visiting scientists need to be explored. Initial negotiations with one branch office within TVA will be discussed at the board meeting. I am requesting board approval to recruit visiting scientists through TVA.

- 4) There have been several reports of high schools making direct contact with visiting scientists, therefore, bypassing the VSP office. Such visits often go unreported. We have tried to be accommodating, but the process of direct contact undermines the program and has alienated some visiting scientists." The Director's report was accepted.

SUMMARY DATA

	1980-81	1981-82	1982-83	1983-84
1. Number of visits requested	31	58	39	46
2. Number of visits completed	28	44	27	5
3. Number of students contacted	2401	3058	1775	
4. Number of teachers contacted	120	101	37	
5. Number of classes contacted	70	15	52	

A motion was passed to allow Dr. Benson to recruit visiting scientists through TVA or other appropriate agencies. An application for membership in the Academy will be sent to each new recruit. A motion was passed to allow Dr. Benson to open the VSP for grades 7-9, as funds allow.

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

"Regional meetings were held during the Spring of 1983 as follows: Western region at Southwestern in Memphis on March 26. Dr. David W. Steinhaus presided. Twenty-four papers were presented by students from Southwestern and Christian Brothers College. Middle region at Austin Peay State University on April 30. Dr. James X. Corgan presided. Ten papers were presented by students from 4 schools. East region at Bryan College on April 16. Dr. Robert G. Ziegler presided. Seven papers were presented by students from 5 schools. Abstracts of the papers will be published in the Journal.

Two students who presented papers were chosen to receive honorary student memberships in AAAS. These were Richard Hugh Sullivan, III and Mary Susan Gamble."

The Director's report was accepted.

The Collegiate Division will meet Saturday morning, November 19, 1983.

A motion was passed to allow papers received after the deadline to be accepted for presentation in the Collegiate Division, although the paper may not be listed in the program. This information will be included in the "Call for Papers".

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

"The Tennessee Junior Academy of Science annual spring meeting was conducted on April 22, 1983, at Glencliff High School, Nashville, Tennessee. Fifty-four papers were submitted by high school students throughout the state in 1983. From this total, a panel of readers selected seventeen for presentation at the meeting.

Judges for the student presentations were Dr. Jean Nicholson, Mr. Tony Beasley, and Mr. Randy Randalls, all of Nashville Metro Schools. Local arrangements were handled by Mr. Beasley and Mr. Bob Bryson, also of Metro Schools. On behalf of the Tennessee Academy of Science, thanks were extended to Glencliff High School and to Metro Schools for hosting the meetings.

The students who were rated highest for their presentations at the annual meeting were Miss Carey Anderson and Mr. Jonathan Burdette, both from Webb School of Knoxville. These two individuals were nominated for one-year honorary memberships in the American Association for the Advancement of Science. They will receive a year's subscription to both *Science* and *Science 83*.

I have recently received donations of \$500 from Tennessee Eastman and \$300 from the Alcoa Foundation to the Junior Academy Program. Letters of appreciation have been forwarded to the appropriate individuals."

The Director's report was accepted.

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

"I attended the annual meeting of the National Association of Academies

of Science and Section X of AAAS at Detroit, Michigan, on May 28-29, 1983. The NAAS Symposium was entitled 'The Crises in Science and Mathematics Education: Perspectives from the National, State, and local levels.' The Proceedings of the Symposium have been distributed to Academy Officers."

The report was accepted.

Mr. John Bennett, representative from the State Department of Education, recommended the following three secondary school science teachers for the TAS "Distinguished Science Educator Award": Steve Pemberton, Angela Lee, Mary Hill. Formal presentation of the award will be made at the Spring meeting of the Junior Academy of Science. Mr. Bennett and Dr. Pafford will coordinate arrangements for the awards ceremony. A motion was passed to accept the recommendations.

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

1. Auditing Committee. The Chairman, Eugene A. Kline, sent the following report:

"The auditing committee met and had James F. McKinnie audit the books for us. He has made his report to us and finds everything in very good order. His audit was from July 1, 1982 to June 30, 1983 and he agrees that the balance of \$8,414.16 was correct to that date.

The audit committee on the basis of Mr. McKinnie's report and audit voted unanimously to recommend to the Academy to accept this as evidence of the financial position as of June 30, 1983. Also, I have included a copy of his report."

The committee's report was accepted.

2. Fellow's Committee. The Chairman, Julian T. Darlington, sent the following nominations for Fellows:

Dr. Kurt Blum, Biology Dept., Middle Tennessee State University
Dr. William H. Martin, Natural Areas Division, Eastern Kentucky University

A motion was passed to approve the nominees as Fellows of the Academy and to present them to the membership at the annual Business Meeting.

3. Membership Committee. The Chairperson, Clay Chandler, sent the following report:

"On 8 February 1983, each member was contacted by the chairman, urged to recruit new members, and sent 10 membership applications. Moreover, each member of the committee was encouraged to communicate with legislators in the member's area and solicit their support for the programs of the Academy.

Dr. Meyer contacted several legislators in the Memphis area, created new interest in joining the Academy, and recruited one new faculty member. Ms. Pav contacted Representatives King, Moore, and Gore, recruiting four new full members from ETSU, and consulted with members who had lapsed in their dues. Drs. Caponetti and Wishart actively recruited at UTK and reported two new members. I recruited three faculty from the Chemistry and Physics Dept. of MTSU and two graduate students of biology."

The committee's report was accepted.

New members will be presented for acceptance by the membership at the annual Business Meetings.

4. Necrology Committee. The Chairman, Albert L. Myers, sent the following report:

"The Necrology Committee regrets to report the deaths during the past year of the following persons who were members or had been members of the Tennessee Academy of Science: Dr. John L. Bailey, former Director of the Junior Academy, Johnson City; Dr. Clayton Hoff, Rock Island, IL."

The committee's report was accepted.

5. Nominating Committee. The Chairman, S. K. Ballal, presented the following proposed slate of officers for next year:

President-Elect: Dr. William H. Ellis, Austin Peay State University
Secretary: Dr. Diane R. Nelson, East Tennessee State University
Treasurer: Dr. R. K. Fletcher, Tennessee Technological University

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

6. Research Committee. The Chairman, Prem Kahlon, sent the following report:

"The Research Committee submitted a proposal for the research support of secondary school students to AAAS requesting \$1,000 for this purpose. The academy was awarded a grant in the amount of \$500. The reason given for not awarding additional \$500 was due to low number (only 5) of applications received during the 1982-83 school year. The Committee advised the availability of funds in all the major newspapers, the Journal of the Academy, and direct mailing to several individuals in West, Middle and East Tennessee. I have not received my applications to date, perhaps due to the fact that the deadline for the applications was advertised as November 15, 1983."

Hopefully, by the Annual Meeting we will receive some applications and recommend awards. The Research Committee will meet at noon on November 18, 1983 and will make the final report at the business meeting. Lack of interest as shown by the low number of requests we have received in the past has been the concern of the Research Committee, and this year does not seem to be any better."

A motion was passed to change the announcement for the research grants to be published in the Journal and the S.A.T. Newsletter; applications can be submitted at any time. The Committee's report was accepted.

7. Resolutions Committee. The report is to be submitted at the Business Meeting.

8. Local Arrangements Committee. Joe Watlington and Tom Miller, VSCC, discussed local arrangements for the meeting. Robert Wilson, Program Chairman, discussed the program for the meeting. The Executive Committee thanked these individuals for their efforts on behalf of the Academy.

OLD BUSINESS

The Academy will meet at the University of Tennessee, Knoxville in 1984 and at Middle Tennessee State University in 1985. An invitation has been received to meet at Belmont College. A motion was passed to rotate the locations of the meetings as follows: Belmont College. A motion was passed to rotate the location of the meetings as follows: East-Middle-Middle-West-Middle-Middle-East. The proposal will be presented to the membership at the Business Meeting.

NEW BUSINESS

A motion was passed to return the publication of the Journal to four issues per year beginning April 1984.

Tentative budgets were proposed. The budget will be finalized at the April Executive Committee Meeting.

Dr. James X. Corgan, Austin Peay State University, was authorized to proceed with writing a history of the Tennessee Academy of Science.

Dr. Charles Jenner, President of the Association of Southeastern Biologists, stated in *The ASB Bulletin* (Vol. 30, No. 3, July 1983, p. 139-140) that he would pledge "a \$100 contribution to the first state academy in our region" to pass a resolution for support "in the effort by the North Carolina Academy of Science to promote interdisciplinary teaching about the global problems of population growth, resource depletion, and environmental degradation." The resolution was passed by the Executive Committee and will be presented to the membership at the Business Meeting.

The meeting was adjourned at 10:25 p.m., C.S.T.

THE NINETY-THIRD MEETING OF THE TENNESSEE ACADEMY OF SCIENCE NOVEMBER 18-19, 1983 Volunteer State Community College

The annual meeting of the Tennessee Academy of Science, Inc., was held November 18-19, 1983, at Volunteer State Community College, Gallatin, Tennessee. Mr. Joe Watlington was Chairman of the Local Arrangements Committee; Dr. Robert L. Wilson, University of Tennessee - Chattanooga, was Program Chairman, Over 200 individuals registered for the meeting.

The General Session was held in the Auditorium, Noble Caudill Hall, on Friday morning, November 18, beginning at 10:00 a.m. C.S.T. The Program Chairman, Dr. Robert L. Wilson, presided over the session. The Academy was welcomed by Dr. Hal Ramer, President of Volunteer State Community College. The theme of the session was "Computers—What's Ahead?" Speakers were Bob McCoy, Hewlett Packard; Kelvin Cary, Digital; and Rick Covington, IBM. Section meetings were held on Friday afternoon in the Warf Building; 67 papers were presented as listed in the program. The Annual Business Meeting was held in the Auditorium, Noble Caudill Hall, at 5:00 p.m. C.S.T.

The Annual Banquet was held in the University Center Ballroom, beginning at 7:00 p.m., C.S.T. Friday evening. President Gordon Morris presided. The speaker was Dr. Diane R. Nelson, Professor of Biological Sciences, East Tennessee State University. The title of her address was "The Bermuda Triangle."

The Collegiate Division held its meeting on Saturday morning at 9:00 a.m., C.S.T. in Noble Caudill Hall. Dr. Prem S. Kahlon, Tennessee State University, presided and four papers were presented by college students.

ANNUAL BUSINESS MEETING November, 1983

The Annual Business Meeting of the Tennessee Academy of Science, Inc., was called to order by President Gordon Morris at 5:00 p.m., C.S.T. in the Auditorium of Noble Caudill Hall, Volunteer State Community College, Gallatin, Tennessee, on November 18, 1983. The President determined that 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 Editor announced that a one-sentence acknowledgment for financial support could be included in an abstract presented at the meeting and published in the Journal. All reports were approved by passed motions and will be recorded in the Minutes.

The Secretary reported individuals who had applied for membership to the Academy in 1982-83. A motion to accept the new members was passed.

The Secretary read the report of the Auditing Committee. Dr. Clay Chandler read the report of the Membership Committee. Dr. Prem Kahlon read the report of the Research Committee. The reports were presented the previous evening at the Executive Committee Meeting. All reports were approved by passed motions and will be recorded in the Minutes.

The Secretary read the names of the Fellows nominees presented to the membership by the Executive Committee. A motion was passed that the nominees be elected Fellows of the Academy.

The Chairman of the Necrology Committee, Albert L. Myers, presented the names of members of the Academy who had passed away:

Dr. C. Clayton Hoff, Rock Island, Illinois, and

Dr. John L. Bailey, Johnson City, former Director of the Tennessee Junior Academy of Science and Chairman of the Department of General Science and Science Education, East Tennessee State University.

Dr. Myers asked the audience to stand in tribute. A motion was passed to accept the report.

The Secretary presented the report of the Nominating Committee. The President 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 Robert L. Wilson as President, William H. Ellis as President-Elect, Diane R. Nelson as Secretary, and R. K. Fletcher as Treasurer.

The Chairman of the Resolutions Committee presented the following resolution:

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 Volunteer State Community College and

WHEREAS, the success of these meetings has resulted mainly from the efforts of the officers of the Academy; the Chairpersons of the respective sections; the Local Arrangements Committee representing Volunteer State Community College, composed of Dr. Hal Ramer, Dr. Thomas Miller, Dr. James Ward, Mr. Wayne Sullivan and Mr. Joe Watlington; the Program Chairman, Dr. Robert Wilson; from the recognition given the meetings by the press, television, and radio stations; and from the general hospitality of the host institution, Volunteer State Community College and its President, Dr. Hal Ramer,

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."

The resolution was accepted by a passed motion.

OLD BUSINESS

The Academy will meet in UTK in 1984 and MTSU in 1985. The Executive Committee presented a motion to rotate the location of the meetings, East-Middle-Middle-West-Middle-Middle-East. The motion passed. An invitation to meet at Belmont College was received.

NEW BUSINESS

The Executive Committee announced that Dr. James X. Corgan, Austin Peay State University, was authorized to proceed with writing a history of the Tennessee Academy of Science.

A resolution was passed for support in the effort by the North Carolina Academy of Science to promote interdisciplinary teaching about the global problems of population growth, resource depletion, and environmental degradation.

The meeting was adjourned at 5:30 p.m. C.S.T.

TENNESSEE ACADEMY OF SCIENCE
CASH RECEIPTS AND DISBURSEMENTS
For Year Ended June 30, 1983
TREASURER'S REPORT

Cash Balance, July 1, 1982	\$ 5,429.35
Receipts:	
Membership dues and subscriptions	\$8,978.00
State Department of Education	4,750.00
Contributions	1,501.00
Banquet fees	520.00
Interest earned	498.58
Registration and exhibitor's fees	482.00
Journal page charges	330.00
Total Receipts	<u>17,059.58</u>
Total Cash Available	<u>\$22,488.93</u>
Disbursements:	
Printing and publications	\$7,214.18
Tenn. Jr. Academy of Science	1,654.63
Treasurer's office expense	1,455.64
Conventions and meetings	1,091.34
Visiting scientist program	1,039.60
Salaries and wages	955.00
Research grants	500.00
Secretary's office expense	94.38
Audit fee	70.00
Total Disbursements	<u>14,074.77</u>
Cash Balance, June 30, 1983	<u>\$ 8,414.16</u>

Receipts	\$17,059.58
Disbursements	<u>14,074.77</u>
Cash increase	\$ 2,984.81
Cash Balance, July 1, 1982	<u>5,429.35</u>
Cash Balance, June 30, 1983	<u>\$ 8,414.16</u>

REPORT OF THE AUDITOR

Executive Committee
Tennessee Academy of Science

I have examined the receipts and disbursements records for the Tennessee Academy of Science for the fiscal year ended June 30, 1983, and in my opinion, the attached Cash Receipts and Disbursements statement correctly reflects the cash position of the organization at June 30, 1983.

I also examined the Form 990 filed on November 10, 1983, and found it to be substantially correct. The entire accounting system appears to be well maintained and cared for meticulously. I found no material errors, whatsoever.

Sincerely,

James F. McKinnie, M.B.A.
Asst. Professor of Accounting
Tennessee Technological University
Cookeville, Tennessee

**TENNESSEE ACADEMY OF SCIENCE
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ABSTRACTS PRESENTED AT THE ANNUAL MEETING

COLLEGIATE DIVISION

RICHARD J. RARIDON, *Presiding*

Phenotypic Determination of Human Erythrocytic Enzymes, LEROY GURGANIOUS, Tennessee State University

The objective of this study was to develop a reliable technique for the phenotype determination of human erythrocytic enzymes by polyacrylamide electrophoresis. The enzymes tested in the polyacrylamide gel were: phosphoglucomutase (PGM) and glyoxylase (GLO). A modification of the method described by Lee and Ying (1979) was used in this study. The enzyme PGM produced the most consistent results. PGM displaying a migration between 7.0 and 12.0 cm was characterized by three bands intensity when viewing from the slowest migrating to the fastest migrating bands. Although the bands for the enzyme GLO did not demonstrate distinct boundaries, the procedure did produce useful results. The crucial factor for this enzyme's visualization is the length of time the enzyme is allowed to incubate. Enzyme-substrate interaction was maximized with an incubation period of between 90 and 120 minutes at 37°C. The dominant band pattern observed contained a single line of bands which migrated 19.0 to 22.5 cm. (This research was conducted under the guidance of Dr. Clint E. Carter of Vanderbilt University).

The Synthesis of 9,10-d₂-9,10-Dihydrophenanthrene and its Analysis with a Mass Spectrometer, EDMUND L. PRATER, D. GREG WHEATLEY, and EUGENE A. KLINE, Department of Chemistry, Tennessee Technological University, Cookeville, Tennessee. 38505

9,10-Bistrimethylsilyl-9,10-dihydrophenanthrene was synthesized in the usual manner with lithium and trimethylchlorosilane in dry THF. The silylated PNA was reacted further with a solution made by reacting cellosolve with equimolar amounts of potassium followed by an equivalent amount of D₂O. The temperature was increased to 100° C. and then the product mixture was worked up to isolate the pure deuterated dihydrophenanthrene. This compound was analyzed with the mass spectrometer and the results compared with calculated results obtained from a program written to include molecules containing most of the common atoms.

Construction of an Ozone Generator and Some Reactions with Phenanthrene, JEFFERY K. STOCKTON, WILLIAM G. WIRT and EUGENE A. KLINE, Department of Chemistry, Tennessee Technological University, Cookeville, Tennessee 38505

An ozone generator was constructed with pyrex glass tubing with a mercury electrode in the center and a water cooled jacket electrode on the outside. Generation of ozone was found to be significant with the use of a Tesla coil as the source of high voltage only when the diameter of the glass tubing were reduced. Amounts of ozone generated were compared with larger systems and was found to be relatively more with the smaller diameters glass tubing. Phenanthrene was reacted with the ozone generated in a dry methanol solution at -20 degrees C., oxidized with hydrogen peroxide/sodium hydroxide, and diphenic acid was isolated.

BOTANY SECTION

GORDON HUNTER, *Presiding*

The Vascular Flora of Haywood County, Tennessee, PAUL O. LEWIS, and E. T. BROWNE, JR., Memphis State University.

A study is in progress of the vascular flora of Haywood County, Tennessee. Haywood County lies within the Mississippi Embayment Section of the Western Mesophytic Forest and has a loess soil with no rock outcrops. The land is gently rolling to flat, with the highest elevations in the northwestern and southeastern corners and the lowest in the flat bottomland floodplains of the Hatchie and the South Fork of the Forked Deer Rivers. Most of the county is agricultural and indigenous vegetation is thus confined to small, private woodlots and the extensive alluvial river bottoms that are periodically inundated with water. *Taxodium* and *Nyssa* occupy oxbow lakes and sloughs, *Fagus*, *Vaccinium*, *Luzula*, and *Tipularia* are characteristic of loess bluffs along the Hatchie River, and marsh-like beaver ponds support populations of *Polygonum*, *Cephalanthus*, *Scirpus*, *Juncus*, and *Sparganium*.

Effect of NaCl on the Regenerative Ability of Soybean S. M. BHATTI and P. S. KAHLON, Tennessee State University.

The ability of cotyledonary nodes to regenerate in the presence of added amounts of NaCl in the culture medium was investigated. Soybean seeds of 4 cultivars, Centennial, Miles, Tracy and Williams were preconditioned by germinating on MS medium supplemented with 5 uM (BA) Benzyladenine. Cotyledonary nodes from 2 weeks old seedlings were inoculated on MS medium with 1 uM BA and different levels of NaCl. The number of shoot-buds formed on each node was counted. In cultivars Miles and Williams a slight increase in the frequency of shoot-bud formation was observed when the nodes were placed on media with .1% and .25% NaCl (as compared to control). At higher concentrations (.5% and 1% NaCl) a drastic reduction in regeneration potential was observed. Cultivar Centennial benefitted from .1% NaCl added to the medium, however, at .25% the number of shoot-buds formed dropped to the same level as control. At .5% and 1% NaCl regeneration was significantly reduced. Contrary to the other 3 cultivars tested, a reduction in shoot-bud formation was observed in cultivar Tracy even at .1% NaCl. No shoot-buds were formed at .5% and 1% NaCl.

Adaptability of Soybean Cells to NaCl Stress, T. M. CURRY and P. S. KAHLON, Tennessee State University.

Two soybean cell lines (SB3 and SBe4) were maintained in Gamborg's B5 media. These cells were exposed to various concentrations of NaCl added to the media. Growth was determined by an increase in cell population. Results show that low levels of NaCl (.1% to .25%) did not have a significant effect on cell growth. At .5% NaCl cells of both lines, after an initial lag period (approx. 7 days), adapted to the stress and grew steadily but at a rate slower than the control. Cells of SBe4 adapted to .75% NaCl after a lag period but SB3 cells could not adapt to this level of stress. Neither cell line could adapt to concentrations at or greater than 1.0% NaCl. An additional focus of this study was to determine the osmotic effects of NaCl versus the toxic ion effects. Cell cultures growing in isosmotic concentrations of mannitol and NaCl had higher viable cell populations in mannitol than in NaCl. Even at the highest osmotic potential used (equivalent to 1.0% NaCl) cell growth was equivalent to or better than the control while no growth was observed in NaCl. Results of these studies suggest that NaCl is exhibiting a toxic ion effect rather than an osmotic effect.

A Preliminary Study of the Diatoms of Reelfoot Lake. LYNN JARRETT, Murray State University.

Past efforts to describe the algal flora of Reelfoot Lake have not been successful in detailing the diversity of diatoms present. This study indicates that the lake supports numerous species and a variety of complex communities. Attention was concentrated on periphytic and benthic substrates. A correlated study, by the author, of three vertical cores taken from the sediments, anticipated the present flora. The cores might also be used to determine approximate rates of sedimentation in the respective areas of the basin, as well as indicate environmental changes that have occurred.

CHEMISTRY SECTION

TOM MILLER, *Presiding*

C-13 NMR of Lauric Acid in Micelles, W. ABRAHAM and D. J. WILSON, Department of Chemistry, Vanderbilt University.

Solubilization of lauric acid in micelles of three different surfactants (sodium dodecyl sulfate, Triton-X-100 and dodecyl trimethyl ammonium chloride) has been studied by C-13 NMR as a function of pH. Spin-lattice relaxation time (T₁) and Nuclear Overhauser Enhancement (NOE) for the carboxyl carbon were measured. A distinct minimum occurs in T₁ values between pH 4.5 and 7 in these micelles, even after minimizing the amount of paramagnetic impurities in the system. The dependence of T₁ values on pH shows the influence of the micelles on the pK_a of the weak acid. pK_a decreases from 7 to 4.5 as we go from anionic to cationic micelles. The large NOE values show that the major relaxation mechanism for the carboxyl carbon in all of the three different micellar environments is dipole-dipole relaxation.

HPLC Assay for Hydrochlorothiazide in Human Urine, RUSS RACKLEY, PHIL HWANG and MARVIN C. MEYER, University of Tennessee Center for the Health Sciences.

A high performance liquid chromatographic method is described for determination of hydrochlorothiazide urine concentrations. Hydrochlorothiazide (HCTZ) is a thiazide diuretic used in treating hypertension. Hydroflumethiazide (the internal standard) is added to HCTZ urine samples and extracted with ether at pH 5.0. The ether phase is evaporated and the residue is reconstituted with methanol, then injected onto a C-18 reverse-phase column. HCTZ and internal standard are quantified by UV absorption at 280 nm. The aqueous mobile phase consists of: dibasic sodium phosphate, 0.142% (W/V); tetrabutylammonium chloride solution (0.1 g/ml), 5.6% (V/V); and acetonitrile, 12% (V/V). The pH is adjusted to 8.0 with phosphoric acid (.1 N). Validation was performed with spiked samples of drug-free human urine. Drug/internal standard ratios are linear for 0 through 40 $\mu\text{g/ml}$ of HCTZ. Coefficient of variation at 3 different concentrations (8 samples each) ranged from 3.15 to 8.62%. Urine samples were collected from a normal healthy male who took 25mg of HCTZ orally. After 48 hours 61% of the dose was recovered.

Mathematical Modelling of Counter-current Liquid-liquid Extraction Columns KENNETH N. CARTER, JR. and DAVID J. WILSON, Vanderbilt University.

A description of a counter-current liquid-liquid extraction column is given, together with the differential equations describing solute transfer in such a column. We then present a physically plausible fast algorithm for solving the equations numerically. After division of the column into finite-difference computational cells, we apply a Lagrangian approach to the droplets of rising dispersed fluid to derive a set of approximate algebraic equations for this phase. The number of difference equations to be solved is thereby halved. To represent advection in the continuous phase, we use a four-point third-order-accurate difference operator, which reduces false numerical diffusion. The model incorporated advection, axial dispersion in the continuous phase, and a finite rate of mass transfer between the phases. The equations are solved in a FORTRAN program using a predictor-corrector method. Results are displayed for simulation of realistic column operation.

Conformational Studies of Diastereomeric Sets of tert-Butyl Octalones Using Proton and Carbon-13 Nuclear Magnetic Resonance Spectroscopy, F. J. MATTHEWS, Austin Peay State University.

The stereochemistry of organic molecules has been of interest to chemists for many years. Previous conformational studies of α -cyperone and epi- α -cyperone have produced anomalous results concerning the B-ring conformation of analogous compounds. More recently, it has been reported that variable temperature carbon-13 nuclear magnetic resonance data can provide results which lead to conformational determinations. This seminar describes a conformational study of diastereomeric sets of tert-butyl octalones in which either chair or nonchair conformers should predominate, depending on the structure of the individual octalone. Conformational determinations were based on variable and ambient temperature carbon-13 nuclear magnetic resonance spectra, as well as high-resolution proton nuclear magnetic resonance spectra of four octalones. The results suggest that those tert-butyl octalones with equatorial tert-butyl substituents exist in a ring-B chair conformation. Those tert-butyl octalones which would exist with an axial tert-butyl substituent in the chair conformation, however, were found to exist either in a twist conformation or as an equilibrium mixture of twist and chair conformers.

A One Chip Digital Panel Meter/ Microcomputer Interface, HARVEY F. BLANCK, Austin Peay State University.

A 4½ digit panel meter with a BCD output can be easily interfaced to a microcomputer through a 6522 versatile interface adaptor (VIA) using only a 7410 triple 3-input NAND gate or a 7400 quad 2-input NAND gate. A chip is necessary since the DPM has four BCD output lines and five BCD valid or indicator lines while one half of a VIA only has eight data lines. The hardware, logic, and software will be presented.

Electrical Aspects of Adsorbing Colloid Flotation XVII. Quasi-Chemical Theory for Mixed Surfactant Adsorption. J. WILSON and K. N. CARTER, JR., Vanderbilt University.

The quasi-chemical approximation is applied to the statistical mechanical calculation of adsorption isotherms for two-component systems. No further approximations are necessary. The effects of the relative sizes of the interaction energies of the various nearest neighbor pairs are investigated, and plots of representative adsorption isotherms are given. Some possible applications of the theory to foam flotation and other surface chemical separation techniques are suggested.

Science ExpOlympics. JOHN D. FOOTE, Austin Peay University.

A day's schedule of exhibitions, demonstrations, lectures, and competitive events was presented and directed in May, 1983, by the faculty, staff, and upper-division students in the departments of chemistry, biology, physics,

and mathematics and computer science at Austin Peay State University for area high school science and mathematics students and teachers. The event strengthened the relation between university and high school teachers and students; the image of science as a college major and as a career choice was enhanced; and science was taught in an improved environment to a group of highly motivated, bright high school students.

Removal of Refractory Organics by Aeration. V. Solvent Sublimation of Naphthalene and Phenanthrene S.-D. HUANG, K. T. VALSARAJ, and D. J. WILSON.

Naphthalene and phenanthrene are readily removed from aqueous systems by solvent sublimation into mineral oil. The process is slightly enhanced by added salts, and slightly retarded by acetone and ethanol. The naphthalene results are used to test a mathematical model for solvent sublimation column operation; satisfactory agreement is obtained.

The emission spectrum of BrF. STUART D. HENDERSON, and JOEL TELLINGHUISEN, Vanderbilt University.

The emission spectrum of BrF has been photographed and analyzed for the single isotopic species, $^{79}\text{Br}^{19}\text{F}$ and $^{81}\text{Br}^{19}\text{F}$. The strongest emission occurs in the region 3400-3600 Å, with peak intensity near 3550 Å. The vibrational analysis of the red-degraded band heads yields approximate vibrational constants for the upper and lower electronic states. However, even though we have spectral data for two isotopomers, we are unable to pin down the vibrational numbering of the lower state at present. A rotational analysis of several key bands, now underway, should remove the remaining ambiguities. This electronic transition appears to be the analogue of the strongest emission systems in I₂, Br₂, and ICl, and therefore is tentatively assigned as $D'(2) \rightarrow A'(2)$. Weaker systems at shorter wavelength are still under investigation.

Competing Nucleophilicities During Methylation of 1,4-Hydroquinone with Dimethyl Sulfate in Basic Solution. MARTIN V. STEWART and SCOTT J. SMITH, Middle Tennessee State University.

Sterically hindered 2,5-dialkyl-1,4-hydroquinones fail to methylate in homogeneous solution, but afford quantitative yields of the corresponding 1,4-dimethoxybenzenes under the heterogeneous conditions of phase-transfer catalysis [TAS Annual Meeting, UT at Martin, Nov. 1982]. Reaction conditions for the homogeneous methylation of 1,4-hydroquinone with dimethyl sulfate at 45° in aqueous sodium hydroxide containing hydrosulfite anion as an antioxidant were optimized for comparison with the unsuccessful reaction of the hindered 2,5-di-*t*-butyl-1,4-hydroquinone. A kinetic expression exhibited a linear correlation between crude product yield and the mole ratio of starting hydroquinone to other nucleophiles in the system (hydroxide anion and even sulfur-containing species derived from the antioxidant). These results allowed extrapolation to nearly quantitative yield and provided a relative measure of the strength of the nucleophiles competing under these conditions. Acknowledgment is made to the donors of The Petroleum Research Fund, administered by the American Chemical Society, and the MTSU Subcommittee on Research for financial support.

The Emission Spectrum of ICl. J. GAIL ASHMORE, J. DAVID SPIVEY, and JOEL TELLINGHUISEN, Vanderbilt University.

The emission spectrum of ICl has been photographed and analyzed, using a Tesla discharge to excite sources containing the single isotopic species, $^{127}\text{I}^{35}\text{Cl}$ and $^{127}\text{I}^{37}\text{Cl}$. The spectrum is dominated by a system which shows red-degraded band structure extending from ~4000 Å to 4400 Å, with peak intensity near 4310 Å. Analysis of this system at high resolution shows that there are actually two electronic transitions present — $\beta - A$ and $D' - A'$. The first of these involves two already well-known states and accounts for about 30% of the total intensity. The second involves two new states, both having Hund's case *c* designation, $\Omega = 2$: The upper state is an ion-pair state correlating with the lowest ($I^+ + Cl^-$) limit, while the lower state is the first excited state of the molecule and correlates with two ground state atoms. Other, weaker emission systems in the spectrum are still under investigation.

Base Specific Interaction of meso Tetra (4-N-methylpyridyl) porphine with DNA Resolved Using Thermal Denaturation Analysis. JAMES C. HOWARD, SHANNON LEESON LYELL, and WILLIAM E. BOEGLIN, Middle Tennessee State University.

In order to characterize the interaction of T4MPyP with DNA, we have performed thermal denaturation experiments (UV/Vis Absorption vs. Temperature) using poly(dG-dC)•poly(dG-dC) and poly(dA-dT)•poly(dA-dT) as model DNA's at several ionic strengths and at several ratios of T4MPyP to DNA base pairs, *r*. At low *r* values, e.g. 0.08 and 0.13, the A_{260} vs. *T* curves were biphasic and hyperchromic for T4MPyP•poly(dA-dT)•poly(dA-dT) complexes. The same complexes resulted in monophasic, hypochromic A_{424} vs. *T* curves. For similar complexes with poly(dG-dC)•poly(dG-dC) both the A_{260} vs. *T* and A_{424} vs. *T* curves were monophasic and hyperchromic. Thus, the combination hyperchromic and hypochromic A_{424} vs. *T* curves observed for Cl. perfringens DNA•T4MPyP complexes seem to be composed of the separate interaction of porphyrin with A•T

base pairs from porphyrin with G•C base pairs which has been resolved by thermal denaturation analysis. This work was supported by a grant #1-31122-0042 from the MTSU Faculty Research Committee.

Theoretical Analysis of Process Control Operations on a Solvent Sublation Pilot Plant. K. T. VALSARAJ and DAVID J. WILSON, Vanderbilt University.

Solvent sublation, a surface chemical technique, was found to be capable of removing certain classes of chlorinated organics and aromatic polynuclear hydrocarbons. A high speed algorithm was developed for simulating the process control operations on a small pilot plant operated in the continuous mode. The response of the system was analysed theoretically with and without a lag time for the concentration sensor. The importance of choosing the right Δt values for the integration of the differential equations involved was also investigated.

Interfacing to a Radio Shack TRS-80 Microcomputer—1983 Update. O. CARL SALTER and JOEL TELLINGHUISEN, Vanderbilt University.

We have built and tested hardware and software for interfacing a TRS-80 Model III microcomputer to a microdensitometer, a monochromator, and a point digitizer. The tests show that the microcomputer is capable of logging data in digital form at a rate of ~ 1000 points per second, which exceeds the mechanical capabilities of the interfaced instruments. However, disk read and write operations are much slower, so when these are included in the data logging task, the speed drops by one to two orders of magnitude. This rate is still more than adequate for a large range of typical chemical laboratory tasks, and the required microcomputer instrumentation is cheap and getting cheaper.

Reactions of 1,1'-Binaphthyl and 9,10-Dihydrophenanthrene Under Hydrogen Pressure. EUGENE A. KLINE and R. SCOTT PUGH, Tennessee Technological University.

Reactions of 1,1'-binaphthyl and H-donor 9,10-dihydrophenanthrene were carried out in a sealed tube with and without hydrogen pressure at 470 deg C. for 1 hour. Differences in total volume of benzene solvent added was found to be important in the amount of coupled product, perylene, that was formed. High pressure hydrogen was found to be important only when the volume was not full. Implications to the mechanism for this unusual reaction were assessed as well as its usefulness in analyzing H-donor solvents in coal liquefaction.

Diatomic Partition Functions from Classical and Semiclassical Phase Integrals. JOEL TELLINGHUISEN, Vanderbilt University.

Two methods are described for evaluating the rotation-vibration partition function (q_{rv}) of a diatomic molecule directly from potential curves. The first involves an explicit sum over states but employs the semiclassical phase integral to estimate the eigenvalues. Since for "realistic" diatomic potentials, the semiclassical eigenvalues generally agree with the quantum mechanical eigenvalues within spectroscopic accuracy ($\sim 1 \text{ cm}^{-1}$), this method is virtually exact and is applicable at any temperature. The second method involves calculation of the classical phase integral and is surprisingly accurate even at temperatures where kT is comparable to the vibrational energy interval. Both methods are computationally very efficient, but the classical method is one to two orders of magnitude faster and typically takes a fraction of a second of CPU time for a single partition function.

ENGINEERING SECTION

DAVID YARBROUGH, *Presiding*

Compressed Natural Gas the Alternative to Gasoline. P. R. SAGGURTI, D. W. YARBROUGH, R. F. BECKMAN, Nu-Fuel Industries, Inc.

Compressed Natural Gas, CNG, is being used successfully as an alternative to gasoline in trucks, busses and cars. The conversion of gasoline powered automobiles to run on CNG involves the simple addition of CNG storage cylinders, pressure regulation equipment, and ignition and timing adjustments. Systems for CNG handling and use have been designed and tested on vehicles built to use gasoline. Tests show vehicle performance comparable to that achieved with gasoline. The range of the converted automobile is extended by 100 to 200 miles by the use of CNG, giving a comparable if not a better fuel efficiency.

Removal of Trihalomethane Precursors by Reverse Osmosis. TALBERT N. EISENBERG and E. JOE MIDDLEBROOKS, Tennessee Technological University.

The effect of pre- and postchlorination on reducing trihalomethane (THM) precursors by reverse osmosis (RO) was investigated. Prechlorination of the feedwater, in contrast to postchlorination of the permeate, resulted in improved reduction of maximum total THM potential (MTP) due to adsorption. No significant difference in permeate MTP concentration occurred between the prechlorinated feed and the postchlorinated permeate. Recirculating permeate water through the RO unit was successful

in restoring flux rates and resuspending the precipitate that accumulated on the RO membranes. The small loss in free chlorine residual indicated prechlorination may be economically attractive in controlling biological fouling of cellulose acetate membranes. Prechlorination was not reliable in removing THM precursors and failed to produce a permeate with MTP concentration less than the maximum contaminant level of 0.10 mg/l.

Application of the OEDC Eutrophication Model to Small Lakes. W. P. BONNER and R. B. BUSTAMANTE, Tennessee Technological University.

National and international organizations point to the deleterious effects of increased nutrient inputs on water quality of lakes and have been instrumental in limiting nutrient releases from point sources. Other sources promote the addition of commercial fertilizers to ponds as a means of enhancing fish production. Members of the Organization for Economic Cooperation and Development (OEDC) conducted a worldwide survey of lakes and developed the OEDC Model for determining the trophic state of lakes and predicting lake response to changes in nutrient input. Data obtained from chemical analyses of water in four small eutrophic lakes (10 to 100 acres) and data gleaned from the literature were applied to the OEDC Model. The data indicate that the model may be used to predict the response of small lakes to changes in nutrient input. Refinement of the data is being obtained in current studies.

Analysis of Isothermal Total Pressure Data Using the Redlich-Kwong Equation. WILLIAM R. MOONEYHAN, JR., Tennessee Technological University.

A method has been developed for the prediction of the saturated liquid-vapor equilibrium states using the Redlich-Kwong equation of state. The method predicts vapor phase compositions, total pressures, and excess Gibbs energies for two and three component systems. The proposed method is compared with experimental data for 367 isothermal binary P-x data points and for 142 isothermal ternary P-x data points.

Experimental Observations of Shear Strength of Tennessee Clay. NATE S. PARATE, Tennessee State University.

The shear strength of clay-water system is explained in terms of clay structure, i.e., size, shape and arrangement of clay particles and interparticle forces. The measured shear strength is a result of frictional resistance between adjacent clay particles, inter particle and is a function of the particle spacing; short or long range. Long range interparticle forces influence particle size, shape and arrangement during sedimentation and consolidation processes. The size and flatness of the clay particles (colloidal or dispersed) maximize or minimize the influence of physico-chemical behavior and determine to an important degree the nature of particle interactions. Large and stiff particles of kaolinite are edge-to-face and edge-to-edge during short-range interactions whereas small and filmy particles of sodium montmorillonite favor long-range face-to-face interaction. Illite and calcium montmorillonite occupy intermediate positions; illite being closer to kaolinite and calcium montmorillonite being closer to sodium montmorillonite in behavior. Therefore, increase in effective stresses cause small decrease in short-range particle spacing in kaolinite, but lead to substantial increases in shear resistance, whereas similar effective stress increase in calcium montmorillonite cause large decreases in long-range particle spacing but result in little or no increase in shear resistance. Results from consolidation-undrained triaxial tests during this investigation show that:

1. The rate of development of shear strength is greater in case of calcium illite than kaolinite and montmorillonite.
2. Montmorillonite clay has greater cohesion than kaolinite and illite clays.
3. These tests confirm the development of shear strength with increase in effective normal stresses.
4. Calcium kaolinite or illite clays have developed higher internal angle of friction (due to particle interference or interlocking) than sodium kaolinite or illite, but is not the case for montmorillonite.

A Study of Strength Properties of Lateritic Concrete as Construction Material. DR. NATH. S. PARATE and Mr. BERNARDO POMPAU NETO, Tennessee State University.

The investigation of concrete using lateritic aggregate instead of crushed stone aggregates was investigated. The work is of particular importance due to the abundant and easy availability of such material in tropical and sub-tropical countries. The investigation was carried out as a Master's Graduate Research program at the University of Paraiba, Brazil. Laterite aggregates are used as local construction material for houses, road and highway base and subbase material in the regions of Amazonia and Northeast of Brazil particularly. The aim of this study was to make a concrete and study the tensile and compressive strengths in the laboratory. Various mix of concrete-aggregates for different water-cement ratios were studied and are discussed in this paper. The results of various tests indicate that the laterite concrete can be used or replaced in number of cases as economic viable construction material for light structures, roadbase or mass concrete. Particular importance of this investigation was for during the project of transamazonian highway construction in the Northeast of Brazil.

Effects of pH on Chromium Contamination. J. T. MASON III, Tennessee Technological University.

Research on removal of low-level chromium contamination from samples of groundwater, along with included impurities, concentrates on effects of pH. In order to find the best pH for reducing the chromium contamination by adsorption on both carbon and ion exchange resin, tests were conducted. By varying adsorbent amount, flow rate, and pH, the results showed that Duolite ES-392 worked best for the sample water at a pH of about 5.6.

Heat Transfer Within the Annular Gap Between Two Cylinders with the Inner One Rotating. W. S. LAM and E. I. GRIGGS, Tennessee Technological University.

Cooling of electric motors is just one application where knowledge of the heat transfer within the annulus between a rotating, heated cylinder and an outer stationary cylinder is needed. In an attempt to initiate some fundamental studies in this area, an apparatus has been built and preliminary tests have been performed. The arrangement included an internally heated rotor (1.5 inches O.D.), a stator (1.75 inches I.D.), and the necessary supporting equipment to measure flow rates, rotational speed and temperatures. Air was used as the fluid. To date, results involve temperature measurements across the $\frac{1}{8}$ -inch wide gap. The goal was to initially validate the equipment by checking known cases and to then extend the work to entrance-length effects. The probe used to measure the air-gap temperatures seemed to affect readings. The system thus needs to be redesigned to accommodate more accurate gap temperature measurements and to allow for rotor temperature measurements when rotation is present.

Aluminum Foils for Building Thermal Insulation. DAVID W. YARBROUGH, Tennessee Technological University.

The factors that affect the thermal performance of thermal insulations fabricated from thin aluminum foil have been studied using a one-dimensional mathematical model for heat transfer. The model is used to calculate the thermal resistance of a series of air gaps with low emissivity boundaries. The calculations include heat transfer by conduction, convection, and radiation. Calculated thermal resistances are compared with experimental measurements from three laboratories. The thermal resistance of Al foil assemblies depends on system orientation, spacing, surface emissivity, and the overall temperature difference across the system. The model is useful for determining quantitatively the effect of the above factors on thermal performance.

Compressed Natural Gas the Alternative to Gasoline. P. R. SAGGURTI and R. F. BECKMAN, Nu-Fuel, Inc., Loretto, TN, D. W. YARBROUGH, Tennessee Technological University.

Compressed Natural Gas, CNG, is being used successfully as an alternative to gasoline in trucks, busses and cars. The conversion of gasoline powered automobiles to run on CNG involves the simple addition of CNG storage cylinders, pressure regulation equipment, and ignition and timing adjustments. Systems for CNG handling and use have been designed and tested on vehicles built to use gasoline. Tests show vehicle performance comparable to that achieved with gasoline. The range of the converted automobile is extended by 100 to 200 miles by the use of CNG, giving a comparable if not a better fuel efficiency.

GEOLOGY SECTION

PHILIP KEMMERLY, *Presiding*

Tennessee Meteorites, JAMES X. CORGAN, Austin Peay State University.

Tennessee has yielded 23 definite and 2 probable meteorites. All major categories are represented. Each of these 25 rocks has been the subject of many technical accounts. Specimens from well-documented nineteenth century Tennessee discoveries were widely circulated at a time when concepts of the taxonomy and mineralogy of meteorites were just developing. For a time Tennessee specimens played an important role in shaping European thought on meteorite classification. Today, no Tennessee meteorite has special importance in widely used taxonomic schemes, but modern concepts of meteorite genesis are being challenged.

The Use of Sinkholes for Drainage, DAVID L. ROYSTER, Tennessee Department of Transportation.

Sinkholes have long been used for drainage in the design and construction of highways. Decisions for their use, however, seem to be based more on expediency than on engineering and scientific analysis. This practice has apparently resulted from the traditional notion that the processes and mechanisms of sinkhole development and proliferation are not totally analyzable and, therefore, not predictable. While it is true that investigations of sinkholes and sinkhole-prone topography rarely produce absolute and finite data that can be applied in a strict quantitative sense, there are methods of analysis that, when coupled with experience and judgment, can be used with a high degree of success. In general, these analyses require information regarding such factors as: geologic structure (joint orientation, direction and angle of dip, etc.); depth, direction of flow, and slope of the

groundwater table; thickness and makeup of the regolith; relief and topographic expression; size of area being drained by the sinkhole; location and size of swallets; and potential for further residential or commercial development.

The Sawdust Sand: Sem Evaluation. D. N. LUMSDEN and S. L. EVERETT, Memphis State University.

The Sawdust Sand (Eocene, Wilcox Group) in West Tennessee reportedly is comprised of abundant aggregate grains made up of clay floccules as well as quartz. In an attempt to verify previously published studies about the texture and origin of the floccules we studied samples from 2 locations and investigated several others. The "Sawdust" appearance is largely a consequence of a thin coating of clay on subangular, sand-sized, quartz grains; it is not a consequence of the presence of clay-aggregate grains.

The Gravity Field on the East Edge of Reelfoot Rift Near Martin, Tennessee. RICHARD G. STEARNS⁽¹⁾ and GLORIA MANSFIELD⁽²⁾, Vanderbilt University and University of Tennessee-Martin.

Bouguer gravity anomaly was determined for about 600 stations in an 8 quadrangle area between 88°45' and 89°00', and 36°00' and 36°30' in Weakley, Gibson, and Obion Counties, Tennessee. There is a spacing of about 1 mile between stations. Survey and reduction techniques permit confidence in an accuracy of better than 0.5 milligal, approaching 0.2 milligal in some cases. From these data we can claim to have discovered all anomalies larger than a mile across and with amplitude greater than 0.5 milligals. Some smaller features may well have been measured by chance.

The east edge of Reelfoot Rift is marked here (as elsewhere) by positive anomalies that coincide with airbourne magnetometer positive anomalies, and also by negative anomalies. The positive gravity and magnetic anomalies probably result from plutons intruded in the faulted edge of the Rift. The negative anomalies may mark grabens with light unconsolidated Cretaceous faulted down in grabens against denser Paleozoic carbonates.

Gravity Models on a Transverse from Dresden, TN. to Hickman, KY. RICHARD G. STEARNS, GERI ALBRIDGE, and ROBERT STEELE, Vanderbilt University.

Gravity stations about a half mile apart were set on a 30 mile long line along Tennessee Highway 22 and Kentucky Highway 5. This line trends northwestward across the zone most likely to contain the east edge of Reelfoot Rift. An aeromagnetic map and regional structure maps of the top Paleozoic and top basement exist for the area containing this section line. Preliminary models were made by assuming simple geometric forms for gravity (horizontal cylinders and spheres) to estimate maximum depth from which the anomalies are likely to come. These depths were compared with the mapped depths of top Paleozoic and top basement, as well as Peter's half slope depths for magnetic anomalies. These previous structure estimates, and gravity and magnetic models were used as constraints to develop a more realistic two dimensional interpretation using blocks with steep boundaries to represent faults. Interpretations continue, but we can conclude now that some gravity anomalies are consistent with faulting of the top Paleozoic surface where a density contrast of 0.6 gm/cm³ would result in the observed anomalies.

Chronostratigraphic Principles and Procedure. LARRY W. KNOX, Tennessee Technological University.

In recent years significant progress has been achieved toward the establishment of common internationally acceptable stratigraphic terminology and rules of stratigraphic procedure. The International Stratigraphic Guide incorporates recommendations on principles, terminology, and practice in stratigraphic classification. Some geologists may be unaware of some of the implications of the International Guide for the definition and recognition of chronostratigraphic units. One problem sometimes encountered in geologic literature is blurring of the distinction between chronostratigraphic units and biostratigraphic units. Chronostratigraphic units depend on designated boundary or unit stratotypes for their definition. Some biostratigraphers have apparently transferred the prime criterion for the definition of chronostratigraphic units from stratotypes of established biostratigraphic zones. Examples of "correct" and "incorrect" application of stratigraphic terminology and procedure will be illustrated with examples from the Carboniferous of Oklahoma, Kentucky, and Tennessee.

Stream Autopiracy near Window Cliffs, Putnam County, Tennessee. H. H. MILLS, F. R. BOGLE, K. B. CARTER, and L. W. KNOX, Tennessee Technological University.

North of its junction with Falling Water River, Cane Creek flows through a meandering valley cut into the Ft. Payne Formation. The narrow neck of one ingrown meander has two natural bridges and is known as Window Cliffs. Immediately upstream another meander has migrated westward until it is separated from a tributary, Phelps Branch, by a narrow divide. Because Phelps Branch is graded to a downstream reach of Cane Creek about 20 m lower than the encroaching meander, it is lower than the main stream at the point of encroachment. Thus, removal of the divide will result in Cane Creek being "captured" by its own tributary, thereby abandoning a reach of stream that includes Window Cliffs. In fact, sub-

terranean diversion is already in progress, as water from Cane Creek flows through a cave in porous limestone and emerges as a spring feeding Phelps Branch. Similar diversion appears unlikely at Window Cliffs itself, for bedrock near stream level here is insoluble silicstone. Hence, the meander neck at Window Cliffs probably never will be cut through, for Cane Creek will be diverted at a point upstream before that can occur.

The Adams, Tennessee, Magnetic Anomaly. PHILIP R. KEMMERLY, Austin Peay State University.

The standard geophysical techniques of horizontal magnetic gradient analysis and second derivative mapping were applied to a prominent elliptical magnetic anomaly in northeastern Montgomery County near Adams, Tennessee. The positive magnetic anomaly, labeled the Adams Magnetic High, appears to be a roughly rectangular rock body measuring 9.5 km by 6.5 km. Magnetic susceptibility estimates average 0.0043 cgs units. Depth estimates to the magnetic anomaly average 2.3 km below sealevel and are consistent with published data on depth to magnetic crystalline basement for the region.

A mafic pluton with a lower than average magnetic content is proposed for the Adams Magnetic High based on both magnetic and gravity data. Gravity data suggest an effective density contrast between the silic crystalline basement and the Adams anomaly in the range of 0.1 - 0.2 g/cm³.

MEDICAL SCIENCES SECTION

DENISE PAU, *Presiding*

The Mobilization of Intracellular Cadmium Deposits Under the Influence of Dithiocarbamates. MARK M. JONES, SHIRLEY G. JONES and LESLIE A. SHINOBU, Vanderbilt University.

Dithiocarbamates are effective antidotes for both acute and chronic cadmium intoxication in mice. Unlike other chelating agents, with dithiocarbamates the antidotal efficacy does not drop off rapidly as the time interval increases between the administration of the cadmium and that of the antidote. In chronic cadmium intoxication, dithiocarbamates can mobilize cadmium from intracellular deposits in the kidney and liver which are two or more weeks old. Structure-activity relationships indicate that the most effective dithiocarbamates are those in which groups of modest polarity are attached to the nitrogen atom.

Chelate Antidotes for Gold (Sodium Bis(thiosulfato) gold (I) Intoxication in Mice. MARK A. BASINGER, MARK M. JONES, WILLIAM M. MITCHELL, ROBERT L. FORTI and STEPHEN J. GIBBS, Vanderbilt University.

As study of the relative efficacy of various chelate antidotes for acute gold intoxication in mice (200 mg Na₃[Au(S₂O₃)₂]-2H₂O/kg, i.p.) showed that 2,3-dimercaptosuccinic acid (DMSA) was the most effective in terms of survival rates. D-penicillamine appeared to hasten death in some animals in comparison to the behavior observed in control animals. DMSA is also effective in preventing much of the kidney pathology characteristic of gold intoxication. Gold levels in the kidneys of control animals were around 900 ppm. In animals treated with DMSA, these levels were reduced to about 100 ppm.

Fine Structure of Ciliated Odontoblasts in Plethodon cinereus (Green). J. D. MOURY, D. I. PAV, and J. L. ROBERTSON, East Tennessee State University.

During an extensive investigation of the cytomorphology of mature and developing teeth in *Plethodon cinereus* (Green), a terrestrial salamander found in eastern Tennessee, transmission electron micrographs revealed some odontoblasts with unusual characteristics. These cells, which were located in the pulp cavities of both mature and developing teeth in the parasphenoid patches, exhibited well-developed basal bodies and cilia. It appears that the cilia possess the characteristic 9 plus 2 arrangement of microtubules. Fine structure and the significance of these cells is discussed.

Carcinogen and Mutagen Induced Histone Modification. R. DEAN BLEVINS and VALENTINE O. WAGNER, III, East Tennessee State University

Chromatin was extracted from human skin fibroblastic cell nuclei. From the chromatin pellet histone was extracted with 0.4 N H₂SO₄ and precipitated with 95% ethanol. The extracted histones were electrophoresed on 18 cm, 15% polyacrylamide gels with 2.5 M urea for 24 h at 200 V. The gels were stained in amido black, and the histones were quantitated by densitometry at 600 nm. Using the arcsin transformation, the proportion of modified histone for each modified histone fraction was analyzed by two-way analysis of variance. A positive histone modifier was indicated by a significant difference in the proportion of modified histone in any histone fraction after any exposure period. 1,3-Propane sultone was identified as a histone modifier. It induced significant changes in the modification patterns of H3 (P<0.05) and H4 (P<0.025) after 24 h. After 12 h, H4 showed a significantly altered histone modification pattern (P<0.05). Carbon tetrachloride was also identified as a histone modifier. Histone H1 was signifi-

cantly modified (P<0.001) after 24 h; whereas, after 3 h, H3 was significantly modified (P<0.001). After 3 h, 1-naphthylamine induced a significant change in the H4 pattern (P<0.005). These results correlate well with the carcinogenicity data, indicating that with further study and verification, induced histone modification may be a reliable means of predicting chemical carcinogenicity.

Mitomycin-C in Non-Oat Cell Carcinoma of the Lung: Analytical Methods Development and Pharmacokinetic Analysis. BILL J. GURLEY and ROBERT G. BUICE, University of Tennessee Center for the Health Sciences.

A reversed-phase liquid chromatographic method is presented by which the cancer chemotherapeutic agent mitomycin-C may be measured in human serum. A mobile phase of methanol/water (35/65) passed through a μ -Bondapak C-18 column at 1.0 ml/min produced a sharp, symmetrical band for mitomycin-C. Extraction from serum using a C-18 sample preparation cartridge proved efficient and reproducible. Recovery at 10-100 ng/ml was 81.6% with between-day precision = 4.6% (N=5). Within-day precision at 50 ng/ml was 5.6% (N=10). UV detection (365 nm) was sensitive to 10 ng/ml. The disposition kinetics of mitomycin-C were studied in six male patients receiving mitomycin-C in combination with cisplatin and vinblastine for non-oat cell carcinoma of the lung. Following rapid intravenous administration of mitomycin-C (10 mg/M²), serum concentration time course data were biexponential with relatively short biologic half-lives (46.2 \pm 12.1 min, mean \pm SD). Findings suggested extensive distribution (V_{area} = 656.8 \pm 169.8 ml kg⁻¹, mean SD) and rapid elimination (total body clearance = 10.3 \pm 3.2 ml kg⁻¹ min⁻¹, mean \pm SD). Interpatient variations in pharmacokinetic parameters were relatively small, suggesting that close monitoring of mitomycin-C therapy might be unnecessary in patients with normal renal and hepatic function.

Effects of Total Body Irradiation Followed by Bone Marrow Transplantation on the Pharmacokinetics of Methotrexate in the Rat. SUSAN E. MCALPIN, and ROBERT G. BUICE, University of Tennessee Center for the Health Sciences.

The effects of total body irradiation (TBI) followed by bone marrow transplantation (BMT) on the disposition kinetics of methotrexate (MTX) have been studied using the rat as an animal model. Eight test animals received 1000 rads TBI (8 rads/min) and eight controls were manipulated in an identical manner with the source shielded. Each test animal received an intravenous suspension of 3 x 10⁸ bone marrow cells per kg body weight and each control was given an equal volume of blank suspension medium. On the following day each animal received MTX (25mg/kg) by rapid intravenous injection and serial blood samples were obtained for 3 hrs. Serum MTX concentrations were measured by HPLC and pharmacokinetic parameters were calculated after NONLIN analysis of data. Longer biologic half-lives in test animals were largely due to increased volumes of distribution as total body clearances were not significantly changed. These findings suggest a radiation-induced increase in extent of distribution with possibly a slight alteration of elimination kinetics.

Effects of Amobarbital and Guthion on Leucocyte Differential. ALEXANDER C. WELLS and JOHN STEWART, Tennessee State University.

Pharmacodynamic interactions with amobarbital, guthion, atropine sulfate and atropine methylbromide have been investigated in Sprague-Dawley male rats. Varying dosages of each drug were given to groups of rats intraperitoneally (i.p.). Dose range for the guthion was 1-10 mg/kg. The dose range for the other experimental agents were between 20-120 mg/kg based on the ED50 and LD50, respectively. A leucocyte differential was performed on each animal of each group and the final value was expressed as the mean value representative of the group. The cells were stained with Wright's rapid stain following the same procedure for all groups for continuity of attained data. The percent of each cell was determined based on 100% total cell count and the values from each group of treated animals were compared to the values of the determined control animals which were subjected to physiological saline solution. These resulting values were compared using student "T" tests, standard deviation and the standard error of the mean. Conditions of leucopenia, leucopenia and pathology of the cells were associated with various dosages of the chemical agents used. (Aided by: an Office of Navy Research Grant - Department of Navy and MBRS awarded to Alexander C. Wells, Sr.)

Formed Blood Elements Changes Produced in Rats by Guthion or Amobarbital. ALEXANDER C. WELLS and CYNANE A. Y. ROBINSON, Tennessee State University.

This investigation was undertaken to determine the effect of guthion and amobarbital on formed blood elements in young adult, Sprague-Dawley male and female rats weighing 100 to 130 grams. Experimental animals were administered varying dosages of guthion intraperitoneally (i.p.) on a daily basis for five (5), fifteen (15) and twenty-five (25) days at 4, 6 and 8 mg/kg to groups of five rats. Control animals received normal saline in a volume of 0.01 ml/g body weight. Animals were sacrificed by cervical

dislocation and the thorax was opened. Blood for hematological measurement was drawn from the heart with the help of a syringe. The blood was placed in EDTA tubes and assayed immediately. Peripheral blood counts of red blood cells (RBC), white blood cells (WBC), platelets (PLT), hematocrit (HCT), and hemoglobin (HGB), were determined with a Cell-Dyn 800. Mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC) were calculated from the hematocrit. The pesticide guthion caused a significant increase in all hematological parameters investigated in the male rats, while in the female rats there was a significant decrease in all parameters. (This study was supported by a grant from the Office of Naval Research awarded to A. C. Wells, Sr.)

PHYSICS AND ASTRONOMY SECTION

JOHN HANNEKEN, *Presiding*

Development of a Trench Water Balance Model. C. J. EMERSON and D. E. FIELDS, Oak Ridge National Laboratory

The Presto code has been developed to model the migration of low level radionuclides from a shallow land burial trench. An important pathway that the model considers is the leaching of nuclides from the trench to the aquifer below. The level of water in the trench and hence the amount of nuclide exposed to water is an important aspect of leaching. Several approaches to trench water balance were tried before the present one was chosen.

Disposal of De Minimis Levels of Radioactive Wastes. D. E. FIELDS and C. J. EMERSON, Oak Ridge National Laboratory.

The U.S. Nuclear Regulatory Commission is currently preparing a revision of rule 10 CFR part 20, which covers disposal of solid wastes containing *de minimis* quantities of residual radionuclide activities. In support of this rule, we have evaluated the consequences (human exposures and associated health effects) of disposing of four waste streams at four types of disposal areas located in three different geographic regions. The PRESTO methodology was used to evaluate radionuclide transport and health effects. The specific climate and geology of each geographic region were taken into account. Example waste streams, waste disposal methods, and geographic regions chosen for this study are clearly specified. Monetary consequences of *de minimis* waste disposal are briefly discussed. The proposed NRC radiation protection standard 10 CFR part 20 defines *de minimis* wastes as being those which will result in members of the public receiving individual doses of no more than 0.1 mrem/y from ionizing radiation. Simulated individual doses for the representative waste streams considered in this study were less than this amount for all disposal scenarios, except for dispersion in the general (aquatic) environment.

Solid State Radiation Chemistry of Caffeine. M. SHAH JAHAN, Memphis State University.

Single crystals of caffeine, when X-irradiated ($\sim 10^3$ Gy) at 77K, produce at the same temperature, an intense phosphorescence of wavelength centered around 517 nm, which lasts for about one hour. After irradiation at 77K, when the temperature of the crystal is increased from 77K to 300K (with heating rate of 0.05 K/s), a broad glow curve is produced with well-defined peaks at 102, 138, 158 and 198 K. The 102K glow peak is characterized by a single emission band whose maximum occurs at 517 nm. The other three glow peaks also exhibit the 517 nm band, but in addition, two other well-resolved maxima are seen at 410 and 493 nm. Thermal activation energies and frequency factors of all peaks are determined to be: 102K (0.08 eV, 2.75×10^4 s $^{-1}$), 138K (0.04 eV, 6.58×10^2 s $^{-1}$) and 158K (0.09 eV, 2.05 s $^{-1}$). Ultraviolet (UV) photobleaching experiments conducted at 77K demonstrated that the 102K peak can be readily photobleached, whereas the other glow peaks are unaffected. Photo-de-excitation of the thermally stimulated luminescence (TSL) suggests that the glow peak at 102K could be associated with an ionic free radical species. Similar observation was made by Cooke, D. W. and Alexander, C., Jr. *J Chem. Phys.* 65, 36515-3619(1976).

Antireflection Coatings for Silicon Solar Cells. MARY C. LU, Walters State Community College and Oak Ridge National Laboratory.

The antireflection coating is one of the most important parts of a solar cell design. Since most semiconductors have a high refractive index, a high reflectance is associated with it. In the case of silicon, if the reflectance as well as the absorption could be reduced to zero, the transmittance of the sunlight would increase from 70% to 100% in the infrared region and from 50% to 100% in the ultraviolet region. Therefore, low cell reflectance calls for antireflection coating. The significant improvement of the efficiency of Si solar cells has been realized by applying antireflective coatings on the cell surface with the proper choice of refractive indices, film thickness, and number of films. The dielectric optical film must have low absorption. In this paper, a survey of dielectric and semiconductor coating materials is presented. In addition, the methods of applying single layer and multilayer antireflection coatings as well as the determination of the refractive index and thickness of a transparent film are also discussed.

Non-Linear Electrical Conduction in NbSe₃ and TaS₃. GUEBRE X. TESSEMA, Memphis State University.

Materials with one-dimensional crystal structure undergo structural phase transitions when their temperature is lowered below a critical temperature. This structural phase transition is followed by the formation of an electronic charge density wave (CDW). We present the peculiar electrical transport properties observed in two such materials, NbSe₃ and TaS₃. Non-ohmic conductivity, dc-induced ac currents and long-term memory effects are among the striking phenomena to be discussed. These properties are explained in light of the classical phenomenological model of the CDW.

An Equilibrium Electrochemical Probe for Nondestructive Determination of H in Metals. JOHN W. HANNEKEN, DONALD R. FRANCESCHETTI and STEPHEN I. SHEFSKY, Memphis State University.

A nondestructive electrochemical method for determining the local hydrogen activity near the surface of a small region of a metal sample will be described. The method is based on the concentration cell: Cu' | Me'H_x (reference) | H⁺ conductor | Me''H_y (sample) | Cu''. The half cell Cu' | Me'H_x (reference) | H⁺ conductor is contained in a movable probe designed so that the H⁺ conductor is in contact with a small portion of the sample surface. The hydrogen activity in this region is determined from the open-circuit potential. Probes using three different proton conductors were investigated: 0.1N HCl - KCl, hydrogen uranyl phosphate (HUO²PO₄•4H₂O) and Nafion. Measurements of the hydrogen concentration profile along a Pd wire sample using probes will be presented. Research supported by grants from American Chemical Society Petroleum Research Fund and Research Corporation.

Superfluid Helium Flow Through Porous Plugs for Space Science Applications. FRANKLIN CURTIS MASON, Middle Tennessee State University.

The need for cryogenically cooled experimental space science apparatus has brought about the development of techniques for utilizing superfluid helium as the primary cryogen for producing the desired cooling. In attempting to flow through the small pores of a porous metal plug, evaporation on the vent (downstream) side causes cooling to occur, resulting in a small temperature gradient across the plug. This gradient in turn gives rise to a thermomechanical pressure gradient, directed upstream, which restrains the helium flow. Thus the porous plug acts as a passive flow control device for superfluid helium. As a background for the study of the true nature of superfluid helium flow through porous plugs for space science applications, this paper describes research performed in the summer of 1983 at the George C. Marshall Space Flight Center in Huntsville, Alabama in conjunction with a Summer Faculty Fellowship Grant awarded the author by the National Aeronautics and Space Administration. In the research being reported on here, several porous plugs were tested. The pore size associated with each plug was measured by the so-called bubble test. The number of flow channels in the assumed parallel channel model of Kozeny was determined from data on the flow of warm helium gas through the plugs. Tests on the flow of superfluid helium through the plugs were also performed. An obvious feature of these tests was that for temperatures below approximately 2.10 K, the data for isothermal flow rate versus ΔP separated into two distinct flow regimes, thus confirming the previously observed presence of a critical phenomenon, with the accompanying critical mass flow rate appearing clearly in the data. As a final step in the research, calculations based on the parallel channel model were made for the low temperature flow, and these were then compared to the actual data. Qualitatively, there was favorable agreement, but the quantitative comparison was not too good. This was to be expected, due to the complex nature of porous plugs in conjunction with the more complex behavior of superfluid helium.

Acknowledgment for the above research opportunity is given to the NASA/ASEE Summer Faculty Fellowship Program at the Marshall Space Flight Center, Huntsville, Alabama.

SCIENCE-MATH TEACHERS SECTION

WILLIAM PAFFORD, *Presiding*

Separation and Detection of Caffeine, Nicotine, Acetaminophen, and Quinine A Thin-Layer Chromatography Experiment for the Freshman Chemistry Laboratory. JUDITH M. BONICAMP, Middle Tennessee State University.

Researchers and technicians in all branches of science apply thin-layer chromatography to separation problems. We believe that no student should go through an introductory chemistry course without completing at least one TLC experiment. TLC is a commonplace analytical tool for separating and identifying drugs. Because of the considerable time expended and certain procedural complications, drug detection with classical TLC is inappropriate for freshman chemistry laboratories. Instead, we used Toxi-Lab®, a simplified and accelerated TLC kit for drug detection. The commercial TLC method has advantages over classical TLC as an educational

tool: color reactions with four reagents, insertable sample application discs, and prestandardized chromatograms. All 50 students reported their unknowns accurately, an unusual result in our laboratories for any experiment. The students liked using a commercial product currently employed in clinical laboratories for drug detection. Many said it was the most interesting experiment of the course.

Good Students by Definition. ROY W. CLARK, Middle Tennessee State University.

This is a report on the successes and humorous failures of the practice of requiring physical science students to define terms in complete English sentences. All of my tests begin with ten words or phrases to be defined, since understanding words is primary to understanding science. Poor logic, linguistic confusions, and blind memorization result in some revealing definitions. The grading and the interpretation of these results is discussed. The message is that we must get away from the multiple choice test to a type of testing which requires students to compose logical thoughts on paper. This is just as important in science as in any other field.

The "Genesis Act"—Ten Years Later. GEORGE E. WEBB, Tennessee Technological University.

In 1973, the Tennessee legislature overwhelmingly passed the first statute based on the concept of "scientific creationism." Although struck down as unconstitutional by federal courts two years later, the so-called "Genesis Act" set the stage for further attempts to weaken the presentation of evolution in public schools. Despite a significant amount of publicity, the creationists have only recently achieved success, securing "equal time" laws in Arkansas and Louisiana in 1981. In both cases, federal courts overturned these statutes on constitutional grounds. The Arkansas case, *McLean v. Arkansas Board of Education*, is particularly instructive in that the court focused on the establishment clause of the First Amendment. A survey of the creationists' campaign over the past decade provides a concise overview of the constitutional issues involved, and suggests that future creationist attempts will focus on the local level.

Construction of the Biology Section of the Dental Admissions Test. J. R. FREEMAN, The University of Tennessee at Chattanooga.

From 1979 through 1981 the test items of the biology section of the DAT were constructed or selected by a three-member committee of university biology teachers under the guidance of professionals in the testing division of the ADA. Analyses of the tests showed a high degree of reliability of the 40 items in each of the versions of the DAT given in 1979 and 1980. Scores ranged from zero to forty correct and their distribution formed a bell curve. Reasons for the relative successes of the DAT and other national tests are proposed.

Biofeedback: An Aid To Reducing The Anxiety of Test Taking, An Update. MARTHA W. STRATTON, Tennessee State University.

Biofeedback is the process of reflecting psychological and physiological information back to a biological system by way of mechanical equipment that monitors internal activities. According to several researchers, every mental event that occurs is correlated to a muscle event. Therefore, it is safe to say that practically all internal physiological activities can be monitored, analyzed, and interpreted with the results being used to illuminate the situation. Anxiety can be defined as a particular state of expecting danger or preparing for it whether it is apparent or not. Many researchers have proposed various ways of reducing or eliminating anxiety; among these are progressive relaxation, meditation, and biofeedback. In order to identify factors that contribute to anxiety prior to test taking situations a log was devised, and is completed by students in a basic science course two (2) to five (5) days prior to an examination. After data is collected it is computerized and analyzed, which eventually will provide clues as to how to remedy anxiety prone situations.

Animal Cell Cultures. GENE VREDEVELD, University of Tennessee at Chattanooga.

For students in high school and freshmen in college to appreciate that cells of animals can live and grow outside the body of the animal is a real revelation. Once they realize that this is possible, they can begin to understand the basis for much of the present study of viruses, the technique for karyotyping and the possibility of producing interferon. A simple method will be shown of a primary cell culture (chicken embryo) which can be done by any high school A.P. teacher.

ZOOLOGY SECTION

DAVID KESLER, *Presiding*

*Acute Toxicity of p,p'-DDT, p,p'-DDD, and p,p'-DDE to the Freshwater Planarian (*Phagocata gracilis*).* JAMES C. BONNER and MARION R. WELLS, Middle Tennessee State University.

The purpose of this study was to evaluate the lethality of p,p'-DDT and its metabolites using a representative organism from an aquatic system.

Acute toxicity studies were conducted to determine the LC₅₀ (mean lethal concentration) values for *Phagocata gracilis*. Planarians were treated with a series of test concentrations for each organochlorine insecticide, using acetone as the carrier solvent. In preliminary tests, planarians treated with sublethal concentrations were homogenized and the supernatant layer extracted. Samples were analyzed by gas chromatography. The results show that the insecticides were present in the tissue and that p,p'-DDT was converted to p,p'-DDE and p,p'-DDD. The toxicity tests indicate that p,p'-DDD is the most toxic, while p,p'-DDT is the least toxic. The ability of planarians to tolerate relatively high concentrations of p,p'-DDT suggests a problem of biological magnification in the environment.

*Morphologic Variation in the Raccoon (*Procyon lotor*).* MARK E. RITKE, Memphis State University.

Patterns of morphologic variation were assessed in a sample of raccoons (*Procyon lotor*) collected from Land Between The Lakes in Stewart County, Tennessee, and Lyon and Trigg counties, Kentucky. Twenty-one skull characters were measured and analyses involved univariate and multivariate statistics. Specimens were assigned to one of four age classes: 1 (4-14 mo), 2 (14-26 mo), 3 (26-38 mo), 4 (> 38 mo). Males in age classes 2, 3, and 4 differed significantly for only one character; there were no significant differences between these three age classes of females. Females were found to be more variable than males in three of four age classes (1, 3, 4). Additionally, characters were more strongly correlated in females for the same three age classes. Sexual dimorphism was prominent with males being larger for all characters in all age classes. Width of upper canine and rostral width provided the strongest discrimination between the sexes.

Relationship of Opossum Demography to Scent-Station Indices. PAUL L. LEBERG, MICHAEL L. KENNEDY, and RONALD A. VAN DEN BUSSCHE, Memphis State University.

Population characteristics of the opossum (*Didelphis virginiana*) were studied in western Tennessee during April 1982-May 1983 using scent stations and removal trapping. A density estimate of one opossum per 15.6 ha was found in upland habitat on the Hatchie National Wildlife Refuge, during March 1983. Yearlings made up 64% of the captures. Sex ratios for both adults and pouch young were approximately 100:100. Mean litter size was 8.8 young, and most litters were born in early February. Scent-station indices reflected trends in opossum population abundance and habitat preference.

*Passage of Selected Heavy Metals From *Sphaerotilus* (Bacteria: Chlamydo-bacteriales) To *Paramecium Caudatum* (Protozoa: Ciliata)* MANSOUR MANSOURI-ALIABADI and RALPH E. SHARP, Middle Tennessee State University.

Sphaerotilus, a bacterium occurring in polluted waters, was found to concentrate Zn, Pb, Ni, and Mn. Metal-concentrated cultures of this bacterium were employed to feed the protozoan *Paramecium caudatum*, and analytical results revealed the accumulation of Zn, Pb, and Ni. Since *Sphaerotilus* was the only food source or paramecia during this study, the results indicate that trace amounts of metals were passed from bacteria to Protozoa in a predator-prey relationship.

*A New Melanistic Population of *Perognathus intermedius* (Rodentia: Heteromyidae) from the Pedro Armendariz Lava Field of New Mexico.* FLOYD W. WECKERLY, Memphis State University.

An undescribed population of *Perognathus intermedius* on the Pedro Armendariz Lava Field in Sierra and Socorro counties, New Mexico, was documented and studied in relation to nearest off-flow population and extent of geographic variation. Four external and 12 morphometric characters were used to assess geographic variation. The closest population geographically exhibited the greatest similarities to Pedro Armendariz specimens; more distant populations displayed lesser similarities. Pedro Armendariz *P. intermedius* were found to be melanistic and morphologically smaller than individuals from a nearby population.

Helminth Parasites of Western Tennessee Coyotes. RONALD A. VAN DEN BUSSCHE, Memphis State University.

Hearts and digestive tracts of 141 coyotes, *Canis latrans*, were examined for helminth parasites; Six species were found which included one cestode and five nematodes. Species determined and percent occurrence were: *Dirofilaria immitis* (41.8%), *Physaloptera rara* (43.3%), *Taenia pisiformis* (65.2%), *Trichuris vulpis* (54.2%), *Ancylostoma caninum* (57.4%), and *Toxascaris leonina* (9.2%).

*Genic Variation in the Raccoon, *Procyon lotor*.* MEREDITH J. HAMILTON, Memphis State University.

Genic variation was examined with starch gel electrophoresis in raccoon (*Procyon lotor*) populations from Tennessee, Illinois, Oregon, Washington, and Wisconsin. Using liver and kidney samples, 21 protein systems were examined. Nineteen were found scoreable; 25 structural loci (presumptive) encoded the scoreable systems. Malate dehydrogenase, peptidase, and phosphoglucosmutase are reported as polymorphic systems in raccoon for the first time in specimens from Tennessee.

Circadian Pattern of Transferrin in Mus musculus. W. J. LAMOREAUX and P. S. RUSHTON, Memphis State University.

Serum containing transferrin, a β -l-glycoprotein that transports diferric iron from sites of absorption in the duodenum to areas of iron utilization, was tested for the total iron-binding capacity (TIBC) in *Mus musculus* at three hour intervals. The TIBC measurement allows for the determination of the amount of transferrin protein present in the plasma. Preliminary data indicate a peak at 2300 hours and a trough at 1400 hours, based upon the arithmetic mean for the given times. Analysis of TIBC was done using the micromethod of Caraway (1963). These results conflict with the report of Schade, et. al. (1981) as they reported a peak at 0200 hours and a trough at 1800 hours in the rat. However, the peak occurs in the dark cycle in both the mouse and the rat.

Water Mites (Genus Arrenurus, Subgenus Megaluracarus) in Tennessee. JAMES L. WILSON, Tennessee State University.

The eighteen species of the Subgenus *Megaluracarus* that have been collected in Tennessee will be discussed with relation to their taxonomic characteristics and distribution in Tennessee.

The Herpetofauna of Barnett Woods Natural Area (Montgomery County, Tennessee): A Preliminary Report. A. FLOYD SCOTT, Austin Peay State University.

Barnett Woods Natural Area is a 40-acre, mostly wooded, tract owned by the Nature Conservancy in Montgomery County, Tennessee. Thirteen monthly samples of the herpetofauna of this site during the frost-free periods of 1982 and 1983 yielded 179 records (146 amphibian, 33 reptilian) representing eight families (four amphibian, four reptilian) and 23 species (14 amphibian and nine reptilian). No unexpected species were found. Amphibians were abundant and widely distributed in both aquatic and terrestrial habitats. They were best represented by the following species: *Eurycea longicauda*, *Plethodon glutinosus*, *P. dorsalis*, *Desmognathus fuscus*, *Acris crepitans*, and *Rana palustris*. Reptiles were comparatively scarce in all environments. *Terrapene carolina* was the only reptilian species encountered with regularity. Of the 11 major habitat types on the area, intermittent streams yielded the most records (51) and species (17); old fields yielded the least (two records representing two species). The herpetofauna of Barnett Woods appears typical of that already described for the more dissected portions of the northwestern Highland Rim of Middle Tennessee.

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THE REPEAL OF THE BUTLER ACT

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ABSTRACT

Because of the publicity surrounding the famous Scopes Trial in 1925, Tennessee has long been associated with the militant antievolution sentiment of the 1920s. Frequently overlooked, however, is the continuation of the state's antievolution statute (the Butler Act) for four decades after the Scopes Trial. Despite occasional attempts to repeal the discredited legislation, no significant gains were made until early 1967. A court case in Knoxville and a concerted repeal effort in the General Assembly combined to focus attention once again on the Butler Act. The crucial element in the ultimately successful repeal effort surfaced in mid-April, when the Campbell County School Board dismissed Gary L. Scott, a high school science teacher, for mentioning evolution in class. Scott's decision to press legal action, and the national publicity his dismissal attracted, cleared the way for the deletion of the Butler Act from the Tennessee Code in May of 1967. The difficult path to the repeal of the nation's most famous antievolution legislation clearly shows the persistence of opposition to Darwinian concepts, and helps to explain the recent growth of "scientific creationism."

HISTORICAL INTRODUCTION

During the past decade, the long-standing controversy surrounding the teaching of evolution in public schools has again erupted. Now characterized as "scientific creationism," antievolution sentiment has gained widespread popular and political support. Creationists in Arkansas and Louisiana have convinced their legislatures to pass so-called "equal time" laws, requiring the teaching of both the creationist and evolutionist accounts of life's origins and development. The attention focused on creationism, however, has obscured the success of the earlier antievolution legislation associated with the religious fundamentalism of the 1920s. In Tennessee, the most famous of these acts remained in force until 1967. Even at this late date, the repeal of the Butler Act was only accomplished as a result

of extraordinary circumstances, including the very real threat of another Scopes Trial.

Following the First World War, the United States experienced many jarring changes. Traditional values appeared to be in a state of flux, with ideas such as Freudian psychology, contraception, and moral relativism threatening long-held beliefs. Although all segments of the American population recognized these changes, conservative Protestant groups (fundamentalists) proved particularly susceptible to the reaction against all that was new. In their campaign to reestablish traditional American virtues, fundamentalists emphasized the importance of public education through which young people would learn their proper place in the natural order and reject dangerous modernist tendencies. Yet much work needed to be done before "proper" education could be established. To their horror, fundamentalists found America's public schools contaminated by the same modernist tendencies they hoped to overturn. Chief among these, and most dangerous in the anti-modernists' minds, was the insidious doctrine known as Darwinism.

TENNESSEE AND THE ANTIEVOLUTION MOVEMENT

As a "Bible Belt" state, Tennessee became one of the foci of the antievolution crusade. Important fundamentalist leaders, such as William B. Riley (president of the World's Christian Fundamentals Association) and William Jennings Bryan, visited the state during the early 1920s to encourage antievolution sentiment. By January of 1925, antievolution had become an important political issue, leading members in both the House and Senate to introduce bills to outlaw the teaching of evolution in Tennessee's public schools. The bill ultimately enacted into law was the work of Representative John Washington Butler of Macon County. A resident of an overwhelmingly rural county with a white illiteracy rate of 22%, Butler shared most of the beliefs associated with southern rural fundamentalism and held membership in the Primitive Baptist Church. His proposed legislation sought to prohibit public school teachers from

instructing their students in "any theory that denies the story of the Divine Creation of man as taught in the Bible, and to teach instead that man has descended from a lower order of animals." Butler's bill gained easy passage in both houses, with fewer than a dozen legislators in opposition. Governor Austin Peay signed the Butler Act and returned it to the Assembly on March 22. Commenting on his action, Peay doubted the law's application, and opined, "Nobody believes that it is going to be an active statute." (Bailey, 1950).

Governor Peay, of course, proved incorrect in his assessment of the Butler Act's impact. Less than four months after the bill became law, much of the world's attention focused on the rural hamlet of Dayton, Tennessee, where a local high school teacher, John Thomas Scopes, was on trial for teaching evolution. The details of the famous Scopes Trial are well known. The jury reached the logical verdict and found Scopes guilty of violating Tennessee's antievolution law. Judge John T. Raulston assessed the minimum fine of one hundred dollars, a sum promptly paid by the *Baltimore Sun*, who had sent H. L. Mencken to cover the trial. As expected, defense counsel appealed the decision, hoping to use the Scopes case as a test of the Butler Act's constitutionality (deCamp, 1968).

The two-day hearing before the Tennessee Supreme Court began in Nashville on May 31, 1926. In contrast to the proceedings in Dayton, *Scopes v. State* was marked by solemnity and a narrow focus on the constitutionality of the Butler Act. Even Clarence Darrow presented his arguments quietly, emphasizing that the antievolution legislation was distinctly unneutral in religion and constituted a danger to the free pursuit of knowledge. Although arguments ended on June 1, the court did not issue its decision until January 15, 1927. The court majority found that the Butler Act represented a legitimate exercise of legislative power and was, in every respect, a constitutional statute. The court went on, however, to overturn Scopes' conviction on a technicality, which the judges discovered on their own. The Tennessee Constitution (Article VI, Section 4) required that a jury impose all fines greater than fifty dollars. By levying a fine of twice that amount, Judge Raulston had violated the Constitution. The court urged that the case be ended at this point, a course of action suggested and followed by the Attorney General (DeLozier, 1969).

AFTERMATH OF THE SCOPES TRIAL

The Scopes Trial has traditionally been seen as the beginning of the end of militant antievolution sentiment. Because the case ended at the state level, however, the U.S. Supreme Court never addressed the question of the Butler Act's accordance with the federal Constitution. More important for Tennessee, the teaching of evolution remained illegal in the state's public schools. Admittedly, many science teachers ignored the law with impunity, but fundamentalists frequently employed the Butler Act to make local school officials proceed cautiously in matters of science education. On the national level, the Scopes Trial had an even more profound effect. In an attempt to keep sales at a profitable level, biology textbook publishers expunged almost all references to Darwinian evolution from their texts. Until the late 1950s, with the introduction of the federally sponsored Biological Sciences Curriculum Study series, American science education remained distinctly non-Darwinian (Grabner/Miller, 1974).

Attempts to correct the situation in Tennessee by repealing the Butler Act continued during the four decades following the Scopes Trial. These attempts met the firm resistance of political and religious leaders who forcefully argued that the repeal of Tennessee's antievolution statute would threaten the moral fiber of the state. Although frequently held up to ridicule in the scientific and popular press, Tennessee remained firm in its official acceptance of the Genesis account of the creation and development of terrestrial life (Nelkin, 1977).

THE FATE OF THE BUTLER ACT

This bizarre situation slowly began to change in early 1967. On the morning of January 13, Knoxville attorney Martin Southern filed in Knox County Chancery Court a bill for declaratory judgment on behalf of his fourteen year old son Thomas, seeking to have the Butler Act declared unconstitutional. The complaint argued, among other points, that the act attempted to establish a state religion (Protestant fundamentalism), abridged freedom of speech, compromised freedom of the press, and denied without due process Tennessee citizens' right "to a normal and customary education in the sciences." Southern's complaint also emphasized that the antievolution statute forced conscientious teachers to "bootleg" evolution into their classes, creating disrespect for both the law and government. Chancellor Len G. Broughton took the matter under advisement (Southern, 1967).

The fate of the Butler Act soon became far more than an isolated court case in Knoxville. On March 1, Representatives D. J. Smith (Memphis), Charles Galbreath (Nashville), and Harold Bradley (Nashville) introduced House Bill 48 to repeal the Butler Act, which was placed on the calendar for Wednesday, April 12. Debate proved extremely emotional, particularly on the part of opponents of the repeal effort. Representative W. A. Richardson of Columbia, for example, argued:

We will bring chaos to the hearts and minds of the young if they believe they are just another type of animal. . . .

They [proponents of evolution] said that protoplasm[sic] made a wiggle-tail. It [the repeal bill] is the go-ahead word to teach as a fact that you came from a wiggle-tailed something.

Despite such arguments, the bill passed 59-30. Some who voted for repeal, however, did so with reservations. Curtis Person, Jr., supported the repeal effort because he thought the Butler Act antiquated, but told his colleagues that he remained concerned "for the lack of religious education that our young children are receiving today." This represented a particularly dangerous situation, he argued, because the United States was "in constant confrontation with communist countries who have power and aggression as their religion and the State as their God." In addition to recording House sentiment, the vote on House Bill 48 convinced Chancellor Broughton to postpone the Southern suit indefinitely, arguing that it would become moot if the Tennessee Senate supported the House decision.

The repeal of the Butler Act proved much more difficult than the Knoxville judge anticipated. When Senate debate began on April 20, the chamber held a number of visitors, including network television crews dispatched to record the fate of the nation's best known antievolution statute. Clayton P. Elam of Memphis, chief sponsor of the Senate repeal effort, admitted during debate that he did not believe in evolution personally, but thought students should be permitted to learn about the subject. Of greater impor-

tance, Elam argued, "I am tired of Tennessee being held up to ridicule to the nation and the entire world." Opponents of the repeal measure remained unmoved by Elam's arguments, and focused their comments on Biblical inerrancy and the danger of evolutionary biology. Ernest Crouch of McMinnville, for example, attempted to refute Elam's statement by arguing:

We know the greatest book ever written, the Bible, tells us where life came from and how God created man. Senator Elam says we are being ridiculed in Europe. That doesn't bother me a bit. If those countries over there would pay us what they owe us, we could retire our national debt.

Senator Fred Berry (Knoxville) made dire predictions based solely on religious grounds, declaring before the television cameras:

... Oh yes, I'm a sinner and proud to testify that I believe the very word and God will deal with America if we do not get down on our knees and profess faith like simple children.

After two hours of debate the Senate vote on the repeal of the Butler Act ended in a 16-16 tie. The bill was returned to the Senate calendar committee. Immediately after that decision, the Senate voted 23-10 in favor of a bill to amend the Butler Act to prohibit the teaching of evolution as "fact or probable fact" only. The Senate forwarded this measure (SB 536) to the House, with no indication that the latter body would act on the bill. As the end of April approached, few dared to predict the fate of Tennessee's antievolution legislation.

Although unrecognized at the time, the crucial factor in the ultimate repeal of the Butler Act had already emerged. In a front-page story, the *New York Times* of April 15 announced that Gary Lindle Scott, a 24 year old science teacher in rural east Tennessee, had been dismissed for teaching evolution. The Campbell County School Board had received complaints from a group of local ministers that Scott had been teaching evolution in his Jacksboro High School classes and had called the Bible, in the words of one of Scott's students, "a bunch of fairy tales." Scott's explanation of the situation proved quite different. He admitted to defining the word "evolution" in response to students' questions, but he emphasized that he had also explained Tennessee's antievolution law. Rather than equating the Bible with "fairy tales," Scott assured officials, he had merely stated that "many things in the Bible were explained in the form of parables and that some of those things cannot be taken literally." The school board remained unimpressed with Scott's explanation, and dismissed him in a closed session the night of April 13.

Over the next few days, and particularly after the Senate's refusal to repeal the Butler Act, Scott decided to press legal action. By the end of April, the American Civil Liberties Union, National Education Association, and National Science Teachers Association had all pledged support. The NEA agreed to join Scott as plaintiff in his suit, promised to pay his living expenses while he remained unemployed, and arranged for the services of the famous attorney William Kunstler. During early May, Scott conferred with local legal and educational officials in an attempt to clarify his position and gain support. On May 9, he travelled to New York City to confer with ACLU attorneys, including Kunstler, and with officials of the NSTA. While in New York, Scott also taped a segment for the popular television show "To Tell the Truth," which aired on May 18. Scott's actions were traced in local and national newspapers, creating significant publicity and interest.

The Campbell County School Board could not ignore the publicity generated by their decision to dismiss Scott. In their meeting on Thursday, May 11 (the same day Scott taped "To Tell the Truth"), the board voted seven to one to rescind Scott's dismissal and pay him his back salary. The reinstatement resolution made no mention of constitutional or legal questions, but merely cited the "considerable controversy and publicity" from the board's earlier action. Restoring Scott to his position, the board hoped, would prevent the county from receiving "much adverse publicity, both now and in the future," and would also save the county a large sum of money in legal fees.

Despite his reinstatement, Scott decided to continue with a modified suit challenging the constitutionality of the Butler Act. On May 15, Scott's first day back in Jacksboro High School, his attorneys filed suit in U.S. District Court in Nashville. Filed as a class action, Scott's suit included as plaintiffs two of his students, the NSTA, and more than fifty professors from nine Tennessee universities and colleges. The suit argued that the Butler Act (1) violated freedom of religion, freedom of speech, and other First Amendment guarantees; (2) violated the due process clause of the Fourteenth Amendment because of vagueness; (3) represented an establishment of religion; (4) penalized teachers for performing their duties; and (5) violated the equal protection clause of the Fourteenth Amendment. The suit sought a permanent injunction to restrain local and state officials from enforcing the Butler Act, an interlocutory injunction to protect plaintiffs from criminal prosecution, and a declaratory judgment to declare the Butler Act unconstitutional (Scott, 1967).

The Scott case catapulted Tennessee's antievolution statute into the national spotlight, a development clearly recognized by members of the state's General Assembly. The House of Representatives refused to consider the Senate bill to amend the Butler Act, insisting that their repeal effort represented the only logical course of action. After placing House Bill 48 on the calendar for Tuesday, May 16, the Senate received many entreaties to repeal the Butler Act. The University of Tennessee College of Liberal Arts, for example, unanimously passed a resolution supporting repeal. All twenty-three members of Vanderbilt University's divinity school petitioned the legislature to repeal the antievolution statute, arguing that evolution remained "a scientific concern which does not pose a threat to sound religious faith or confidence in the Bible." The Tennessee Senate responded quietly to the new demands for repeal. In three minutes, with no debate, the Senate voted 20-13 to delete the Butler Act from the Tennessee Code. On May 18, Governor Buford Ellington affixed his signature to the repeal measure. Scott and Southern quickly withdrew their suits, ending four months of frenzied activity.

AFTERMATH OF REPEAL

Tennessee's repeal of the Butler Act marked the opening of the last chapter in America's antievolution debate. The year following repeal witnessed the U.S. Supreme Court's declaration that a similar Arkansas statute was unconstitutional in the famous case of *Epperson v. Arkansas* (393 U.S. 97). The only remaining antievolution statute, that of Mississippi, was declared void by a state court in 1970 (*Smith v. State, Miss.*, 242 So.2d, 692).

As has become evident in the past decade, however, the death of legislation prohibiting the teaching of evolution

failed to eliminate antievolution sentiment. Conceding the unconstitutionality of earlier legislation, opponents of Darwinian biology have attempted to restore the Genesis account by the indirect method of "equal time" laws. Adopting the name "scientific creationists," these modern antievolutionists seek the same end as their fundamentalist forebears of the 1920s. Faced with concepts that threaten their belief in the literal truth of the Bible, they are attempting to prevent or compromise the discussion of those concepts. The current strength of scientific creationism suggests that the place of evolution in American education remains far from secure.

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INTERNAL PARASITES OF THE COYOTE (*CANIS LATRANS*) IN WESTERN TENNESSEE

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ABSTRACT

From the fall of 1979 through the summer of 1981, 54 coyotes (*Canis latrans*) were examined for internal parasites. Parasites detected and percent occurrence were as follows: nematodes (84.9) and cestodes (48.1). This study records the occurrence of six coyote parasites in Tennessee for the first time.

INTRODUCTION

The coyote (*Canis latrans*) has been the subject of many investigations. Many data have been collected because of economic interests and control and management programs. However, little of this information has been assembled from specimens in the southeastern United States. Since the coyote is a recent invader of this region, it makes an ideal subject for many ecological studies.

Parasites are a significant factor in the ecology and natural history of host species. These organisms are known to have a much greater influence on coyote well-being than was once considered (Gier et al., 1978). The occurrence, rate of infestation, and immediate effect of parasite infestation are not fully understood. However, Gier et al. (1978) pointed out that the incidence of parasites or diseases in one state may not be interpolated for other states. Coyotes are known to carry a wide variety of parasites (Young, 1951; Gier, 1968; Thornton et al., 1974). Since little is known of *C. latrans* parasites in the southeastern United States and there are no reports of these organisms from coyotes in Tennessee, there exists a need to examine the parasites of coyotes from this part of the United States.

The purpose of this study was to investigate the internal parasites of *C. latrans* from western Tennessee. This work should add to our understanding of this predator in the state as well as provide additional information which could be useful in predicting health hazards to other species including man.

MATERIALS AND METHODS

Fifty-four digestive tracts of Tennessee coyotes (25 male; 29 female) were examined from the fall of 1979 through the summer of 1981. Counties from which specimens were examined and sample sizes were as follows: Crockett Co., 1; Decatur Co., 1; Dyer Co., 1; Fayette Co., 7; Gibson Co., 4; Hardeman Co., 7; Henry Co., 1; Lauderdale Co., 3; Shelby Co., 17; Tipton Co., 12. Most specimens were provided by trappers, hunters, and Tennessee Wildlife Resources Agency personnel. Coyotes were transferred to the Department of Biology, Memphis State University, for examination. Digestive tracts and other internal organs were removed. Intestinal contents (54) were washed through a wire sieve; intestine and washed contents were examined under a dissecting microscope for the presence of parasites. Hearts (40) were examined for occurrence of heartworms. Diaphragms (31) were examined for *Trichinella spiralis* using the digestive technique described by Newsome and Wilhelm (1979). Cestodes were dehydrated, stained with Harris hematoxylin or borax carmine, mounted, and identified. Identifications followed Schmidt (1970). Nematodes were dehydrated, mounted with Turttox clear mounting medium, and then identified according to Yamaguti (1959, 1961). Unmounted nematodes were stored in 70 percent ethanol. All specimens examined (coyotes and parasites) have been deposited in the Memphis State University Museum of Zoology.

RESULTS

Results of the examination of 54 *C. latrans* are given as Table 1. Five species of nematodes and one cestode are reported. Of the digestive tracts examined, 45 (84.9 percent) contained nematodes. Twenty-two hearts (55.0 percent) contained heartworms. No diaphragms were infected with *T. spiralis*. Only one species of cestode was detected; it was found to occur in 26 (48.1 percent) of the samples.

TABLE 1. *Internal parasites recorded for 54 coyotes (Canis latrans) from western Tennessee.*

Helminth	Hosts infected/ examined	Percent of host infected	Density range of parasites
Nematoda			
<i>Ancylostoma caninum</i> (dog hookworm)	32/54	59.3	1-36
<i>Dirofilaria immitis</i> (heartworm)	22/40	55.0	1-40
<i>Physaloptera rara</i> (stomach worm)	25/54	46.3	1-59
<i>Toxascaris leonina</i> (intestinal worm)	10/54	18.5	1-15
<i>Trichuris vulpis</i> (whipworm)	3/54	5.6	1-5
Cestoda			
<i>Taenia pisiformis</i> (tapeworm)	26/54	48.1	1-54

DISCUSSION

Coyotes carry a wide variety of parasites (Young, 1951; Gier, 1968; Thornton et al., 1974; and others). Many of these are common to canids but vary in their frequency of occurrence throughout the range of *C. latrans*. All of the parasite species recorded in the present study have been reported in previous coyote investigations (Bekoff, 1977). However, their rates of infection for Tennessee coyotes appear to be moderate to high when compared to those reported in other studies.

Hookworms of the genus *Ancylostoma* have been consistently reported in parasite studies of the coyote (Gier et al., 1978). Mitchell and Beasom (1974) found many coyotes along the Gulf Coast in Texas to be infected with up to 250 *A. caninum* each. Custer and Pence (1981) reported the occurrence of *A. caninum* in 82.0 percent of wild canids in Texas. Gier and Ameel (1959) recorded a 25.0 percent infection rate for this species in Kansas, and Franson et al. (1978) indicated the presence of this parasite in 50.0 percent of the Iowa coyotes. The 59.3 percent of hosts infected in the present study is well within the range reported in previous studies.

Occurrence of the heartworm *Dirofilaria immitis* in coyotes is variable. Reports of 1.0 percent and 15.0 percent have been indicated for Kansas coyotes by Gier et al. (1978), and Grahman (1975) found 8.0 percent occurrence in Kansas specimens. Franson et al. (1976) recorded 3.6 percent of the coyotes in parts of southwestern Iowa to carry *D. immitis*. The 55.0 percent host infection in the present study appears relatively high when compared to other works. Effects of *D. immitis* on coyotes has not yet been established. However, Gier et al. (1978) indicated that in areas where coyotes were regularly chased by dogs, the occurrence of heartworms was minimal, indicating that a light infection may mean the difference between survival and death in a chase.

The 46.3 percent occurrence rate of the stomach worm *Physaloptera rara* found in the present study is higher than the 23.0 percent (Thornton et al., 1974) and 30.0 percent (Smith, 1967) reported for Texas coyotes. While being somewhat lower than the 51.0 percent (Gier and Ameel, 1959) found for Kansas specimens and the 66.7 percent determined in Iowa (Franson et al., 1978), the occurrence

rate found in the present study appears to be among the higher frequencies reported for coyotes. Gier et al. (1978) reported 25 to 50 *P. rara* to be fatal for coyote pups under a month old in the laboratory. Evidence of fatalities from this parasite in nature is lacking.

Intestinal worms of the genus *Toxascaris* have been reported as occurring in various frequencies, Gier et al. (1978) summarized many of these occurrences and gave a high of 52.0 percent in Alberta and a low of 10.0 percent in Texas. The 18.5 percent occurrence of *T. leonina* in the present study is moderate when compared to other works. *T. leonina* is the persistent ascaroid of coyotes, and numbers of this parasite rarely exceed 50 or 60 per coyote, which is not enough to cause intestinal blockage (Gier et al., 1978).

The whipworm *Trichuris vulpis* is little known in coyotes. Gier et al. (1978) reported two to 12 *T. vulpis* from 6.0 percent of over 1200 coyotes studied in Kansas. The 5.6 percent occurrence of this parasite recorded in the present study is very similar to that recorded in Kansas; these results support the findings of Gier et al. (1978) that small numbers recovered of this whipworm indicate a relatively high resistance of coyotes to this infection and suggest little adverse effects.

Taenia pisiformis is apparently a common tapeworm associated with coyotes and is reported in varying degrees of occurrence. Self and McKnight (1950) recorded 100.0 percent of the coyotes studied in Oklahoma to be infected with this tapeworm. Gier and Ameel (1959) reported a frequency of 95.0 percent for the parasite in Kansas coyotes, and Franson et al. (1978) found 86.8 percent of the coyotes studied in Iowa to carry *T. pisiformis*. Frequencies of 19.5 percent (Freeman et al., 1961), 30.7 percent (Holmes and Podesta, 1968), 39.0 percent (Erickson, 1944), and 54.6 percent (Butler and Grundmann, 1954) have been reported for Ontario, Alberta, Minnesota, and Utah, respectively. The percent of coyotes infected with *T. pisiformis* in the present study is well within the range reported in other investigations. Extremely heavy infection of several hundred *T. pisiformis*, as is frequently found in dogs, has not been reported for coyotes (Gier et al., 1978).

The lack of occurrence of *T. spiralis* in coyote diaphragms is not surprising. Rausch et al. (1956), Zimmerman et al. (1959), and Olsen (1960) have reported *T. spiralis* in coyotes, but the frequency of occurrence was low in all studies. The general occurrence of *T. spiralis* was reviewed by Zimmerman (1971).

Since there are no previous reports of internal parasites from Tennessee coyotes, the species listed in Table 1 are recorded for the first time in the state. In order to more completely understand the occurrence and degree of parasitism in Tennessee coyotes, additional specimens which represent the statewide coyote distribution should be examined.

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SOME BENTHIC INVERTEBRATES FROM TENNESSEE AND KENTUCKY CAVES

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ABSTRACT

Benthic invertebrates were collected from six caves in Tennessee and two in Kentucky during July 1980, with particular emphasis on obtaining oligochaetes and chironomids. Only two troglobitic forms were found, the amphipod *Stygobromus* and the oligochaete *Haplotaxis* cf. *gordioides*. No distinct occurrence or distributional patterns were observed for any taxa in any of the cave systems.

INTRODUCTION

Although detailed surveys have been conducted of certain troglobitic organisms in the southeastern United States (e.g., Barr, 1967; Holsinger and Peck, 1971; Hobbs et al., 1977), most of these studies have concentrated on the larger-sized invertebrates and vertebrates, especially crayfishes, cavefishes, cave spiders, amphipods, and bats. Few collections have been made of the smaller benthic invertebrates, particularly oligochaetes and chironomids. Cook (1971) described a new species of Lumbriculidae from a cave in southern Tennessee, and in a later paper (Cook, 1975), he discussed 10 taxa collected from eight caves in Virginia, West Virginia, and Tennessee. As Cook (1975) noted, most phreatic aquatic oligochaetes are lumbriculids (*Trichodrilus*, *Stygodrilus*, and *Spelaedrilus*) or haplotaxids (*Haplotaxis*), whereas members of the other common families (i.e., Tubificidae, Naididae, and Enchytraeidae) gen-

erally occur near cave entrances. Evidence supporting this idea comes from Delay (1972, 1973) who described three new species of *Haplotaxis* from Swiss and French caves. However, most of the cave forms found by Pop (1972, 1974) in Swiss and Near Eastern caves are common European forms.

Chironomid larvae have not been recorded previously from any southeastern caves, but were recently found by Waters (1981) among the invertebrate drift below a cave in Minnesota.

METHODS

In July 1980, qualitative collections of oligochaetes and chironomids were made in eight caves, six in northcentral Tennessee and two in south central Kentucky (Table 1). Names and locations for the Tennessee caves are those found in Barr (1961) and Matthews (1971). Collections were made at least 500 m inside each cave to ensure representative faunal composition. Substrate, generally mud, was washed through a 250 μ m sieve, examined on site, then preserved in 5-7 percent buffered formalin for laboratory analyses. It should be noted that considerable on-site examination of streams and pools yielded no organisms, yet when sorted in the laboratory under a dissecting microscope at least several specimens from each site were found. Oligochaetes and chironomids were mounted in CMC medium for identification using a com-

pound microscope; all other organisms found were identified using a stereomicroscope.

TABLE 1. Names, locations and coordinates of caves sampled.

I.D. No.	Name and Location	Coordinates
1.	Ament Cave Putnam Co., Tennessee	36°08'42" N 85°29'24" W
2.	Rocky Point Cave No. 1 Putnam Co., Tennessee	36°08'10" N 85°24'10" W
3.	Stamps Cave Putnam Co., Tennessee	36°07'35" N 85°23'52" W
4.	Mill Cave Cumberland Co., Tennessee	35°51'21" N 84°55'37" W
5.	Green Cave No. 1 Warren Co., Tennessee	35°42'45" N 85°47'15" W
6.	Green Cave No. 2 Warren Co., Tennessee	35°42'45" N 85°47'15" W
7.	Flint Ridge Cave Mammoth Cave System Edmonson Co., Kentucky	37°12'49" N 86°03'48" W
8.	Echo River Mammoth Cave System Edmonson Co., Kentucky	37°11'23" N 86°05'10" W

RESULTS AND DISCUSSION

Oligochaetes, chironomids and other benthic fauna collected did not include any unusual or new species, with the exception of a possible new species of the amphipod *Stygobromus* at Rocky Point Cave No. 1 (J. Holsinger, personal communication). Eleven genera of chironomids and nine species of oligochaetes were collected (Table 2). Mill Cave and Green Cave No. 2 yielded the most taxa, with ten and eight, respectively. No chironomids or oligochaetes were found at Green Cave No. 1, although this cave was located in close proximity to Green Cave No. 2, which had seven chironomid and oligochaete taxa plus the amphipod *Gammarus minus* Say. Green Cave No. 1 was the only cave with other prevalent benthic fauna, including the crane fly larva *Tipula*, the beetle larva *Dubiraphia*, the caddisfly larva *Hydropsyche*, leeches, and the isopod *Lirceus*.

No distinct pattern for chironomids was observed, although many of the genera (e.g., *Procladius*, *Chironomus*, *Microtendipes*) collected were from burrows in muddy habitats. Most genera belonged to the Tribe Chironomini, generally tolerant of a wide range of pollution and other environmental factors, although representatives from two other subfamilies, Tanypodinae and Orthocladiinae, were also found in a variety of habitats. No observable differences occurred between chironomid genera and type of river-cave system (i.e., a flow-through stream or originating stream). No chironomid pupae were found in any samples. This may suggest that the chironomid larvae were either carried out of the cave by drift mechanisms, or failed to develop fully once in the cave. No data are available on survival or emergence of chironomids collected in caves.

TABLE 2. Lists of benthic organisms found in eight caves in Tennessee and Kentucky during July 1980.

Organisms	Caves by I.D. Numbers							
	1.	2	3	4	5	6	7	8
Oligochaeta								
Tubificidae								
<i>Aulodrilus americana</i>								X
<i>Aulodrilus limnobius</i>				X				
<i>Ilyodrilus templetoni</i>								X
<i>Isochaetides freyi</i>				X				X X
<i>Limnodrilus hoffmeisteri</i>	X			X		X		
Naididae								
<i>Nais</i> sp.								X
<i>Pristina foreli</i>				X				
Haplotaxidae								
<i>Haplotaxis</i> cf. <i>gordioides</i>						X		
Enchytraeidae								
<i>Achaeta</i> / <i>Marionina</i> sp.								X
Diptera								
Chironomidae (larvae)								
<i>Larsia</i> sp.			X					
<i>Procladius</i> sp.				X				
<i>Chironomus</i> sp.		X		X				
<i>Cryptochironomus fulvus</i>				X				
<i>Endochironomus</i> sp.								X
<i>Microtendipes stygius</i>					X			X
<i>Paratendipes connectens</i>								X
<i>Polypedilum halterale</i>				X	X		X	X X
<i>Cricotopus bicinctus</i>	X							
<i>Limnophyes</i> sp.		X						
<i>Orthocladius</i> sp.				X				
Tipulidae								
<i>Tipula</i> sp.			X		X			
Coleoptera								
Elmidae								
<i>Dubiraphia</i> sp.						X		
Trichoptera								
Hydropsychidae								
<i>Hydropsyche</i> sp.						X		
Hirudinoidea						X		
Isopoda								
Asellidae								
<i>Lirceus</i> sp.					X			
Amphipoda								
Gammaridae								
<i>Gammarus minus</i>							X	
<i>Stygobromus</i> sp.		X						
Nematoda								X

Waters (1981) found both oligochaetes and chironomids immediately below a cave source, but because no coldwater species were found, he felt that the chironomids had crawled into his drift net and that few, if any, had drifted in from the cave. Our findings do not support this assumption, since seven of the eight caves sampled had common chironomid larvae, and all caves contained two or more taxa of benthic invertebrates. Despite obvious differences in geographical locations and consequential ecological conditions, drift studies at the mouths of the caves we investigated would produce taxonomic results similar to those of Waters (1981). This demonstrates that not all caves are necessarily inhabited by aquatic crenobionts or troglolobionts.

One true groundwater species of oligochaete, the haplotaxid, was collected. This single specimen was immature, as have been all specimens of this distinctive North

American form. The large sickle-shaped single ventral setae and small dorsal setae are distinctive. The tiny straight dorsal setae, often missing from some or all segments, are present in all segments in this specimen. Several other U.S. and European species also display setae in all segments (Brinkhurst, 1966), and it has generally been assumed that these all belong to *Haplotaxis gordioides*. However, the Australian *H. heterogyne* Benham would be indistinguishable from these specimens when immature, as would another specimen from South America that has hairlike genital setae (undescribed, Brinkhurst collection). Genital setae in the form of crochet hooks were seen in *H. dubius* Hrabec which Brinkhurst (1966) regarded as a subspecies of *H. gordioides*. The North American species has yet to be fully determined, including other immature specimens named *H. ichthyophagous* (Gates, 1971).

In contrast to the work of Cook (1971, 1975), who found some interesting phreatic oligochaetes, all other species found by us occur in surface waters and most are widespread, if not ubiquitous, in North America.

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ALTITUDINAL AMELIORATION OF CONTINENTALITY IN THE SOUTHERN APPALACHIANS

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ABSTRACT

Continentality is a general climatic characteristic that is best developed in the interior of large continents. Large temperature ranges, low relative humidities, and relatively small annual precipitation totals (<300 mm), are common features of continentality. Indices have been devised by several authors by which to assess the thermal effects of land. This study employs five such indices in analyzing data from 236 stations from the southeastern United States. Three research questions are addressed: (a) what patterns of continentality are portrayed by isopleths derived by different formulas, (b) how does continentality vary with elevation, and (c) are the indices really different from each other? Results of the study indicate that patterns of occurrence are broadly similar; continentality is inversely related to elevation; though at differing rates and with differing degrees of explanation, and the indices truly are different from each other.

INTRODUCTION

Seasonal ranges of temperature with respect to latitude have most meaning in the context of thermodynamic ex-

changes near the earth's surface. When the juxtaposition of land and water accentuates those exchanges, the magnitude of apparent temperature contrasts can be striking, particularly in the middle latitudes. Temperature profiles across such surfaces have been studied by many (Leighly, 1938 and 1941; Fobes, 1954; and Arroyo, 1955).

An extension of interest stemming from temperature profiles is a comparison of the range of temperature at a station, and subsequently, between stations. Comparisons typically have taken two approaches, part of regional climatic classifications, and index values. The Koppen system of climatic classification, for example, uses tertiary subscripts, *a* through *d*, to indicate relative heating or cooling. Trewartha follows the same notation but also designates some middle-latitude regimes as *c* for continental or *o* for oceanic or marine (Trewartha and Horn, 1980). One problem with such designations is that arbitrary distinctions occasionally yield anomalous locations. In some years, for instance, portions of southern West Virginia can be designated *Cfb* in the Koppen system or *Do* in the Trewartha system — both purporting to be marine climates. Yet West Virginia does not experience a marine

climate; it generally experiences a humid climate with temperatures influenced by elevation. Mean temperature ranges of 20-25 C annually are common.

The other approach is to derive an index by which to assess or compare thermal impacts over a wide range of surface conditions, from most oceanic (least continental) to most continental (Currey, 1974). In the context of indices, three research questions will be addressed: (a) what are the spatial distributions of continentality (a measure of mean annual temperature range and latitude) using indices devised by different researchers; (b) how does continentality vary with elevation; and (c) do the indices assess the same characteristic?

The southern Appalachian Mountains were selected for study for three reasons. First, the region contains varied relief. Ranges in elevation of up to 1000 m within relatively short horizontal distance are not uncommon. Topographic features have a dominant orientation, so that the development of continentality patterns is to be expected. Second, the distribution of climatic stations, although not ideal, is much better than can be found in the mountains of the western United States. The belief is encouraged that any apparent patterns of continentality evident from the data result from real causes, not voids in data. Third, several studies of temperature profiles, precipitation distributions, and vertical zonations of vegetation have been conducted in the southern Appalachians so that index values might be better understood and explained than would the case in other extensively mountainous areas.

Climatic data used to derive indices of continentality came from published sources. The length of record used to derive monthly mean temperatures is not the same for all stations. Although some inconsistency is thus introduced into the calculations, areal coverage was given preference over length of record. Data from Wernstedt (1972) supplement station data obtained from the National Oceanic and Atmospheric Agency (1973, 1975, 1976).

CONTINENTALITY INDICES

Five indices of continentality were selected for study. Indices provide a consistent means to assess the mosaic of interrelationships associated with the concept of continentality. Continentality is a general term applying to places which experience large ranges of temperature, both diurnally and annually, generally low relative humidities, and precipitation that is small in annual amount (typically less than 300 mm), has a summer maximum of occurrence, and is frequently unreliable (Duckson, in press).

One of the earliest attempts to quantify continentality was Zenker (1888). His emphasis was upon mean annual temperature range (A) in degrees celsius and the latitude (ϕ) of the place under investigation:

$$K = mA/\phi + n \quad (1)$$

Continentality is denoted by K; m and n were empirically derived constants having values of 6/5 and 20, respectively (Okolowicz, 1969). Gorczyński (1920) adjusted Zenker's equation so that values derived would range between zero and one hundred. Arbitrarily, Verkhojansk (USSR) was selected as the most extreme example of the thermal effects of land, the most continental. Thornshavn in the Faroe Islands was selected as the most oceanic. Gorczyński's (1920) equation,

$$K = (1.7 A/\sin\phi) - 20.4 \quad (2)$$

was an attempt to adjust for the role of latitude but produced K-values as large in the Sahara as in Poland.

Conrad (1946) offered a different equation with which to calculate continentality. Zenker's (1888) index permitted K-values equatorward of twelve degrees to exceed their theoretical maxima. Conrad (1946) believed more practical

$$K = [1.7 A/\sin(\phi + 10)] - 14 \quad (3)$$

in which $\sin(\phi + 10)$ replaced the \sin of Gorczyński (1920). Other symbols remained the same. However, because of that change, Conrad's method cannot be applied to stations at latitudes greater than eighty degrees. Continentality is a middle-latitude concept, and in view of the paucity of human settlement poleward of eighty degrees, $\sin(\phi + 10)$ is a minor limitation.

A slightly different approach to continentality was taken by Evert (1966). Reasoning that no philosophical grounds existed for designating a scale having end-values of zero and one hundred, Evert (1966) argued for the possibility of K-values greater or lesser than those possible following earlier methods. Values of $K < 0$ would indicate "super oceanicity," and $K > 100$ represents "super continentality." Conceding that mean annual temperature range is proportional to latitude ($\sin \phi$) and acknowledging that slope and relief influence temperature regimes also, Evert (1966) derived empirical constants to incorporate these variables into the calculation of continentality using the formula

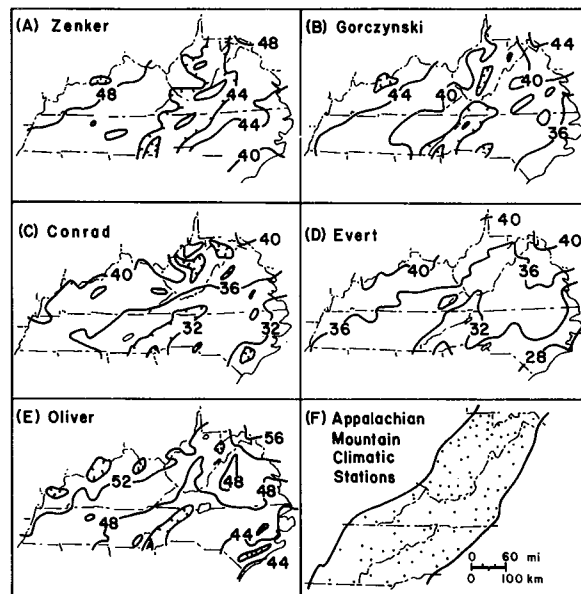
$$K = 100[(A-3.81)(\sin\phi+0.01)/(38.39 \sin\phi)+7.47] \quad (4)$$

More recently Oliver (1970) has suggested that continentality might better portray part of the climate of a given place if consideration of air masses could be given during index calculation. One measure of the time dominance of an air mass over a station is the amount of precipitation received, and Oliver (1970) calculates his index following the equation $C = L \cos A$ where C is the degree of continentality (hereafter referred to as a K-value, for consistency), L is the length in millimeters of the long axis and A is the angular deviation of L away from the vertical on a climograph. Climographs are constructed so that one inch along the abscissa represents one inch of precipitation and one inch along the ordinate represents 20 F of temperature. Points are plotted for the mean warmest and mean coldest months; a line is drawn to connect the two points. Oliver (1970) argues that the long axis of a continental station should parallel the ordinate; a marine station should have a substantial departure, perhaps approximating the abscissa in an extreme case. His graph is in English units while measurements are, at least in part, metric, a curious aside.

SPATIAL DISTRIBUTIONS

Climatic data were compiled for 236 stations from among the southeastern states of Kentucky (41), North Carolina (56), Tennessee (37), Virginia (47), and West Virginia (55). Data were manipulated according to the above methods in order to derive continentality indices. Isoleth maps of continentality were then prepared for each method. (Fig. 1).

FIG. 1 Isoleth maps of continentality using the indices devised by (A) Zenker, (B) Gorczyński, (C) Conrad, (D) Evert, and (E) Oliver. Panel F shows the location of mountain stations used in regression equations.



Continentality after Zenker (Fig. 1A) tends to increase with distance inland. Theoretically, highest values of continentality should occur near the geometric center of a

continent, so the notation that coastal North Carolina has K-values under 40 and western portions of Kentucky and Tennessee have K-values in excess of 48 is consistent with what is the expected trend. Prominent on the map is a large region of reduced K-values. This region corresponds to the Appalachian Mountains excluding the southern Shenandoah Valley in Virginia. Higher portions of the North Carolina Blue Ridge and the West Virginia Appalachian Plateau have even further reduced K-values.

Gorzynski continentality (Fig. 1B) shows a pattern generally similar to that of Zenker. K-values range from the mid-thirties along coastal North Carolina to the mid-forties for western Kentucky and Tennessee. More anomalous locations are evident compared to Zenker. The Blue Ridge and Appalachian Plateau again are regions of lower continentality, but the anomalous areas are smaller. Positive anomalies exist on both the Piedmont and coastal plain of Virginia and also the Kentucky-Virginia border. A large negative anomaly can be identified coincident with Charlotte, North Carolina.

Patterns of continentality after Conrad (Fig. 1C) are at once both simpler and more complex. Continentality isopleths have a more latitudinal orientation that was evident on the Zenker or Gorzynski maps (Figs. 1A and 1B, respectively). Local gradients are lower, but anomalies are more numerous and more intricate in pattern compared to those earlier. For example, both the coastal and Blue Ridge sections of North Carolina have K-values less than 32, while the Piedmont is above 32. Negative anomalies (<28) exist for the Coweeta Experimental Forest, Charlotte, Maysville, and Newburn, North Carolina. West Virginia has an irregular distribution at best. Kentucky also has anomalies, positive and negative, with no apparent explanation readily available.

The distribution of K-values after Evert (Fig. 1D) consists of a series of curved isopleths, concave to the southeast, with lower values in the southern Appalachians and the city of Charlotte. Gradients are reasonably smooth and reflect distance inland and latitude, again with the exception of the southern Blue Ridge.

Oliver continentality is portrayed in Fig. 1E. Isopleths of 44, 48, and 52 generally have the same curved pattern noted on the Evert map (Fig. 1D). The major difference between the distribution after Evert and Oliver is the number of anomalies using the Oliver method. An area of reduced continentality is coincident with the southern Blue Ridge but is more restricted in size and is skewed toward North Carolina using the Oliver method. Two crescentic areas of reduced K-values exist on the Carolina coastal plain, and several islands of elevated K-values exist in Kentucky and Tennessee.

Considerable spatial variability is apparent from the mapped distributions of continentality. Although isopleth intervals on all maps were four percent, values were not similar. Comparison of pattern is thus more important than comparison of value. Gorzynski, Conrad and Oliver methods produce numerous anomalies within the same broad pattern of continentality displayed by all the methods. Some differences of regional gradients may also be noted. Many anomalies and increases in gradients may be linked perceptually with topographic forms. Indeed, it may be that elevation is the casual element in explaining those anomalies.

VARIATIONS WITH ALTITUDE

One relationship quickly discerned from maps of continentality is that K-values tend to decrease with altitude. Low or reduced K-values are associated with altitude, but not in a consistent manner among indices. It is suggested that the association between continentality and altitude might provide a context in which evaluation of indices is possible.

Although slope, exposure, and elevation frequently combine to make spatial delineation of climates difficult or impractical, visualization of climates or of climatic patterns on a regional basis is, nonetheless, pedagogically useful (Eagleman, 1976). It is not surprising, then, that maps of continentality have been constructed by authors attempting to improve such visualization. Emphasis of these efforts typically is regional, with little attention being given to mountainous areas or with rates of change.

The Conrad (1946) method is the most frequently used method of determining continentality. Regional studies of continentality following that method were published by Fobes (1954), D'Ooge (1955), and Kopec (1965) for New England, the western U.S., and the Great Lakes, respectively. Highlands were consistently identified as negative anomalies. A recent text by Eagleman (1976) contains a map of continentality for the conterminous United States. Construction of the map followed Johannson (1931). Mountains were again identified with low k-values.

That continentality or its principle component, mean annual temperature range, tends to decrease with altitude has been noted by others is important. Similar findings in the southern Appalachians (Fig. 1 A-E) thus serve as additional verification of an observed relationship. Methods used to derive index values often assume linear functions of latitude, and the literature includes the substitution of altitude for latitude (Eagleman, 1976; Arroyo, 1955; and Trewartha and Horn, 1980). Studies of the rates of change of K-values with either latitude or altitude have not been found.

Regression analysis was employed to determine which method best describes continentality in the southern Appalachians. Elevation was designated as the independent variable. Variations in elevation, implicitly including aspects of slope and exposure, are postulated to cause variations in continentality, the dependent variable. Regression analysis was performed on a subset of stations used in compiling Figs. 1 A-E. Only stations in the Appalachian Mountains were used (Fig. 1F). Indices of continentality were regressed on elevation. Results of the analysis are provided in Table 1.

TABLE 1. Regression Equations for Continentality on Elevation Appalachian Mountain Stations.

Method	Coefficients			Standard Error
	Intercept	Slope	Determination	
Zenker	46.6	-0.006	.465	1.67
Gorzynski	42.1	-0.008	.507	1.87
Conrad	38.1	-0.006	.185	2.83
Evert	37.0	-0.006	.273	2.18
Oliver	51.4	-0.006	.225	3.07

Slope coefficients are significantly different from zero at the 0.05 level. However, slope after Gorczynski is *not* statistically different from the others. All coefficients are negative in sign. Highest correlation between elevation and continentality is evident following Gorczynski, lowest following Conrad. The Oliver method yields the largest standard error. Although standard errors tend to decrease with increasing coefficients of determination, considerable variation occurs in that relationship. Coefficients of determination were consistently low. Variation about the regression lines generated suggest that elevation alone cannot encompass adequately slope, exposure, and (for the Oliver method) vapor transport.

Several studies conducted in the Appalachians have analyzed the rates at which temperatures change with altitude on a seasonal, monthly, or even daily basis. Daily temperature ranges increase with altitude to approximately 500 m (Landsburg, 1964). Although ground inversions (Anthes, 1976) and upper air inversions (Leighly, 1938 and 1941) are exceptions to the isentropic value of 1C/100 m, lapse rate conditions prevail above inversion levels. Frequency and persistence of inversions is very site-specific and therefore irregular in distribution within the southern Appalachians, especially the Blue Ridge (Cox, 1923). Rates of temperature decrease regularly exceed isentropic values, and temperature range was found to decrease with altitude at rates which were related to vapor pressure (Cox, 1923).

Temperature difference over a range in elevation was observed to be greater in winter than in summer. In investigating temperature relationships along an east-west profile of the Great Smoky Mountains, Dickson (1959) calculated regression equations for mean monthly temperatures and for mean annual temperatures on elevation using data from 75 stations in North Carolina and Tennessee. Correlation coefficients ranged from -0.87 for January means to -0.97 for July mean temperatures; standard errors were 1.6 to 0.9, respectively. Actual temperatures frequently departed from expected values to an extent greater than anticipated on theoretical grounds (Dickson, 1959). Tanner (1963) used six stations on a seasonal basis in observing a non-linear relationship of temperature gradients and altitude. Air drainage consistently yields substantial negative departures from expected or calculated temperatures.

The point is that studies outside the Appalachians suggested that the rates of change in temperature or continentality with elevation were generally known. In maritime regimes (Manley, 1945), New England (Hopkins, 1960), the northeastern U.S. (Lee, 1969), and Ontario (Machattie and MacCormack (1961), atmospheric circulation and radiation balances must be more stable and more predictive than would seem to apply in the southern Appalachians, where specific rates of change vary widely in both space and time. Further, differing slope exposures do not always lower correlations by increasing scatter (Hicks, 1979).

ASSESSMENT OF METHODS

Given the approximate similarity of continentality isopleths (Figs. 1 A-E) and virtually identical regression slope coefficients (Table 1), it is of interest to know whether the methods under study are, indeed, different from each other. Analysis of variance was performed with "between group" variance separated into constituent parts. Test results (Table 2) yield F-values that are significant at the 0.05

level. The null hypothesis thus rejected, spatial patterns generated result from real differences in derivation. That pattern similarities also exist probably are due to differing empirical manipulation.

TABLE 2. *Summary Statistics for Anova*

Source	df	SS	MS	F
Between	4	13047.18	3261.80	306.27
Z vs GCEO	1	310.10		29.18
G vs CEO	1	1207.40		113.37
C vs EO	1	2217.22		208.19
E vs O	1	9312.46		874.41
Within	460	4899.13	10.65	
Total	464	17946.31		

Source: calculated by author. Tabled value of F .95, df 4, ∞ = 2.37

To explore differences between methods, examination was focused upon residuals. Preliminary attempts to plot residuals from the regression equations were soon abandoned when it became evident that the continentality-elevation relationship consistently differed across the Blue Ridge (Table 3). The number of samples per state was not equal, and, as a result, none of the correlations for Kentucky is significant. B-coefficients for Kentucky are positive, a departure from the expected.

TABLE 3. *Regressing Equations by State.*

SOUTHERN APPALACHIAN MOUNTAINS				
State	Method	Y = a + bX (elev.)	r	
Kentucky ^a (n=5)	Zenker	43.1 + 0.008	+0.318	
	Gorczynski	36.9 + 0.012	+0.374	
	Conrad	33.7 + 0.008	+0.306	
	Evert	34.8 + 0.002	+0.092	
	Oliver	43.7 + 0.024	+0.641	
Tennessee (n=13)	Zenker	46.1 - 0.005	-0.530	
	Gorczynski	41.9 - 0.007	-0.525	
	Conrad	36.8 - 0.005	-0.531	
	Evert	35.0 - 0.004	-0.486	
	Oliver	46.9 - 0.0004	-0.043 ^b	
North Carolina (n=16)	Zenker	44.7 - 0.005	-0.781	
	Gorczynski	40.4 - 0.008	-0.723	
	Conrad	35.1 - 0.006	-0.780	
	Evert	33.3 - 0.005	-0.693	
	Oliver	48.2 - 0.006	-0.649	
Virginia (n=23)	Zenker	45.4 - 0.003	-0.615	
	Gorczynski	40.4 - 0.005	-0.652	
	Conrad	36.2 - 0.004	-0.605	
	Evert	36.1 - 0.003	-0.458	
	Oliver	49.6 - 0.003	-0.417	
West Virginia (n=36)	Zenker	47.4 - 0.007	-0.671	
	Gorczynski	43.0 - 0.008	-0.760	
	Conrad	40.4 - 0.005	-0.427	
	Evert	39.0 - 0.006	-0.731	
	Oliver	54.2 - 0.007	-0.697	

^aSmall sample size does not allow testing for the statistical significance of the correlation coefficient

^bCorrelation coefficient not significant at the 0.05 level

Perhaps of more interest than an apparent change of sign is the variation by division of regression data. Slope coefficients and correlations differ by method when data are analyzed by subset. North Carolina, east of the Blue

Ridge, consistently exhibits better predictive equations than Tennessee, west of the Blue Ridge. Similar differences were noted in minimum temperature gradients (Shanks, 1954). Generally similar relationships, albeit at differing rates of change, are also apparent between Virginia and West Virginia. Combined regression equations (Table 3) thus mask more localized influences within mountainous regions.

CONCLUSIONS

The concept of continentality was derived initially from acknowledged differences in the heating and cooling of land vis-a-vis water. Assessment of the impacts of land is possible using scaled indices predicated primarily on annual temperature range and latitude.

Testing of five indices of continentality for a portion of the southern Appalachian Mountains results in largely similar isopleth patterns. Anomalies appear to result from factors other than simple elevation, although the tendency for continentality to decrease with altitude is strong and consistent between methods. Even the inclusion of precipitation as a surrogate for air-mass dominance (Oliver, 1970) did not alter substantially patterns evident by using other methodologies which are easier to employ.

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STIMULATORY AND INHIBITORY EFFECTS OF LIGHT UPON AUXIN BIOSYNTHESIS

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ABSTRACT

The auxin (indole acetic acid) content of *Avena* coleoptile tips has been determined spectrophotometrically using $\text{FeCl}_3\text{-H}_2\text{SO}_4$ reagent, the quantities ranging from 0.074 to 0.160 μg / coleoptile tip. In comparison with dark-grown controls, the auxin level was decreased following growth under 510 nm light, but increased by 605 nm light. These findings correlate well with the results of growth experiments with coleoptile segments including the tip, reported previously. The growth response of coleoptiles is directly

proportional to indole acetic acid concentration, which is controlled by the wave length of incident light under which the seedlings are grown. Inhibition of coleoptile growth is not due to super-optimal indole acetic acid production.

INTRODUCTION

The inhibitory effect of white light upon plant growth is well known (Galston and Hand, 1949, and others cited by these workers). In a previous study of the effects of light

quality upon growth of *Avena* coleoptile segments which included the coleoptile tip (Wolf, 1979), *stimulatory* as well as inhibitory effects of various wavelengths of light were observed. It is the purpose of the present communication to attempt to correlate these effects upon growth with levels of auxin (indole acetic acid) concentration.

When three-day-old dark-grown *Avena* coleoptile segments including the tip were exposed to light of different wavelengths for 24 hours, growth inhibition of 4.0 percent with respect to the dark controls was noted in 510 nm light. In the case of coleoptiles of intact seedlings treated similarly, growth was inhibited by 14.0 percent. Exposure of coleoptile segments including the tip to 605 nm light resulted in 9.6 percent growth stimulation (Wolf, 1979).

MATERIALS AND METHODS

The oats used in the present experiments were obtained from the same source as previously reported; Carolina Biological Supply Company, Burlington, NC. Seedlings were grown for four days, in petri dishes containing two sheets of filter paper and water. Illumination was provided by two Dyna-Lume lamps (Scientific Instruments, Inc., Skokie, IL). There were four experimental treatments. Growth took place under continuous exposure to white light, to darkness, or under interference filters with maximal transmittance of 510 and 605 nm. The filters used were the same as in earlier experiments; type Filtraflex-K, nos. 3 and 5, produced by Balzers Aktiengesellschaft, Balzers, Liechtenstein. Their half band width was *ca.* 50 nm. Light intensity measurements were made with a Yellow Springs Instrument Company radiometer, model 65. The light intensity under the 510 nm and 605 nm filters was 1.4×10^3 ergs/cm²/sec. Under white light, the intensity was ten times as great.

Coleoptile tips *ca.* 5 mm in length were cut from the seedlings. Owing to limitations as to the number of seedlings which could be grown at any one time, harvested coleoptile tips were stored in a deep freeze at -4°C until 100 of each treatment had been accumulated.

TABLE 1. Growth data of *Avena* coleoptiles and indole acetic acid content of coleoptile tips subjected to different light treatments.

Light treatment	Growth of 10mm coleoptile segment, mm	Difference from dark control, %	Initial absorbance of extract	Final absorbance of extract	Net absorbance	[IAA] in extract $\mu\text{g/ml}$	IAA per coleoptile tip, μg
605nm	15.73	+9.6	0.033	0.166	0.133	8.0	0.160
Darkness	14.35	0	0.048	0.169	0.121	7.4	0.148
White light	—	—	0.028	0.110	0.082	5.0	0.100
510nm	13.78	-4.0	0.018	0.077	0.059	3.7	0.074

In a variety of plant tissues including roots, buds and stems, Thimann (1937) demonstrated that indole acetic acid has both growth-stimulatory and growth-inhibitory effects which are concentration dependent. Growth inhibition can result from either sub-optimal or super-optimal auxin concentrations. In the case of coleoptile segments, in which the greatest growth response correlates with the greatest indole acetic acid concentration, it is clear that growth inhibition is not due to excess indole acetic acid production, and that growth is limited by indole acetic acid concentration.

Iino (1982) has recently reported that in intact etiolated seedlings of maize, exposure to red light stimulates coleoptile elongation but inhibits indole acetic production in the coleoptile tip. The present findings are in accord with

Each of the four samples was homogenized in a Potter, Elvehjem tissue grinder with 2.0 ml of distilled water. The resulting extracts were then centrifuged in a Sorvall RC2-B centrifuge at 12,000 g for 20 minutes, which resulted in optically clear solutions. Indole acetic acid was assayed spectrophotometrically in a Varian Techtron Model 635 spectrophotometer using the $\text{FeCl}_3\text{-H}_2\text{SO}_4$ reagent of Tang and Bonner (1947).

To a 0.6 ml aliquot of each sample, 2.4 ml of distilled water was added, and the absorbance at 530 nm was measured. To another 0.6 ml aliquot of each sample, 2.4 ml of the $\text{FeCl}_3\text{-H}_2\text{SO}_4$ reagent was added, 30 minutes was allowed for color development, and the absorbance was measured against a blank consisting of 2.4 ml of Tang and Bonner reagent plus 0.6 ml of distilled water. The initial absorbance of each extract was then subtracted from its absorbance after reaction with the $\text{FeCl}_3\text{-H}_2\text{SO}_4$ reagent.

Absorbances of dilutions of an authentic sample of indole acetic acid (Eastman Kodak Co., Rochester, NY) ranging from 0.6 to 10.0 $\mu\text{g/ml}$ were determined subsequent to addition of the reagent and color development. From these data a standard curve was constructed, from which the indole acetic acid content of extracts of coleoptile tips subjected to the various treatments was determined.

RESULTS AND DISCUSSION

The results, together with those of the growth experiments reported previously (Wolf, 1979), are presented in Table 1.

From the data presented, it is apparent that the indole acetic acid content of the coleoptile tips from seedlings grown in white light is less than in tips from seedlings grown in darkness. Growth under 510 nm light resulted in an indole acetic acid content less than in dark-grown controls, while 605 nm light induced the production of a slightly higher indole acetic acid level than in dark-grown seedlings. These findings correlate well with the results of the growth experiments with coleoptile segments including the tip, reported previously.

those of Pjon and Furuya (1967) in which "the elongation of apically excised rice coleoptile segments is promoted by a brief exposure to red light The growth of intact coleoptiles was inhibited by red light while that of excised segments in a buffer was rather promoted by red irradiation." Similarly, Shinkle and Briggs (1982) reported increased elongation of oat coleoptile sections, relative to that of dark controls, in response to red light treatment.

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OXYGEN CONSUMPTION OF SEVERAL SPECIES OF PLECOPTERA

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ABSTRACT

Oxygen-consumption values for several stonefly species, adults and immatures, are presented. Included are representatives of families not previously reported: Chloroperlidae, Leuctridae, and Peltoperlidae. Respiratory rates of adults of different species indicated a correlation to body weight.

INTRODUCTION

Oxygen-consumption in Plecoptera and its relationship to body weight, temperature, light, development, and sex have been the object of a number of recent studies and reviews (Knight and Gaufin, 1966; Olson and Rueger, 1968; Kapoor, 1972, 1974; Hynes, 1976; Zwick, 1980; Modlin and Jayne, 1981). The present study provides additional base-line information on oxygen consumption for adults and immatures of several stonefly species. Included are representatives of families for which oxygen-consumption values have not been previously reported: Chloroperlidae, Leuctridae, and Peltoperlidae.

MATERIALS AND METHODS

Specimens were obtained from several stream sites in Hamilton County, Tennessee, and Dade County, Georgia. Adults were collected using either an aspirator or an aerial net and forceps. Immatures were either hand collected or obtained using the standard kick method with a fine mesh net having 363 μ m openings. To minimize the death of specimens due to fluctuating temperatures, captured adults and immatures were placed in plastic containers, those holding immatures containing water. They were transported back to the laboratory in a styrofoam chest containing ice. Nymphs were maintained in the laboratory in a refrigerated water bath (10°C or 15°C) in containers holding aerated water. Oxygen-consumption measurements for adults and immatures were conducted at 10°C or 15°C using a Gilson Differential Respirometer. After the measurements were taken, the specimens were oven-dried at 50°C for 72 hours and then weighed.

RESULTS AND DISCUSSION

Oxygen-consumption values were variable, ranging from 288.7 to 1498.0 ul/g/hr for material measured at 10°C and from 863.4 to 9850.4 ul/g/hr for material measured at 15°C (Table 1). Because of the larger number of species measured at 15°C, these data served as the basis of com-

TABLE 1. Oxygen-Consumption Values for Various Stonefly Species

Taxon	Sample Size	Body Weight (mg)	ul/g/hr	Developmental Stage	Temperature (°C)
Leuctridae					
<i>Leuctra rickeri</i>	2	0.41	2975.6	M	15
	2	0.28	8950.4	M	15
	2	0.30	8763.0	M	15
	2	0.39	8165.9	M	15
	4	1.69	3076.9	F	15
	2	0.70	5399.9	F	15
<i>Paraleuctra sara</i>	1	0.51	883.5	M	10
	1	0.36	1398.2	M	10
	1	1.11	1056.4	F	10
	1	1.33	1498.0	F	10
	1	0.85	1251.0	F	10
Nemouridae					
<i>Amphinemura wui</i>	1	0.28	8775.0	M	15
<i>A. nigritta</i>	1	0.70	2386.8	F	15
	1	0.55	5636.3	L	15
Peltoperlidae					
<i>Talloperla laura</i>	1	2.70	962.7	M	15
	1	9.90	957.4	F	15
	1	10.05	1110.4	F	15
<i>Peltoperla arcuata</i>	1	3.60	1774.5	M	15
	1	8.28	863.4	F	15
Chloroperlidae					
<i>Sweltsa mediana</i>	1	1.30	2532.6	F	15
	1	2.02	1800.1	F	15
<i>Sweltsa</i> sp.	1	1.36	898.2	L	10
	1	0.91	924.2	L	10
Perlodidae					
<i>Clioptera clio</i>	1	3.49	2005.7	F	15
Perlidae					
<i>Acroneuria</i> sp.	1	8.65	1186.7	L	10
	1	6.68	360.3	L	10
<i>Neoperla</i> sp.	1	1.17	563.8	L	10
	1	1.63	288.7	L	10

M = Adult Male, F = Adult Female, L = Immature

parison. In those instances where individuals of both sexes could be measured the respiratory rates of males per gram appears to be slightly greater than those of the females. A comparison (Fig. 1) of the log of oxygen-consumption (ul/g/hr) to body weight in milligrams of adults of seven species reveals a negative slope with a significant negative correlation ($P < 0.01$). In recent years some controversy has existed as to whether the decline in oxygen-consumption values as an individual matures is a function of increased

body weight or of some other development phenomenon (Modlin and Jayne, 1981). Our results indicate that when adults of different species of stoneflies are compared, the larger species consume less oxygen per gram of body weight than smaller species. These findings are consistent with the earlier observation of Knight and Gaufin (1966).

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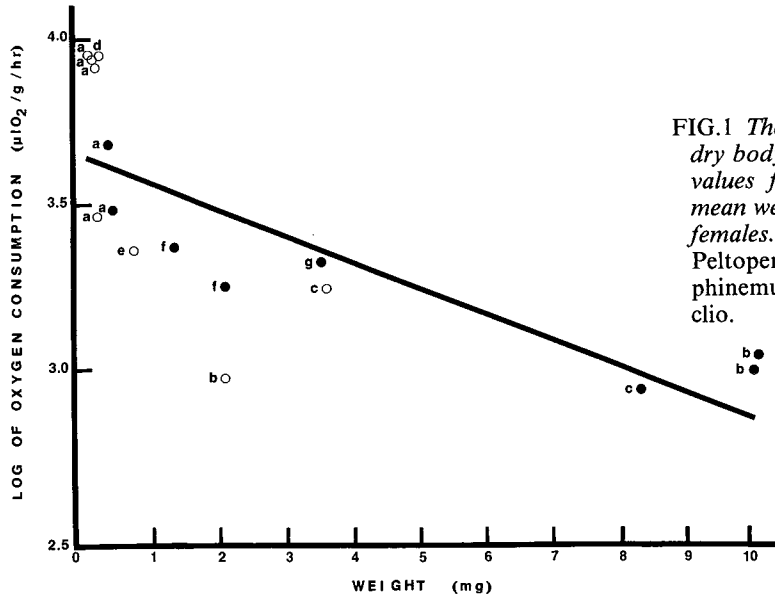


FIG.1 The relationship of oxygen consumption to oven-dry body weight of seven species of Plecoptera. {Weight values for *Leuctra rickeri* specimens are reported as mean weight.} Open circles represent males, closed circles represent females. a = *Leuctra rickeri*, b = *Taloperla laura*, c = *Peltoperla arcuata*, d = *Amphinemura wui*, e = *Amphinemura nigritta*, f = *Sweltsa mediana*, g = *Clioperla clio*.

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SEASONAL ACTIVITY OF THE EASTERN CHIPMUNK, *TAMIAS STRIATUS*, IN CENTRAL TENNESSEE.

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ABSTRACT

Seasonal activity in a population of eastern chipmunks, *Tamias striatus*, in central Tennessee was monitored from October, 1977 through April, 1980. The annual cycle commenced with arousal from winter torpor in February/March when spring mating occurred. Resumption of torpor followed but full above-ground spring activity was gradually adopted by more chipmunks so that by early May, all individuals had entered this phase. Each year, spring juveniles were first recorded above-ground on different dates: 28 April, 4 May and 5 June. Summer mating occurred in July and was soon followed by an activity lull

lasting some three and one-half weeks. Summer juveniles first appeared above-ground in late September/early October, 27 to 44 days after lull termination. Torpor was first adopted at various times in November and lasted until the resurgence of spring activity. Throughout torpor, some chipmunks resumed short-term, above-ground, activity fairly frequently.

INTRODUCTION

Relatively little is known of the biology of the eastern chipmunk, *Tamias striatus*, in the southern part of its range in North America. From 1977 through 1980 an opportunity was afforded to accumulate some data on the

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seasonal activity of this sciurid in central Tennessee. Although these data generally conform to patterns reported elsewhere for this species (e.g. Ellis 1979; Yahner and Svendsen 1978; Yerger 1955), some deviations are evident.

METHODS

Observations and live-trappings were completed from October, 1977 through April, 1980 on a 1.2 ha deciduous woodland plot about 11 km southwest of Nashville, Davidson County, Tennessee. Seventy-two Longworth pattern (Chitty and Kempson 1949) live-traps were set daily within this area and baited with sunflower seeds. Traps were positioned randomly, close to chipmunk activity sites/burrow entrances or arranged into a grid within the plot depending on which concomitant studies were being undertaken (Durden 1981). Trapped chipmunks were etherized, examined, recorded, dye-marked for future identification and released at their site of capture (following recovery from anesthesia). Chipmunks within the plot were regularly observed through binoculars during the survey.

RESULTS AND DISCUSSION

Ninety-three different chipmunk individuals were distinguished on the experimental plot at some time during the survey duration, although some of these were considered resident (occupied permanent burrows) elsewhere. The greatest number of individuals resident within the plot for any given month (excluding juveniles in maternal burrows) was 23 (October, 1979).

TABLE 1. *Timing of seasonal activities in a population of eastern chipmunks in central Tennessee for 1977-1980.*

Activity	1977	1978	1979	1980
Spring mating period (minimum)		7-11 Mar.	25 Feb.- 10 Mar.	14 Feb.- 10 Mar.
50% individuals fully active		6 Apr.	29 Mar.	9 Apr.
First spring-brood juv. above ground		4 May	5 Jun.	28 Apr.
Summer mating period (minimum)		18 Jul.- 4 Aug.	11-23 Jul.	
Summer lull		14 Aug.- 6 Sep.	27 Jul.- 20 Aug.	
First summer-brood juv. above ground	25 Sep.	3 Oct.	3 Oct.	
Torpor onset	1 Nov.	18 Nov.	29 Nov.	

Table 1 shows seasonal occurrences of major activities for resident chipmunks. Yearly cycles commenced with arousal from torpor in February or March when spring mating ensued. Spring mating was actually observed on only one occasion (March, 1978) as chipmunks were rarely seen at this time but those trapped had characteristically developed genitalia (Smith and Smith 1975). Adult females entered estrus asynchronously during this period with estrus lasting up to 10 days in some individuals (this also held true for the duration of summer mating); this was determined by the morphological appearance of the external genitalia for each female at subsequent captures as outlined by Smith and Smith (1975). Adult males had descended testes from this time until the summer mating period (regression occurred from mid-August onwards) with negligible atrophy between the two annual mating times, a finding common to that reported by Ellis (1979) and Snyder (1982). Excavation from burrows for spring mating appeared haphazard since earth mounds were common (21 of 24 burrows detected during this period for 1978 and 1979 combined, had earth piles); at all other times, burrow entrances were partially

concealed and devoid of surrounding soil debris.

Following spring mating, torpor was resumed as reported by Yahner and Svendsen (1978) for Ohio *T. striatus* populations. By mid-March, some chipmunks had abandoned torpor for full spring activity and by late March/early April, about half the resident population had done so (exact numbers and dates varied slightly for the three years). By early May, all resident adults surviving torpor were fully active above-ground. Earliest post-torpor activity dates recorded for this species in the southern extremities of its range include 19 April for Georgia (Golley 1962) and 22 April for Florida (Stevenson 1962). Juveniles resulting from the spring mating were first recorded above-ground on 28 April in 1980, 4 May in 1978 and 5 June in 1979, the latter date probably resulting from a scarcity of juveniles consequential to three short-term floodings on the plot that inundated these in burrows. Throughout May and June, spring-brood juveniles dispersed and established their own burrow systems.

Summer mating occurred from 11 July to 4 August without spring-born juveniles of the same year participating. Two males, did however, develop partially descended testes in late August (one in 1978 and one in 1979) of their birth years. Ellis (1979) states that some spring-born females occasionally breed during the summer, prior to their first winter, but this was not recorded for the present survey. The activity level was high during the summer mating period, but soon after its termination, indolence ensued as chipmunks entered a summer lull. Individuals were rarely observed or trapped at this time, although one juvenile male remained fully active during the 1978 lull. Causes of this lull have yet to be ascertained (Dunford 1972; Wrazen 1980), but its presence is widespread in *T. striatus* populations. After about three and one-half weeks (24 days in 1978 and 25 days in 1979) the lull ended and activity, as judged from foraging level, again increased. Summer-brood juveniles first appeared above-ground 27 and 44 days subsequent to lull completion during 1978 and 1979, respectively. This contrasts markedly with the findings of Dunford (1972) who reported summer-brood juveniles in New York *T. striatus* populations appearing above-ground immediately after lull completion.

Throughout October and November, summer-brood juveniles dispersed and foraging and food caching was intense by all individuals. Torpor onset occurred in November and throughout its duration (November to March/April), some chipmunks resumed activity quite frequently. Throughout the 1978-1979 torpor, one adult male could continually be captured within a day of setting traps and four additional individuals were trapped at circa 2-week intervals (except during very cold spells). Winter inactivity onset for eastern chipmunks was recorded on 19 November by Golley (1962) in Georgia and on 5 December by Stevenson (1962) in Florida. Although winter torpor appears ubiquitous for eastern chipmunk populations (including those at the southern limits of this species range) the degree of inactivity shown by different individuals in the same area varies greatly (Snyder 1982).

All described events, except initiation of full spring activity and entering estrus for adult females, occurred within 1 to 4 days for all resident individuals.

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EGGSHELL THICKNESS AND EGG DIAMETER
OF CAPTIVE GIANT CANADA GEESE

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ABSTRACT

Average shell thickness of 69 eggs from a captive flock of *Branta canadensis maxima* at Land Between the Lakes, Kentucky, was 538.7 μm . Twenty-three eggs which hatched had thinner shells than 11 eggs which had no embryonic development. The diameters of 31 eggs averaged 60.1 mm. Eight-year-old females laid larger eggs than 2-year-old females.

INTRODUCTION

A review of the literature dealing with the Giant Canada Goose (*Branta canadensis maxima*) revealed no information on eggshell thickness and a meager amount of data on egg dimensions (Hanson 1965; Manning 1978). This situation, coupled with the availability of eggs from the captive flock of Giant Canada Geese at Land Between the Lakes (LBL), prompted the study reported here. Necessary changes in goose management procedures at LBL terminated our study prematurely. We hope the publication of our data, even though incomplete, will stimulate other workers with access to Giant Canada Geese of known age to conduct similar, but more intensive, studies.

METHODS

The LBL flock consisted of approximately 60 pairs of Giant Canada Geese. The flock was built from birds acquired in Illinois, Minnesota, Ohio, North Dakota, Michigan, and Alabama. The original propagation effort, in 1971, was done in cooperation with the Tennessee Wildlife Resources Agency at their Buffalo Springs Game Farm in Rutledge, Tennessee. Goslings produced at Buffalo Springs were retained as breeders. In the fall of 1978 the breeders were brought to the Wildlife Restoration Center at LBL.

The geese were maintained in a 12 ha enclosure and were wing-clipped to prevent their escape; otherwise, the

birds were not harmed or disturbed. As pair formation occurred individual pairs were isolated in small pens, approximately 3 m x 11.5 m, where nest construction and egg laying took place. The diet of the penned geese was Purina Game Bird Layena. Eggs were removed from the nests, pencil marked for identification, and then placed in an incubator with a dry bulb temperature of 37.5°C and wet bulb temperature of 28.9°C. Prior to the anticipated time of hatching the eggs were placed in a hatching chamber with a dry bulb temperature of 37.2°C and a wet bulb temperature of 31.1°C. Many of the females laid replacement clutches; the egg identification procedure did not allow us to distinguish eggs from original and replacement clutches.

During the 1980 breeding season shells and shell fragments from some of the eggs were collected and marked by LBL personnel and made available to us. Shells from infertile eggs, eggs with dead embryos, and eggs that successfully hatched were included in the collections. The collected shells were washed with tap water and dried at room temperature. Measurement of the maximum diameter was made on 31 eggs. These measurements were made with a dial micrometer calibrated to 0.1 mm. No measurements were made of egg length since most of the eggs had part, or all, of the blunt end missing as a result of hatching or the collection procedure.

Shell thickness was measured by a technique similar to that described by Cooke et al. (1976). Shell fragments averaging approximately 0.4 cm x 0.6 cm were removed from each shell with scissors and forceps. Eggshell membranes remained attached to the shell fragments. Each fragment was then embedded in Bio-plastic (a polyester monomer manufactured by Ward's Natural Science Establishment, Inc.). After the Bio-plastic had cured, it was sawed into blocks exposing a radial surface of each shell fragment. This surface was sanded and polished and then etched in 10% HCl for 5 seconds. A series of imprints of the shell was made by firmly pressing the exposed shell surface onto a strip of Parafilm (a flexible, semi-transparent sheet manu-

factured by the American Can Co.) attached to a glass microscope slide. A microscope with an ocular micrometer accurate to 1 μm was used to measure the thickness of each shell imprint. Eggshell membranes, which were still present, were not included in the measurements.

To estimate shell thickness variation within eggs, samples were taken from the equator and each end of 3 eggs. Five samples were taken from each region and 5 thickness readings were made from each sample, for a total of 75 thickness determinations from each of the eggs (25 from the blunt end, 25 from the equator, and 25 from the small, or pointed, end).

Since many of the remaining eggs were represented by shell fragments from only the equator, all of the other thickness measurements were made in the equatorial region. Three small fragments were taken from each of 66 eggs, and 5 measurements of thickness were made on each fragment giving 15 thickness measurements for each egg.

RESULTS AND DISCUSSION

A summary of egg diameter measurements is given in Table 1. Eggs laid by 2-year-old females were significantly smaller than eggs laid by 8-year-old females ($P = 0.0007$, t-test). Uncertainty about the age of some females and small sample sizes prevented further comparisons with other age classes. In several other species it has also been shown that older females lay larger eggs, although in some species, such as chickens, egg size initially increases with the age of the bird but declines as the bird reaches old age (Preston 1958).

Hanson (1965:109) gives the average diameter of 11 clutches of wild Giant Canada Geese as 59.9 mm, with the smallest clutch averaging 58.2 mm and the largest averaging 62.2 mm. Manning (1978) found the average diameter of 18 eggs of wild Giant Canada Geese to be 60.06 mm. Measurements of the diameter of LBL eggs are very similar to those of wild birds; apparently conditions of captivity are not adversely affecting the size of eggs produced. Egg length of LBL eggs was not measured and comparisons could not be made with wild birds. However, Preston (1958) showed that comparisons of diameter are more meaningful than comparisons of length, since egg length is much more variable.

TABLE 1. Egg diameter (in mm) and shell thickness (in μm) of eggs from the LBL Giant Canada Goose flock.

Characteristic	N	$\bar{x} \pm \text{S.E. (range)}$
Egg Diameter		
Combined	31	60.1 \pm 0.55 (55.5-65.2)
2-yr old	5	58.0 \pm 0.81 (55.7-60.5)
8-yr old	16	62.4 \pm 0.55 (58.6-65.2)
Shell Thickness		
Combined	69	538.7 \pm 5.2 (422-641)
Infertile eggs	11	551.6 \pm 7.7 (519-593)
Hatched eggs	23	508.5 \pm 9.2 (422-583)

TABLE 2. Variation in shell thickness (in μm) within and between Canada Goose eggs.

	Small end ^a	Equator ^a	Blunt end ^a	Average ^b
Egg No. 1	523.2	522.7	526.4	524.1
Egg No. 2	533.7	579.6	508.9	540.7
Egg No. 3	511.6	484.8	459.0	485.1

^aAverage of 25 measurements.

^bAverage of preceding columns.

Variation in shell thickness within eggs was considered in 3 eggs. Table 2 compares shell thickness in the 3 sampled regions for each egg. As might be expected from such a small sample, no clear pattern emerged. The results generally agree with the findings of Tyler (1964) that while variation does occur within each egg, this variation is usually less than the variation in thickness between eggs.

Equatorial shell thickness was measured in 69 eggs. These measurements are summarized in Table 1. Eleven eggs were known to be infertile, and 23 eggs were known to have hatched. It was not possible to accurately determine whether the remaining 35 eggs had hatched, but it was clear that each had undergone embryonic development. Shells from the infertile eggs were significantly thinner than the shells of eggs that hatched ($P = 0.0008$, t-test). Rothstein (1972) reported thinning of Cedar Waxwing (*Bombycilla cedrorum*) eggs during incubation, but Anderson and Duzan (1978) did not find any decrease in shell thickness of Loggerhead Shrike (*Lanius ludovicianus*) eggs during incubation. The removal of calcium from shells of domestic chicken eggs during incubation is well documented (Simkiss 1967), but the effects on shell thickness were not indicated.

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