PROCEEDINGS
of the
PENNSYLVANIA
ACADEMY OF SCIENCE

Founded on April 18, 1924

VOLUME 56
Issue No. 1
1982

SHYAMAL K. MAJUMDAR, Ph.D., EDITOR
DEPARTMENT OF BIOLOGY
LAFAYETTE COLLEGE
EASTON, PA. 18042

58th Annual Meeting
Seven Spring Resort
Champion, Pennsylvania

SHYAMAL K. MAJUMDAR, Ph. D., *Editor*
Department of Biology
Lafayette College
Easton, Pennsylvania, 18042

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58th ANNUAL MEETING
JOINT MEETING
PENNSYLVANIA ACADEMY OF SCIENCE AND
PENNSYLVANIA SCIENCE TEACHERS ASSOCIATION
MARCH 26-28, 1982
SEVEN SPRINGS RESORT
CHAMPION, PENNSYLVANIA

Sponsored by
DUQUESNE UNIVERSITY
PITTSBURGH, PA

CONTENTS

STANLEY J. ZAGORSKI, PRESIDENT
PENNSYLVANIA ACADEMY OF SCIENCE
1982-1984

Professor Stanley J. Zagorski, President, Pennsylvania Academy of Science; B.S., Slippery Rock State College; M.S. Ed., Edinboro State College; Doctoral studies, The Pennsylvania State University. Associate Dean, College of Science and Engineering, Gannon University; Director of Environmental Studies; Director of Environmental Education; School of Graduate Studies; Professor of Biology; Director, Medical Technolgoy Program, Gannon University. Recipient of several National Science Foundation and Environmental Protection Agency grants. Published numerous articles on Environmental Studies of the Bay of Lake Erie at Erie, Pennsylvania. Treasurer of the Pennsylvania Academy of Science, 1973-76; re-elected 76-78 and 78-80; President elect 1980-1982. Member of Pennsylvania Teachers Association, International Association of Great Lakes Resarch, Audubon Society, Societas Internationalis Limnologiae.

58th ANNUAL MEETING
MARCH 26-28, 1982

Sponsored by
Duquesne University
Dr. Kurt Schreiber
General Chairman

Time and Place Chairman
Dr. William Uricchio, Carlow College

Program Chairman
Robert F. Denoncourt, York College of Pennsylvania

EXHIBITORS

American Optical Instrument Div.
Carolina Biological Supply Co.
Charles E. Merrill Publ. Co.
Connecticut Valley Biological Supply

D. C. Heath and Company
Fisher Scientific Co.
New Jersey Marine Science Consortium

Parco Scientific Company
Prentice-Hall Media, Inc.
Scott, Foresman & Company

FRIDAY, MARCH 26, 1982

1:00 P.M. — Executive Council Meeting .... Dupre Room
1:00 P.M. — PSTA Executive Committee Meeting .... Directors Room
4:00-7:00 P.M. — Exhibits .... Five Seasons Room
4:00-7:00 & 8:00-9:00 P.M. — Registration & Room Check-In .... Main Hotel Lobby
6:00-8:00 P.M. — Dinner - Buffet .... Alpine Room
8:00-9:30 P.M. — "The Exploitation of Pennsylvania's Coal Reserve" .... Sunburst Forum
9:45 P.M. — Wine and Cheese Party .... Dupre Room

SATURDAY, MARCH 27, 1982

8:15-10:00 & 12:00-2:00 — Registration .... Dupree Lobby
8:15-10:00 & 12:00-5:30 — Exhibits .... Five Seasons Rooms
8:30-9:45 A.M. — Geography (PAS; papers #1-5) ....
    Geology (PAS; papers #6-10) .... Sunburst Room
    General Biology (PAS; papers #11-15) .... Snowflake Forum
    Seeds of Change (PSTA; workshop #1) .... Dupre Room
    Science & Computer (PSTA; workshop #2) .... Laurel Room
10:00-11:00 A.M. — BRUNCH .... Fox Den
11:00-12:30 P.M. — PAS Business Meeting & Election of Officers .... Oak Room
11:00-12:00 — PSTA Executive Board Meeting .... Snowflake Room
12:30-2:30 P.M. — Chemistry (PAS; papers #16-23) .... Directors Room
    Physiology & Development (PAS; papers #24-31) .... Sunburst Forum
    Aquatic Biology (PAS; papers #32-39) .... Snowflake Forum
    Mammals Skulls, Skins & Things (PSTA; workshop #3) .... Dupre Room
    From Trash to Class (PSTA; workshop #4) .... Fox Den
1:00-5:00 P.M. — Poster Session (papers #40-46) ....
2:00-5:30 P.M. — Fruit & Cheese Hospitality, Mrs. Judy Dodd, Dairy Council ... Five Seasons Room
3:00-5:00 P.M. — Making the Outdoors Come Alive in an Urban Setting (PSTA; workshop #5) ... Matterhorn Room
    Energy Management & Conservation (PSTA; workshop #6) .... Laurel Room
    Biology & Strip Mining (PAS; papers #47-52) .... Fox Den
    Medicine/Biochemistry (PAS; papers #53-60) .... Sunburst Forum
    Animal Behavior (PAS; papers #61-68) .... Snowflake Forum
6:00-7:00 P.M. — Social Hour .... Dupre Room
7:15-8:45 P.M. — Dinner .... Alpine Room
8:45 PM. — Dr. Shyamal Majumdar (Lafayette College) "Genetic Engineering Technology" ... Sunburst Forum

SUNDAY, MARCH 28, 1982

7:00-8:15 A.M. — Breakfast .... Oak Room
8:15-10:00 A.M. — Registration .... Dupre Lobby
8:15-10:30 A.M. — Exhibits .... Five Seasons Rooms
8:30-10:00 A.M. — Computer/Engineering/Mathematics (PAS; papers #69-74) ...
    Toxicology (PAS; papers #75-80) .... Sunburst Forum
    Animal Ecology/Behavioral Science (PAS; papers #81-86) .... Snowflake Forum
    Marine Biology Filed Study (PSTA; workshop #7) .... Dupre Room
    M.A.S.S.-Alternative to High School Science (PSTA; workshop #8) .... Laurel Room
10:00-Noon — Education through Exploration (PSTA; workshop #9) .... Fox Den
    Hinduism and the Evolution-Creation Controversy (PSTA; workshop #10) ... Laurel Room
    General (PAS; papers #87-91) .... Fox Den
    Botany (PAS; papers #92-98) .... Sunburst Forum
    Terrestrial Ecology/Environmental (PAS; papers #99-104) .... Snowflake Forum
by 1:00 P.M. — Room Checkout .... Main Hotel Lobby

MINUTES OF THE EXECUTIVE COUNCIL MEETING
March 26, 1982

MINUTES
PENNSYLVANIA ACADEMY OF SCIENCE
EXECUTIVE COMMITTEE
FRIDAY, MARCH 26, 1982

Meeting convened at 1:20 p.m.

Members present: B. Martin, S. Zagorski, Sister Gabrielle, M. Bucholtz, P. Griesacker, D. Ostrovsky, S. Majumdar, K. Schreiber, S. Hendrix, R. Denoncourt, F. Brenner, T. Ziegenfus, D. Boone, G. Schoffstall, W. Uricchio, D. Zappa, C. Myers, V. Yakstis.

I. Reports of Officers and Committees

A. The President, Bruce Martin, welcomed everyone to the meeting and described his activities for the year 1981-1982. He mentioned the fact that the new book published by PAS on *Energy, Environment and the Economy* has been sent to all members with paid up dues before December. He also mentioned the possibility that a new book is in the first stages of outlining titled "Pennsylvania Coal."
He also extended his best wishes and support to the new incoming President Stanley Zagorski.

B. President-elect, Stanley Zagorski, spoke about his assignments and accomplishments during the past year as President-elect and the meetings he has attended during the year.

C. Immediate Past President, Sister Gabrielle, spoke briefly on all the activities she has attended as Immediate Past President, especially getting a grant from the State of Pennsylvania in the amount of $100,000 for The Pennsylvania Academy of Science and Pennsylvania Junior Academy of Science. Executive Council congratulated Sister on her efforts and accomplishments.

D. The Secretary, David Ostrovsky, reported that the membership list has been kept up-to-date.

E. The Executive Secretary, George Shoffstall, reported that the recommendations of Pennsylvania Academy of Science Advisory Council to the Academy during meetings in Philadelphia in 1978, in Pittsburgh and Harrisburg in 1979, have come to fruition.
That the proposed symposium to be held at the 1983 Annual Meeting of AAAS in Detroit, Michigan will be covering "Impact of Federalism on Science at the State and Local Levels."

F. The Treasurer, Paul Griesacker, and Assistant Treasurer, Michael Bucholtz, presented financial statements of PAS. Dues notices will be sent for second time, if needed. Paul explained certain points of the report; i.e., memorials, grants and membership dues.

G. The Editor of the *Proceedings,* Shyamal Majumdar, reported that 1981, Volume 55, Issue No. 1 was published in December 1981. No. 2 Issues of Volume 55 is expected to be published in March 1982. A total of 902 copies of first issue was posted.
The book, *Energy, Environment and The Economy* was published as a special publication of PAS. Publication of another book titled "Pennsylvania Coal" is in the planning stages.

H. The Editor of the *Newsletter,* Kurt Schreiber, reported that there will be five newsletters printed this year. Printing is on schedule.

I. Director of Pennsylvania Junior Academy of Science, Clarence Myers, reported on his activities for the three years of his directorship.

J. The Honorary Executive Council Chairman, Justice John Flaherty, sent a letter explaining the functioning of his committee regarding the new publication of *Energy, Environment and the Economy.*

K. The Historian, Thomas Knepp, reported an acquisition of pictures and vita of past presidents of the Academy.

L. The Membership Chairman, George Boone, reported that the new strategy of 725 posters were displayed in Colleges, Hospitals and Libraries. He asked for more help to aid him on the membership committee. He asked for two more people.

M. The Pennsylvania Science Talent Search Chairman, Kurt Schreiber, reported on the Westinghouse Science Talent Search. Pennsylvania Science Talent Search Department also needs more encouragement from teachers.

N. The Program Committee Chairman, Robert F. Denoncourt, reported that this year we have 104 people presenting papers. Dr. Shyamal Majumdar was the keynote speaker after the Banquet on March 27. His topic was "Genetic Engineering."

O. The Time and Place of Meeting Chairman, William Uricchio, reported that there were 170 people registered for PAS meeting and 75 from Pennsylvania Science Teachers

Association. Next meeting will be at Host Farms in Lancaster, Pennsylvania. Prices will be basically the same as 1982. Another possible site to look into is Center City, Philadelphia or Bedford Springs, which is larger and may be able to accommodate our large group. This is all for future meetings. An invitation will again be sent to PSTA to join our meeting. Senior and Junior Academy will be together again in 1983 and perhaps thereafter.

P. The Symposium Committee Chairman, Fred Brenner, reported on symposium for 1982 - The Exploration of Pennsylvania Coal.

Q. The Exhibit Chairman, Ted Ziegenfus, reported that he mailed 61 letters - 45 to publishing houses and 16 to scientific supply companies. He received 34 responses, resulting in 13 exhibitors for this meeting. An increase of fees for Exhibitors was one of the comments.

R. The Research Grants Committee Chairman, Sherman Hendrix, reported that PAS has received a grant of $800 from the Office of Education, AAAS to support research projects of secondary school students during 1982-1983 academic year. Miss Pamela Cornelio of St. Marys, Pennsylvania, sponsored by Stan Zagorski, will receive a grant in the amount of $210 for her research paper.

S. The Industrial Relations Chairman, Don Zappa, reported on the decline in the labor market of major corporations and how hard it is to get substantial help from the large corporations. Since many smaller companies are filing for bankruptcy, we cannot solicit for funds from them either.

II. NEW BUSINESS

1. Soliciting for new members. Mailing the new published book as an incentive to paying the membership dues on time. Cost will be $5.00 plus dues for new members.

Motion made by W. Uricchio and seconded by S. Majumdar to enact this suggestion. Motion carried. New members will pay $5.00 for the book plus dues.

2. Motion was made by Research committee to award $210 grant to a student working with Stan Zagorski. Motion carried.

3. Dr. Shoffstall stated that we send two college students and two high school students to AAAS meeting being held in 1982 in Michigan. Since there will be an eighteen-month span between next AAAS meeting, PJAS directors should be alerted to choose two juniors instead of seniors because by the time of the AAAS meeting, the seniors selected to go my be in College.

4. Sister Gabrielle made a motion to make prepare an amendment to the bylaws allowing two secretaries to take office in the future - a recording secretary and a corresponding secretary. Amendment will be brought up again at the next meeting because there are two announcements required for the amendment to be effective to enact into the bylaws. Draft of the amendment will be published in the Newsletter. Dr. Martin has consented to draft the amendment. George Shoffstall seconded and the motion carried.

Also suggested that after the nominations are sent in to the Nominating Committee, ballots should be prepared and sent to all members to vote by mail. This will be enacted in two years for the next election.

5. Dave Ostrovsky made a motion that members who are not paid up will remain on the membership list until they get the last proceedings to which they are entitled; i.e., if they paid for 1981 - after last 1981 issue of proceedings. David proposed that they automatically be dropped from the list if they have not paid their dues before the last issues has been mailed. This will become effective with the next dues notice. Motion was seconded and carried.

Meeting adjourned at 4:20 p.m.

MINUTES OF THE ANNUAL BUSINESS MEETING MARCH 27, 1982

MINUTES OF THE ANNUAL BUSINESS MEETING
March 27, 1982
Seven Springs Resort, Champion, Pa.

REPORTS OF OFFICERS AND COMMITTEES

1. REPORT OF THE PRESIDENT — Bruce D. Martin

Highlights of the 1981-82 Year

May 5, 1981 — Executive Board Meeting, PJAS, Region 7, Pittsburgh

May 19, 1981 — PAS Committee Meeting, Pittsburgh

June 3, 1981 — Presentation of Honorary Membership to Mayor Caliguiri of Pittsburgh, with Sr. Gabrielle and Dr. Shoffstall.

September 9, 1981 — PAS Committee Meeting, Pittsburgh

September 11-12, 1981 — Executive Council PAS, Pittsburgh

October 6, 1981 — PJAS Meeting, Region 7, Pittsburgh

October 7, 1981 — Represented PAS at opening of Sheraton Hotel, Pittsburgh

December 3, 1981 — Region 7, Christmas Party

December 4, 1981 — Meeting with Dept. of Commerce, Harrisburg, with Sr. Gabrielle

December 30, 1981 — Release of Energy book at luncheon sponsored by Justice Flaherty, Press Club, Pittsburgh

Jan. 2-6, 1982 — AAAS Meeting, Washington, D.C.

January 30, 1982 — Region 7 PJAS Regional meeting and PSTS interviews

Feb. 5-10, 1982 — Submission of grant agreements to Pa. Dept. of Commerce, with assistance of Justice Flaherty, Sr. Gabrielle, Dr. Shoffstall.

March 26-28, 1982 — PAS Meeting; March 28-30, PJAS State meeting.

Special Comments

The major activity of the Academy in 1981-82 revolved around the production and release of the first hard cover book from the Pennsylvania Academy of Science. Through the efforts of the Editor, Dr. Shyamal K. Majumdar, Justice John P. Flaherty, the Honorary Executive Board and many, many more supporters, funds were raised and the book released on December 30, 1981. These books have been sent to all 1982 members and are available for sale to bookstores via the Editor. This major accomplishment has brought accolades from all over the nation and the book will undoubtedly become a standard reference and text for those who will be dealing with future energy problems.

The book, *Energy, Environment and the Economy,* not only is a success in its own right, but has led to offers by the Pennsylvania Department of Commerce and the office of the Lieutenant Governor to assist with the dissemination of information about Pennsylvania coal. Editor Majumdar is working with governmental and private industry officials, as well as distinguished members of the Academy in this venture. Our sights are set on a 1982 symposium on Pennsylvania Coal and a future look at hazardous waste disposal. The goals are being incorporated within the program of your new President.

Another area of continuing concern, and sometimes frustration, has been the acquisition of adequate funding for an active and growing Academy of Science. While the unbelievably low dues often raises eyebrows, the budget in recent years has been able to cope with expenses. As long as officers and members volunteer to pay their own expenses while on Academy business and the home institutions of our members contribute time, salary, support staff and sometimes even expenses for our members to contribute their services, we can survive but probably not grow to meet even our own expectations, much less those of our goverment and the community of scientists which is beginning to view the Academy as a sleeping giant just beginning to stir. The efforts, primarily of Sr. Gabrielle, over a period of some nine years has brought the Academy to the attention of the state government and the recent grant to the Academy is a milestone in our lifetime of existence. However, the grant of nearly $100,000 is for one year only. To continue to support the Academy and the Junior Academy with the programs started this year, ongoing support at this level must be continued. We are at a junction in the road where we must decide whether to remain small and live within dues income or to start down the lane which will require a permanent staff of employees, a permanent home and a continuing major effort to produce books and symposia and to advise government on items of scientific importance. For myself, I would choose the latter way to go now that I have seen the operation of the Academy from the inside. However, it is a decision I gladly leave to your new President with my best wishes and offer to help.

The President takes this opportunity to thank all the officers and committee chairpersons for their help and devote work during the past two years. The organization is progressing every year and it is a most exciting Academy in which to be involved. I personally hope more members will step forward to offer their assistance in the years ahead. It takes many people and much volunteer time to carry our the activities we have undertaken. I especially congratulate and thank the members who have developed and produced this annual convention. We are proud of you all.

Bruce D. Martin
March 26, 1982

2. REPORT OF THE PRESIDENT-ELECT
Stanley J. Zagorski
Meeting Attended

April 1981 — PAS business meeting, Host Farms, Lancaster, PA;
    Bruce D. Martin, presiding

September 1981 — PAS Executive Council, Parkway Center Inn,
    Pittsburgh, PA; Bruce D. Martin, presiding

The President of the Pennsylvania Academy of Science, Dr. Bruce D. Martin, gave the President-Elect two specific assignments during the past year.

The first was to review the present Academy informational brochure and evaluate it for possible additions and/or corrections. After a complete review, the President-Elect determined that the brochure is adequate as it stands, and that the expense involved in making some very slight changes would not be in the best interests of the Academy.

The second assignment given the President-Elect was to update the *Guide Book for Officers of PAS.* This has been completed, and a revised edition printed for distribution at the Annual Meeting.

In addition, the President-Elect has used this year to acquaint himself with the operation of the Academy, and to benefit from the experience and knowledge of his fellow officers and colleagues. The President-Elect ahs examined items of interest to the Academy as dictated by the President.

3. IMMEDIATE PAST PRESIDENT'S REPORT
Sister M. Gabrielle Maze

During the past year your Immediate Past President was involved with the following activities:

1. September 17, with Dr. Bruce Martin, Dr. George Shoffstall and Dr. Shyamal Majumdar, I attended and took part in getting the Consolidated Coal Corporation interested in our project of Coal of Pennsylvania to advertise and to plan how to get shipments to foreign countries. The Consolidated Coal Corporation was already doing that with Germany.
2. Dr. Bruce Martin, Dr. G. Shoffstall, Dr. Brenner and I met at Duquesne University to plan a Coal Seminar at the State Meeting.
3. December 11, I attended the Energy Council Meeting with Dr. Martin and Dr. Majumdar. The Council at this time was planning to get two brochures on Coal and wanted the Academy to prepare it. But after the PAS book on *Energy, Environment and the Economy* was published, the Harrisburg Energy Council desires a book instead of 2 brochures. This is left to Dr. Majumdar to plan.

    While in Harrisburg, we met with the Commerce Department officials who were in charge of our Grant. We at least got to know some of the people we had to deal with to get our money released.

4. Also, while in Harrisburg, Dr. Martin and I visited the Charitable Commission Office and made plans to get us registered. Dr. Martin later received the Certificate-thus allowing PAS to receive grants and money.

    On April 27, Dr. Shoffstall and I will attend a Charitable Commission Meeting in Monroeville-to find out about their new plans for member organizations.

5. Also, while in Harrisburg, Dr. Martin and I visited the Tax Exemption office and asked them to add PAS to PJAS form we already had with the same number. The special that I wrote brought us the long-awaited Tax Exemption form.

6. On January 2-9, 1982, Dr. Martin, Dr. Shoffstall and I left by car for Washington, D.C. to attend the AAAS, NAAS and American Junior Academy of Science meetings. Three students arrived and met us there. The three girls, representing the Pennsylvania Youth, had poster presentations. We were proud to attend the NAAS meeting which Dr. George Shoffstall chaired, as first president from the State of Pennsylvania. Next Year he is in charge of the program for the Meeting in Detroit.

7. On February 5, at the invitation from Justice Flaherty, the Chairman of the Honorary Executive Board from Industries, we met for luncheon at the Press Club, for the presentation of our new book. The Officers of PAS and Members of the Honorary Executive Board, who helped to finance the printing of the book, were guests. The book *Energy, Environment and the Economy* is OURS. Dr. Shyamal Majumdar is to be congratulated for the fine editing.

8. The DREAM of getting funds from the State for PAS and PJAS started way back in 1973. The "AGNES FLOOD" took all the funds. When the new regime's appropriation committee was apprached they did not show interest. So, in 1979 a HOUSE BILL No. 2061 was introduced by K. Leroy Irvis, this sat in the committee for a year. In 1980 we asked Mr. Irvis and Mr. James Manderino to try again. I visited the Sessions of the House of Representatives and tried to lobby for our cause. Finally, on July 2, 1981, I received a letter stating that $100,000 dollars was placed in the Commerce Department for PAS and PJAS. Eight months of waiting started. Through much communication by letters and telephone, finally the CONTRACT arrived. In Justice Flaherty's suite, Dr. Martin, Dr. G. Shoffstall and I were present for the signing of the contract. It was mailed February 8 and returned approved on Mar. 15. Now we began waiting for the check. It finally arrived on March 19. It should be noted that the administration's decision was to withhold 1% of the grant. We thus received $99,000 dollars. The money will be proportionally distributed based on the need between PAS and PJAS.

4. REPORT OF THE EXECUTIVE SECRETARY AND GOVERNOR'S LIAISON — Dr. George C. Shoffstall

In retrospect, the recommendations of the PAS Advisory Council to the Academy during its meeting in Philadelphia in 1978, Pittsburgh and Harrisburg in 1979 have come to fruition. During this past year, the Academy has assumed a new posture in meeting and providing resources for the solutions and recommendations of technological and educational matters and concerns for the Commonwealth of Pennsylvania-especially to the Governor's Energy Council. Government has approached the Academy for other areas of scientific and technological concerns during the next decade.

Regarding the PAS Governor's Advisory Council, attention should be directed towards the Commonwealth's scientific community in order to examine the overall research enterprise at the state and local levels. This would include academic research and industrial research in order to learn how we can preserve and best utilize our scientific strengths in a period of financial stringency.

As immediate past-president of the National Association of Academies of Science and concomitantly its 1983 National Program Chairman, I am proposing that a symposium be held at the 1983 annual meeting of the AAAS in Detroit, Michigan concerning, "Impact of Federalism on Science at the State and Local

Levels." The resulting information will be made available to the PAS.

A Pennsylvania School for the Sciences (formerly proposed as the Pennsylvania Governor's School for the Sciences which I served as chairman) has been funded. The Pennsylvania Department of Education will coordinate the potential training site(s), selection criteria for high ability secondary school students and staffing. This will be an additional avenue to extend and enhance scientific training for student members of the Pennsylvania Junior Academy of Science. Moreover, a continued PAS link to this school has been implemented with the nominations of PAS Past Presidents Sr. M. Gabrielle Maze and Dr. George C. Shoffstall to the school's Advisory Board by the Pennsylvania Secretary of Education.

5. REPORT OF THE TREASURER
P.B. Griesacker and M.L. Bucholtz

PENNSYLVANIA ACADEMY OF SCIENCE
Balance Sheet
December 31, 1981

ASSETS

Cash:		
Checking account		$ 4,604.17
Savings accounts:		
General Savings Account	$ 2,569.99	
Zappa Endowment Fund	2,447.29	
		5,017.28
Savings Certificate:		
Life Membership	$ 200.00	
Oerlein-McCullough	5,000.00	
		5,200.00
Investments:		
Merrill-Lynch	21,825.98	
Bache	14,560.37	
		36,386.35
Equipment (net of depreciation)		802.00
TOTAL ASSETS		$52,009.80

LIABILITIES AND NET WORTH

NET WORTH	$52,009.80

Pennsylvania Academy of Science
Lafayette College
Easton, Pennsylvania

I have examined the balance sheets of the Pennsylvania Academy of Science as of December 31, 1981, and the related statements of revenues and expenditures for the year then ended. My examination was made in accordance with generally accepted auditing standards and, accordingly, included such tests of the accounting records and such other auditing procedures as were considered necessary in the circumstances.

In my opinion, the financial statements referred to above present fairly the financial position of the Pennsylvania Academy of Science at December 31, 1981, and the revenues and expenditures for the year then ended, in conformity with generally accepted accounting principles applied on a consistent basis.

Dennis C. Steele, Auditor

Erie, Pennsylvania
February 24, 1982

PENNSYLVANIA ACADEMY OF SCIENCE
Statements of Income and Net Worth
For the year ended December 31, 1981

REVENUE:

	Meeting registration	
Energy Seminar		$ 9,315.97
Interest & dividends	8,000.00	
Dues	6,299.75	
Printing (page charges)	4,610.00	
Library subscriptions	3,250.00	
Gifts	2,131.25	
AAAS	1,158.00	
Grants	800.00	
	750.00	
		$36,314.97

EXPENDITURES:

Printing & Publications	$10,360.97	
Meeting expenses	9,050.96	
Travel	1,981.44	
Salaries	1,280.95	
Awards	1,280.00	
Rent	957.00	
Supplies	884.48	
Postage	873.65	
Dues	113.50	
Professional Services	100.00	
Depreciation	89.00	
Insurance	54.00	
		27,025.95

EXCESS REVENUE OVER EXPENDITURE	$ 9,289.02
NET WORTH, JANUARY 1, 1981	$42,720.78
NET WORTH, DECEMBER 31, 1981	$52,009.80

EXHIBIT "A" — Receipt and Disbursements of The Pennsylvania Academy of Science for the period of January 1, 1981 to December 31, 1981

	1981	1980	1979
Receipts			
Membership Dues:			
Institution	$ 75.00		
Student	290.00		
Sustaining	195.00		
1978	40.00		
1979	150.00		
1980	430.00		
1981	3140.00		
1982	290.00		
Total Membership Dues	$ 4,610.00	$ 2,040.00	$ 4,615.00
Library Subscriptions			
Vol. 52	25.00		
Vol. 53	68.75		
Vol. 54	1356.25		
Vol. 55	418.75		
Vol. 56	262.50		
	2,131.25	1,825.00	2,193.75
Gifts:			
Mrs. Castro	$ 948.00		
Ann Schreiber Leifer	10.00		
J.A.F. Memorial	200.00		
Pittsburgh Spectroscopy	750.00		
	2,017.00	3,055.00	3,160.02
Grants:			
AAAS	$ 800.00		
	800.00	2,500.00	541.00
Interest and Dividends:			
Darbaker Certificate	780.16		
Life Membership Fund	13.00		
Orlein-McCulloch Bond	575.00		
Merrill-Lynch	10,900.00		
Energy Seminar	74.42		
	12,342.58	8,188.53	3,046.67
Page Charges	$ 3,100.00	$ 3,530.00	$ 3,110.00
Annual Meeting	9,000.97	10,034.09	7,927.88
Advertisements	—	200.00	200.00
Exhibitors Fees	260.00	1,976.00	975.00
Admission Fees Fall Meeting	70.00	310.00	—
1979 Meeting Registrations	—	295.75	—
TOTAL RECEIPTS	**$34,222.80**	**$32,118.37**	**$25,769.32**
DISBURSEMENTS			
Printing:			
Proceedings	$ 8,811.70		
Newsletter	888.87		
	$ 9,699.97	$ 8,700,04	$11,684.82
Postage	873.65	584.35	585.58
Wages	1,280.95	947.40	808.50
A.A.A.S. Dues	113.50	108.50	50.00
Travel Expenses for Officers	2,010.84	1,976.83	2,173.99

Awards:
Darbaker Award
Zappa Science Awards $ 630.00
  Lance Williams   100.00
  Andrew Seville   100.00
Oerlein Award
  Eric Scharpf   100.00
  Renee Franceschi   100.00
  David Farley   100.00

	$ 1,130.00		
Professional Services:		545.00	541.00
Auditing and Income Tax			
Supplies	100.00	100.00	100.00
Petty Cash Expenditures	769.70	1,734.69	719.41
Meeting Expenses	—	38.91	8.68
Office Rent	8,996.46	9,506.14	8,564.56
Insurance	957.00	516.00	—
Energy, Economy and the Environment	—	130.00	—
	511.00	—	—
TOTAL DISBURSEMENTS:	**$26,443.07**	**$24,887.86**	**$25,736.54**

EXHIBIT "B" — Accounts for the Pennsylvania Academy of Science, Inc.
for the period of January 1, 1981 to December 31, 1981

I. Checking Account
Balance, December 31, 1980 $ 850.29
Deposits   34,222.80
    $35,073.09
Disbursements   30,459.07
Balance, December 31, 1981

II. Publications Endowment Fund
Balance, December 31, 1980 $ 4,614.02
Receipts:
  Interest $ 5,859.76
Transfer to Bache   179.46
Balance, December 31, 1981 $ 6,039.22

III. General Savings Account
Balance, December 31, 1980   -0-
Receipts:
  Interest $ 1,724.29
Transfer to Merrill Lynch   52.81
Balance, December 31, 1981 $ 1,777.10

IV. Darbaker Account
Balance, December 31, 1980   -0-
Receipts:
  Interest $ 2,493.62
Balance, December 31, 1981   156.40

V. Zappa Endowment Fund
Balance, December 31, 1980 $ 2,650.02
Receipts:
  Interest $ 2,374.56
Balance, December 31, 1981   148.94
    $ 2,523.50

VI. Merrill-Lynch Ready Assets Trust
Balance, December 31, 1980 $ 2,849.23
Deposits:
  Six Month Money Market (4/10/81) $10,676.00
  Six Month Money Market (4/21/81)   10,650.00
  Checking Account (4/30/81)   4,000.00
  General Savings Account Transfer (9/21/81)   1,777.00 $27,103.00
    $29,952.23
Disbursements:
  Withdrawal (3/31/81) (Annual Meeting) $ 2,900.00
  Withdrawal (5/28/81) (Printing of Proceedings)   4,000.00
  Withdrawal (9/29/81) (Printing of Proceedings)   4,000.00 $10,900.00
    $19,052.23
Receipts:
  Interest $ 2,628.25
    $21,680.48

VII. Bache
Balance, December 31, 1980 $ -0-
Deposits:
  Business Savings Account (9/28/81)   8,010.66
  Publications Endowment Fund (9/28/81)   6,039.22
    $14,049.88
Receipts:
  Interest   510.49
    $14,560.37

VIII. Savings Certificate-Life Membership
Balance, December 31, 1980 $ 200.00
Receipts:
  Interest $ 13.00
Disbursements (Transfer to Checking)   13.00
Balance, December 31, 1981 $ 200.00

IX. Orlein-McCulloch Certificate
Balance, December 31, 1980 $ 5,000.00
Receipts:
  Interest $ 575.00
Disbursements (Transfer to Checking)   575.00
Balance, December 31, 1981 $ 5,000.00

**FINANCIAL REPORT
FOR THE 57th ANNUAL PAS SPRING MEETING
APRIL, 1981**

REVENUE:
Rooms $ 8,515.97
Registration—
  Members $ 440.00
  Nonmembers   100.00
    $ 540.00
Exhibitors Fees $ 260.00

    TOTAL REVENUE $ 9,315.97

EXPENSES:
Seven Springs (Rooms, meals, etc.) $ 7,442.56
Refunds on Rooms   15.00
Refreshments   400.00

Program Expense
Oerlein Awards
Zappa Science Award 100.00
Plaques and Pens 300.00
Dr. Uricchio's Expenses - Travel to arrange meeting 200.00
Dr. Schreiber's Meeting Expenses 329.20
195.00
60.00

TOTAL EXPENSES

Revenue of Expenses

$ 9,041.76

$ 274.21

BALANCE SHEET
(March 12, 1982)

ASSETS

Cash:
  Checking Account $14,709.98
  Petty Cash Fund 5.83

Savings Accounts:
  Darbaker Savings Account $ 2,650.02
  Zappa Endowment 2,523.50

$ 5,173.52

Savings Certificates:
  Life Membership $ 200.00
  Oerlein-McCullough 5,000.00

$ 5,200.00

Investments:
  Merrill-Lynch $21,680.48
  Bache 14,560.37

$36,240.85

Total Assets $61,330.18

LIABILITIES AND NET WORTH

Net Worth

$61,330.18

6. REPORT OF THE EDITOR OF THE PROCEEDINGS OF THE PENNSYLVANIA ACADEMY OF SCIENCE
Shyamal K. Majumdar

The 1981 *Proceedings,* Volume 55, Issue No. 1 was published in December, 1981 following the same editorial style as in the past. The No. 2 Issue of Volume 55 is expected to be published in March 1982. A total of 902 copies of the first issue was posted; 45 were undeliverable. A book titled *Energy, Environment, and the Economy* was published as a special publication of the Pennsylvania Academy of Science. The book was conceived as a collection of energy, environment, and the economy related papers presented at the two seminars sponsored by the Pennsylvania Academy of Science. As of today, between 465-475 books were distributed among the PAS members who paid their 1982 dues. Approximately 27 books were sold to non-members, private organizations, and private libraries.

An Editorial Committee has been appointed consisting of the Editor and thirty-six members. The members are specialists in various fields (see Vol. 55, #2 Issue for names and their affiliation). In 1981, fifty four manuscripts were submitted, of which 40 were accepted. Every paper was read and evaluated by one or more reviewers in whose field the paper lies.

The Editor expresses his appreciation to the members of the Editorial Committee for their generous assistance in reviewing the manuscripts, to the contributors for their excellent cooperation, and to Professor Robert S. Chase, Head, Department of Biology, Lafayette College for his generosity in allowing the department to absorb certain expenses (telephone and secretarial) incurred by the Editor's office. The Editor is deeply grateful to many other members and non-members of the PAS who helped in the evaluation of the manuscrips submitted for publication in the *Proceedings.* The Editor answered many queries relating to publications in the *Proceedings,* and is working toward the publication of the second book, *Pennsylvania Coal.*

7. REPORT OF THE EDITOR OF THE NEWSLETTER
Kurt C. Schreiber

With the publication of the April 1982 issue of the *Newsletter,* which will shortly be at the printer, I am completing my third year as editor of the *Newsletter.* For the second year in a row we published five issues of the *Newsletter.*

Inflation continues to plague us. The cost of publication continues to increase. This is especially true with respect to postage. In July 1981 the rate of third class mail increased from 3.5¢ per piece to 3.8¢. A further increase to 5.9¢ per piece went into effect in January 1982 and an additional increase is being considered to take effect in July 1982.

We continue to explore different ways of bringing items of interest to our members. This past year we started a Historian's Column featuring biographical information about the past presidents of the Academy. Judging from the mail that this column has generated there must be a good number of our members who read this column.

We hope to continue to serve the membership of the Academy through new features during the concluding year of my term as editor of the *Newsletter.*

8. REPORT OF THE STATE DIRECTOR, PENNSYLVANIA SCIENCE TALENT SEARCH
Kurt C. Schreiber, Director

On the plus side, for the first time in three years we had a trip winner from Pennsylvania in the Westinghouse Science Talent Search. However, on the negative side the number of Honors winners from PA declined to six and the number of entries from PA declined to 41. These two figures are disappointingly low and shows clearly the decline in interest in science and mathematics in the Commonwealth. It may be argued that this decline is due to the decline in the school population. However, while this may be a contributing factor, the fact that the number of entries received nationwide has changed very little over the last five years indicates that PA is not keeping up with the national trend.

It is hoped that the Pa. School for Science, to be inaugurated this summer, will reverse the trend observd above. The selection procedure for the school weighs heavily awards in science fairs, PJAS, and PSTS.

As of this writing no interview reports have been received from four regions (Region #6, 8, 9, & 10). The number of participants in the Pa. Science Talent Search is also down from previous years. Award winners: Honors awards - 6; First awards - 8; Judges awards - 23; Junior awards - 36. At the September meeting on the directors of the Pa. Jr. Academy of Science the requirements for the judge Awards in the PSTS was tightened. At the time the question arose to what extent would that decrease the Judges awards presented. My answer was a guess of 25%. 21 twelfth graders received no awards. Nine of these were disqualified in the interviews. Twelve were disqualified because of the changed requirements. Since 44 twelfth graders were involved in the interviews, the twelve represent 27% of the students. Careful analysis of these 12, shows that eight of them participated in the PJAS competition for the first time. The other four, two had four years participation in PJAS, but well below 1000 on the SAT, one had three years and one two years, neither received a first award in their presentations. Of the twelve there are only two that I feel sorry that they did not receive recognition by PSTS.

9. REPORT OF THE HISTORIAN
Thomas H. Knepp

The Historian has completed the acquisition of pictures and vita of the Past-Presidents of the Academy.

Dr. Schreiber has taken on the project of publishing pertinent material about the Past-Presidents in the *Newsletter.* Through Dr. Schreiber, via a letter from Dr. Roy Tasker, formerly of Bucknell University, I have additional information about Dr. Norman Stewart of Bucknell which I have added to his vita.

I have found a Kodachrome of Dr. O.E. Jennings which I am going to have enlarged and put with his vita.

The balance in this Historian's account according to my book is $16.01.

10. REPORT OF THE HONORARY EXECUTIVE COMMITTEE — Justice John P. Flaherty, Chairman

The Committee has functioned well and productively during the year just passed. The fruit of its immediate efforts is the highly acclaimed publication, *Energy, Environment and the Economy.* I do not think it is necessary for me to restate the background which lead to the publication, but during 1981 it was most supportive, and indeed furnished the Academy with the $8,000 necessary for production.

At a recent luncheon meeting the Committee discussed and authorized, first, a seminar and resulting publication involving Pennsylvania coal, and, secondly, a seminar and publication involving solid waste disposal. Serious efforts are underway in the development of these projects.

I am greatly elated to observe that within a relatively short span of time the scope and function of the Academy has expanded and is being fulfilled. The Commonwealth of Pennsylvania now recognizes the Academy and its unique roll as an objective source which can be relied upon involving policy matters affecting any aspect of scientific application. I also feel the credibility of the Academy has greatly increased in the eyes of the public and of the academic community.

Speaking on behalf of the Committee, there is every reason to believe that 1982 will continue our progress.

11. REPORT OF THE PENNSYLVANIA JUNIOR ACADEMY OF SCIENCE
Clarence D. Myers, State Director

As the third year of my term of office comes to an end, my desk is a real "Mess" — there is so much unfinished business. Throughout the three years of my term of office, I have tried to promote a greater participation in science-oriented activities for all the students in Pennsylvania.

The following committees and or Directors have been changed. Dr. Frank Hoffman of Slippery Rock State College has resigned from the State Judging Chairmanship effective following the State Meeting this year. Mr. Joseph Mascetta of Region VII (Co-Director) will resign after this year as he is now Principal of Mt. Lebanon High School. (Congratulations Joe). Sister Colette is still Co-Director of Region VII and they are looking for a replacement. (An excellent possibility is Wayne Mikach of North Hills High School.) Mr. Robert Everly of Region V will be the new Co-Director of that Region. He has been an assistant for some time.

STATE MEETING REPORTS

1981 State Meeting at Host Farms in Lancaster - Region III hosted this meeting, April 5-7, 1981. There were 989 students registered to present papers. There were 326 First place awards. the computer was used to help in the summary room and everything worked well with the exception of a few small problems. Instructions were given the Directors so that we can avoid them.

1982 State Meeting at Seven Springs will be hosted by Region X on March 28-30, 1982. There are 1,000 students presenting papers at this meeting. Even though it is early, housing is filled to capacity. We will have the usual package which includes meals, housing, insurance and registration. The cost will be $61.00 on a 4-5 persons per room basis.

We will also have several Commercial Exhibitors to demonstrate various instruments and equipment. (Spec 20, Analytical balance, incubators, spirometers, Oscilloscope, EKG machine, etc.) This will be for the benefit of all present but sessions are limited. Demonstrations will run from 10:00 a.m. to 4:00 p.m. (Hopefully, these instruments will be purchased with the money received from the state grant.) These instruments will be available on a loan basis to all Regions once a request is written.

1983 State Meeting at Host Farms. Region I will host, April 10-12, 1983 with PAS Committees have been appointed. Coordinators are Gloria Hallowell and Pat McGeever; Judging, Dr. Robert Stamper; Housing, Rosemary Calabretta; Program, Dr. William Ritter; Finance, Clyde Dry and Awards, Jim Imler.

1984 State Meeting at Seven Springs. Region VIII will Host, April 1-3, 1984.

REGIONAL ACTIVITIES

Each Region conducted various workshops and seminars. Most Regions are now giving Special Awards to stimulate interest in independent research projects.

I did not get reports from some Regions. I will include the report of Regions in the next report.

REPORT OF DIRECTORS' ACTIVITIES

Reprinted 2,500 PJAS brochures for distribution to all Regions. This brochure was also sent to all the surrounding Junior Academies. (Also a state program)

The "Guide for Conducting a State meeting" will be distributed to the committees and Directors as soon as it comes from the printers. A 45-page booklet with all very specific details (spiral bound).

The "Catalog" for supplies and equipment is complete except for the inclusion of the instruments and equipment which will be available for loan after receiving funds from the State Grant. (Sister Gabrielle's report.)

A SPECIAL AWARD for Marine Science at Wallops Island (one week). One or two students will be selected. Dr. Ivan Reimold and Mr. James Imler will select the students through interviews.

Still working on an up-date of history and activities of all Regions. This is about half completed as I have not received information from some of the Regions.

Attended as many of the local and organizational meetings as possible in as many capacities as I could. Some as advisor, some as an onlooker, and some as participant.

Attended PAS meeting at Parkway Center Inn on September 11-12, 1981.

November 27-29, 1981, went to Philadelphia to determine "state of affairs" of schools due to strikes in that city.

December 3, 1981 to Grove City for Region IX Organizational meeting.

January 30, 1982 to Greensburg to attend Region VII Regional meeting.

February 13, 1982 to Grove City to attend Region IX Regional Meeting. (I had 8 students entered in various categories - six received first awards.)

March 13, 1982, met with treasurer and hospitality committee to plan State Meeting Activities.

12. REPORT OF THE MEMBERSHIP COMMITTEE
George C. Boone

This past year a new strategy to attract members was tried. About 725 membership posters containing tear-off membership forms were mailed to academic departments, hospitals, etc. to solicit new members. A "Call for Papers" poster was mailed with the membership poster. Hopefully, both posters were displayed in prominent locations so all non-members had access to the information.

This past year the Membership Committee consisted only of myself. As a result, I was not able to canvas the industrial sources for new members.

I am requesting help from the Executive Committee to find one or two members who will be willing to work with me on increasing the numbers of members in the Academy. Industrial memberships need attention.

Actually, every member of the Academy is on the Membership Committee. If each member encouraged one person to join we would *double* our present membership. A membership of over 1500 would create a strong Academy and help produce a greater science awareness in the state of Pennsylvania.

13. REPORT OF THE TIME AND PLACE OF MEETING COMMITTEE — William A. Uricchio

The 58th Annual Meeting of the Pennsylvania Science Teachers Association was held in conjunction with the Pennsylvania Science Teachers Association on Friday, March 26 to Sunday, March 28, 1982 at Seven Springs Lodge, Champion, Pennsylvania. The host and local arrangements committee was Duquesne University, under the leadership of Dr. Kurt Schreiber. The program responsibility was again assumed by Dr. Robert Denoncourt.

The 59th Annual Meeting will be held at Host Corral, Lancaster, Pennsylvania, April 10-12, 1983 in conjunction with the Pennsylvania Junior Academy of Science.

The committee visited the Holiday Inn-Center City, Philadelphia as a possible site for a future meeting. The report of this visit was presented at the executive council meeting.

The Time and Place of Meeting Committee would like to recommend that all future meetings be held in conjunction with the Pennsylvania Junior Academy of Science. This, of course, does not mean at the exclusion of the Pennsylvania Science Teachers Association.

14. REPORT OF THE SYMPOSIUM COMMITTEE
Fred J. Brenner, Chairman

The symposium for the 1982 meeting is entitled "The Exploration of Pennsylvania's Coal Reservoir." The speakers include Mr. Gerold R. Spindler, Vice-President, Exploration, Consolidation Coal Company; Dr. Heinz G. Pfeiffer - Manager, Technology and Energy Assessment, Pennsylvania Power and Light; and Mr. George E. McCoa - Department of Mining Engineering, University of Pittsburgh. As a suggestion for future meetings, we may want to consider an invited paper session in conjunction with a Keynote Symposium.

15. REPORT OF THE EXECUTIVE COUNCIL
Theodore T. Ziegenfus, PAS Exhibit Chairperson

The solicitation of exhibitors for the 58th Annual meeting of PAS and the Spring meeting of the PSTA was a joint venture involving myself for PAS and Ken Mechling for PSTA. I was responsible for scientific supply companies, Ken was responsible for publishing houses. Approximately 61 letters were mailed - 45 to publishing houses and 16 to scientific supply companies. A total of 34 responses were received, resulting in 13 exhibitors. It should be noted that several of the negative responses indicated that they would possibly exhibit in the future. Also names of several exhibitors for future meetings have been suggested.

Letters of acknowledgement and housing packages were sent to exhibitors responding prior to February 16, 1982. Late exhibitors are not listed in our program and should be recognized in some other manner. Letters of appreciation will be sent following this meeting.

16. REPORT OF THE RESEARCH GRANTS COMMITTEE
Sherman S. Hendrix, Chairman

The Pennsylvania Academy of Science, through the Research Grants Committee, received a grant of $800.00 from the Office of Science Education, American Association for the Advancement of Science to support research projects of secondary school students during the 1981-82 academic year. This award was added to the $300.00 previously budgeted for research grants.

Announcements of the availability of these research funds for student projects were made in the PAS Newsletter. Secondly, Mr. Clarence Myers was asked to notify his ten regional directors and other interested persons that these funds were available. The plan was to seek at least one proposal from each of the ten PJAS regions.

The committee received one proposal this year. Miss Paula Ann Cornelio of St. Marys, with Dr. Stanley Zagorski as sponsor, requested $209.64 for a project involving oxygen, ATP, CO_2, and NADPH production in photosynthesis in *Elodea*. After a number of rounds of correspondence for clarification of several points about the project and the role of Dr. Zagorski, the committee recommended funding.

The committee is still open to suggestions as how to increase the number of applications for funds. This money is going begging.

17. REPORT OF INDUSTRIAL RELATIONS COMMITTEE
D. E. Zappa, Chairman

The past year has shown a definite decline in new employment by most major corporations. High interest rates, foreign competition and union demands have all contributed to the present situation.

Most corporations have indicated that when employment of new people begins again, only those graduates in the upper third of their class will be considered. It is extremely important that this message is imparted to our college students.

18. REPORT OF THE PROGRAM COMMITTEE
Robert F. Denoncourt, Chairman

A total of 104 papers were scheduled for presentation at the 58th Annual meeting of the Pennsylvania Academy of Science, 26-28 March, 1982 at Seven Springs Resort in Champion, Pennsylvania. These were divided into topic related sessions as follows: Geography, Geology, General Biology, Chemistry, Physiology and Development, Aquatic Biology, Poster Session, Medicine/Biochemistry, Biology and Strip-Mining, Animal Behavior, Computer/Engineering/Mathematics, Toxicology, Animal Ecology/Behavioral Science, Botany, Terrestrial Ecology/Environment, and General.

The program was completed with the exception of "List of Exhibitors" by mid-December and copies forwarded to Dr. Kurt Schreiber. Postcards with day, time and subject session and an application form for the PAS were sent to each presentor.

Dr. Fred Brenner again organized a special symposium of pertinent interest to Academy members and all Pennsylvanians: "The Exploitation of Pennsylvania's Coal Reserve."

AND, "our own" Dr. Shyamal Majumdar will be the keynote speaker after the banquet on 27 March. He will present a topic/information from his area of specialization - Genetic Engineering.

Dr. Kurt Schreiber deserves special credits for his efforts in behalf of the program publications.

19. NEW BUSINESS

An amendment will be made to change bylaws in the proper procedure to allow for two seretaries.

President called for nomination from the floor.

Dr. Ernest Braue was nominated from the floor for office of assistant treasurer. He gave a background of his experience and activities.

Dr. Howard Spencer Pitkow, second nominee for assistant treasurer also gave a background of his experience and activities.

Dr. Boone made a motion and it was duly seconded and carried to close the nomination. A special ballot was taken for this one office. While balloting was going on, Stanley Zagorski, the new President of PAS, was asked to say a few words. Before proceeding with his speech, and assuming the presidency, Stan presented Dr. Bruce Martin, the outgoing president, on behalf of the Academy, a plaque of gratitude, and a plaque designating with our deepest appreciation for Dr. Martin's outstanding service to the scientists of Pennsylvania and members of PAS.

Stan Zagorski remarked that the Academy is heading in the right direction, he has been a member of the Academy for fourteen years and served as treasurer for eight years.

Stan thanked Paul Griesacker for his devoted duty to the job of treasurer and gave encouragement to Michael Bucholtz, who assumes the job of treasurer for 1982. Stan also thanked the key people who helped him adjust to the new job of President.

The New President made the following appointments, in addition to the elected officers:

Dr. Ernest H. Braue, Jr. was elected to the office of Assistant Treasurer of PAS.

Dr. Robert J. Halma, was elected to the office of Historian. President: Stanley J. Zagorski; President-Elect: George C. Shoffstall; Immediate Past President: Bruce D. Martin; Treasurer: Michael L. Bucholtz; Assistant Treasurer: Ernest H. Braue, Jr.; Editor of the Proceedings: Shyamal K. Majumdar; Secretary: David S. Ostrovsky; Historian: Robert J. Halma.
Appointed Chairmen and Special Liasion Persons:
Advisory Council Chairman: Justice John F. Flaherty; Annual Meeting Coordinator: George C. Shoffstall; Membership Chairman: George C. Boone; Assistants: Henry Fremount, Paul Griesacker and Jennie Ranii; Time and Place Chairman: For the West-Bill Uricchio, For the East-Henry Fremount; Local Arrangements: East - Anton Fontes, West - Kurt C. Schreiber; Program Chairman: Robert Denoncourt and Carolyn Mathur; Auditing: V. Yakstis and Bernard Fried; Nominating Committee: Bruce Martin, Sister Gabrielle and Justice Flaherty.

SPECIAL COMMITTEES
Special Symposium - October 17, 1982 - Hopefully at Gannon University. Topic: Hazardous and Solid Waste.
Special Chairman for this program - Don Zappa, Industrial Liaison person. This may result in our third published book.
Science Talent Search: Kurt C. Schreiber; Recording Secretary: Viola Yakstis; Special Student Awards: James Imler; Grants Awards: Sherman Hendrix, Jack Harclerode, F. Brenner; Fund Raising: Sister Gabrielle; Representatives to the AAAS Meeting:

George C. Shoffstall and Sister Gabrielle; Affiliate Liaison: Ken Mechling; Industrial Relations Liaison: Don Zappa; Pennsylvania School of Science: George C. Shoffstall; Resolutions Committee: Dr. Jack Schumann; Finance: William Gregory; Publications Endowment: Dr. Karl Oerlein; Speaker's Committee: Dave Ostrovsky; Exhibits: Ted Ziegenfus; Symposium Chairman: We do not have one at this time. Need suggestions for topic and chairman; PJAS State Director: Clarence Myers.

Motion on amendment to include recording secretary and a corresponding secretary as officers was made. This would have to be formulated in an appropriate amendment and printed in the Newsletter for official vote at the next business meeting. Motion was seconded and motion carried.

Don Zappa, Industrial Relations Chairman, asked to make a presentation. He spoke on the merits and concern of Sister Gabrielle for PAS and PJAS. He formally presented a check in the amount of $1,000 to the Academy as an Endowment Fund, in Sister's name. The interest from this Fund will be used every year as an extra award for a student coming to the State meeting, representing PJAS. He also presented a check in the amount of $300.00 to be given at this meeting to three people.
Meeting adjourned at 12:30 p.m.

Viola Yakstis
Recording Secretary

MINUTES OF THE ANNUAL BUSINESS MEETING MARCH 28, 1982

MINUTES: PENNSYLVANIA ACADEMY OF SCIENCE ANNUAL BUSINESS MEETING MARCH 28, 1982

A short third Business Meeting was held on Sunday morning, March 28, 1982 commencing at 9:15 a.m. Following are items of unfinished business that were taken care of before members departed for home.
The new president, Stanley Zagorski, introduced all the new officers who will serve with him for two years beginning as of this meeting.

UNFINISHED BUSINESS
1. Dr. Bruce Martin, Immediate Past President, distributed a packet of insurance information on Friday, March 26, and asked the members to look it over and it will be voted upon at a later meeting. This information came up at this meeting. The Monarch Life Insurance Company requested from us to solicit for members by asking PAS to send them a list of our members and they in turn will give us a 10% discount on supplemental insurance. This insurance covers businessmen, professional men and is a concancellable type policy. After a brief discussion, motion was made to Bill Uricchio not to accept the offer of Monarch; it was seconded by George Shoffstall. Motion carried.
2. Regarding Emeritus Membership for George C. Ziegler, who was a member of PAS from 1965 to 1979. He retired from active work in 1977. Motion was made by George Boone and seconded by Michael Bucholtz. Motion carried. He will pay no dues and will receive the Newsletter only.
   Emeritus Membership clarification will be explored further at the fall meeting.
3. Suggestions for fall meeting - coincide with symposium; tentative dates October 15, 16 and 17. The President, Stanley Zagorski, will explore and notify everyone by mail.
4. The President, Stanley Zagorski, also suggested since the two treasurers live a distance from one another, they should meet at least twice before our meeting in April. They are also requested to send a reorganization pattern so that the President can send the copy to the Executive Board Committee. One meeting should take place before the Fall Meeting and one meeting before the Spring Meeting.
5. Sherman Hendrix, Research Grants Committee, asked for authority to pay out money to sponsors and/or students on a committee basis rather than going to membership or Executive Board at annual meeting. One suggestion was made that the President of PAS should clear the authorization and then ratify it with the Executive Board.

Motion reads: That the Research Grants Committee be given approval to approve grants to have them funded and also that the President and Treasurer of PAS clear these applicants as well as the Research Grants Committee without having to go through membership or Board of Directors. Dr. Hendrix motion was seconded by Don Zappa. Motion carried.
6. Sister Gabrielle asked for a budget plan from PAS for next year's grant. Sister will present the budget for Committee's comment and approval.
7. William Uricchio made a motion and Shyamal Majumdar seconded for adjournment. Motion carried and the Meeting was adjourned at 9:50 a.m.

Viola Yakstis
Recording Secretary

MINUTES OF THE EXECUTIVE BOARD MEETING
SEPTEMBER 11 and 12, 1981

MINUTES OF THE
PENNSYLVANIA ACADEMY OF SCIENCE
EXECUTIVE BOARD MEETING
September 11 and 12, 1981

The meeting convened at 1:20 p.m. at the Parkway Center, Greentree, Pennsylvania. Dr. Bruce Martin, presiding.

Following were present: Dr. Bruce Martin, Dr. Shyamal Majumdar, Dr. Kurt Schreiber, Sister M. Gabrielle, Dr. George C. Shoffstall, Dr. William Uricchio, Dr. Paul Griesacker, Dr. George Boone, Dr. Michael Bucholtz, Dr. Ted Ziegenfus, Clarence Myers, Vic Polk, Stanley Zagorski and Viola Yakstis.

The following reports were presented:

OLD BUSINESS

Ted Ziegenfus has consented to be the Chairman of the Exhibits for the March 1982 meeting at Seven Springs.

TAX EXEMPT STATUS:

Sister Gabrielle will work to get the tax exemption status for PAS just as she did for PJAS.

NEW BUSINESS

The Book titled *Energy, Environment and the Economy* is in the process of being printed and will be ready for distribution sometime in November or December. The artist for the cover of the book Algert (Fritz) Ziaukas, a member of Region 7 of Pennsylvania Academy of Science.

Marketing of the book will be the responsibility of Justice Flaherty of Pittsburgh and Dr. George Shoffstall. Members with paid up dues by January 1 will receive a book.

FUNDING REPORT:

Sister Gabrielle gave a glowing report about a letter she received from State of Pennsylvania giving us a grant of $100,000 for PAS and PJAS. Sister sent a thank you letter to Mr. Mandarino and Mr. K. Leroy Irvis for their efforts in getting us this grant. Sister Gabrielle and George Shoffstall will act as liaison between us and the State of Pennsylvania until we receive the money.

William Uricchio made a motion to give a vote of thanks to

Sister for her perserverance, for nine years, in obtaining this money for the academies. It was seconded and approved unanimously.

REPORTS OF COMMITTEES:

TREASURER—Paul Griesacker reported that checks are being processed within the month of receipt. As of this meeting, PAS has $2,781.67 in the checking account, $690.00 in undeposited checks and $6.19 in the petty cash fund. Including endowment funds, checking and savings accounts, there is a total of $52,019.47 in assets. Since there is a depressed bond market, motion was made by Bruce Martin and seconded by George Shoffstall to take the $8,000 out of Energy Book account and publication account and combine into a money market certificate as we have done with the other monies. Motion carried.

TIME AND PLACE CHAIRMAN — William Uricchio stated that the total cost of the package will be $77.00 per person, double occupancy, at Seven Springs from March 26 to 28, 1982. This meeting will be held jointly with the Pennsylvania Science Teachers Association. The Pennsylvania Junior Academy of Science will meet on March 28 to 30, 1982, following our meeting. It was suggested that we raise the registration fee from $5.00 to $10.00 for members and $15.00 for nonmembers.

The 59th Annual Meeting will take place on April 10 to 11, 1983 and will be held at Host Farm and Corral, Lancaster, Pennsylvania. The total package will be basically the same as 1982. This meeting will be held jointly with the Pennsylvania Junior Academy of Science.

STATE DIRECTOR'S REPORT

Clarence Myers, State Director, Junior Academy of Science gave out report and explained some of the points in his report; i.e., computer printouts used in judging, entries of first awardees to state meeting, Region X as host for 1982 meeting, publishing of Judges Handbook and brochure, guide for hosting a state meeting, catalog for supplies, special awards, participation in Westinghouse Science Talent Search, establishing criteria for AAAS awards, developing a certificate to be used for special awards, helping Sister Gabrielle and Finance Committee, Judging committee and updating history of the regions.

AAAS REPORT — George Shoffstall has mentioned to Lt. Governor Scranton that PAS is available to help the Governor as advisors on science matters in the State. George spoke briefly on the following matters: Governors School of Science, Funding of Governor's School of Science. Coordinators of this project will be George Shoffstall, Sister Gabrielle and John McDermott.

EXHIBITOR'S REPORT — Ted Ziegenfus, Chairman, began discussion concerning exhibitors.

TENTATIVE ITINERARY — Dr. Bruce Martin reviewed the up-coming PAS meeting in March and presented a tentative format and also explained the package, cost, etc.

SYMPOSIUM — A symposium will be held on March 28, 1982. Fred Brenner has consented to get speakers whose subjects will for the most part be concerned with Hazardous Waste. After a lengthy discussion it was finally decided to go with hazardous waste on Friday night.

MEMBERSHIP — Dr. George Boone, Chairman, stated that he needs help with membership and asked for some suggestions as to how he can get someone from Western region to help him.

PROCEEDINGS EDITOR — Dr. Shyamal Majumdar presented his report and spoke on importance of presenting manuscripts early. He also spoke on the forthcoming book *Energy, Environment and the Economy*. Dr. Majumdar mentioned that the no. 1 issue of Volume 55 (1981) is ready for publication and is due to be out in the latter part of September

1981. The No. 2 issue is scheduled to be published in December. Dr. Majumdar has also obtained a permanent Inernational Standard Serial Number for our Proceedings.

GENERAL

1. A regret report was received from Dave Ostrovsky, Secretary of PAS, who is currently on a sabbatical. He mentioned the fact that the mailing list was updated, and envelopes are ready for 1982 dues mailing.
2. Clarence Myers will be asked to notify his directors to send a proposal to Research Grants Committee to apply for a grant for science students. There is a total of $1,100 in the Research Grant Committee Fund at this time.
3. Dr. Thomas Knepp, Historian, was not able to attend the meeting but he sent pictures of former presidents and biographies to be used in forthcoming newsletters. Dr. Schreiber, Newsletter Editor, has consented to take care of the matter.
4. William Yurkiewicz, Resolutions Committee Chairman, wrote a letter of resignation. He had no report.
5. Nominations Committee — Sister M. Gabrielle, Chairman, stated that openings for officers will be advertised in the Newsletter. All officers position, with the exception of President-elect, are open. Sister, George Shoffstall and Malcolm Korach, of the Advisory Council, are the key people on the nominating committee.
6. Dr. Bruce Martin asked for names of people whom we wish to honor this year.

No further business to discuss. Motion was made and seconded for adjournment at 12:15 p.m. on September 12, 1981.

Viola Yakstis
Recording Secretary

THERMAL VALUES FOR TWO SETS OF LIMNETIC SEDIMENTS[1]

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ABSTRACT

Mean monthly temperatures for the sediments of Nuangola Bog (1967 through 1977) and for the mean temperature of the sediments and water of Cummings Pond (Februaries of 1967, 1969, 1973, 1978, and 1981) are presented and a periodicity of temperature is shown for the bog and suggested for the lake sediments. A discussion of circulation of water in Cummings Pond, under ice cover, is included.

INTRODUCTION

Lake Nuangola and Cummings Pond, Luzerne County of Pennsylvania, occupy depressions glacially gouged in hard shales, both of which basins at present are more than half-filled with limnetic sediments that have accumulated since the formation of the lakes approximately 27,000 years ago. More than one third of the original area of Lake Nuangola has now succeeded into a typical northern bog with sphagnum, swamp loosestrife, leather-leaf, cranberry, tamarack, and black spruce. The shoreline of Cummings Pond with the exception of one tenth of the original circumference, now occupied by cattails and alder, has its original configuration. A concrete dam curtails further erosion by the outlet stream. The sediments of Nuangola Bog have a thickness of thirteen meters at the station selected for study. Cummings Pond has a maximum depth of three meters beneath which at their greatest extent the sediments are another nine meters in thickness. Several aspects of Lake Nuangola, Nuangola Bog, and Cummings Pond have been examined; however, this presentation is concerned only with thermal phenomena.

MATERIALS AND METHODS

Since 1965 monthly temperature readings have been made at the Nuangola Bog station with a thermistor which, mounted on a probe, can be inserted to desire depths in the sediments, with a read-out assembly (YSI-T2630) held at the surface. Insertion of the probe into the bog can easily be accomplished from the surface of the bog, thus readings can be made at any time of the year; however, inserting the probe into the deepest sediments of Cummings Pond can satisfactorily be accomplished only through the ice and so observations are necessarily limited to periods when the lake is safely frozen. Whereas the bog sediments prevent the bending of the extension rods of the probe, the water of Cummings Pond does not, and although the extent of the original basin of Cummings Pond has been charted, thermal observations there have been restricted to a depth of eight meters from the surface of the ice. The maximum depth to which one can insert the probe from a boat on open water is four meters and thus the most complete readings are available for the month of February as shown.

RESULTS AND DISCUSSION

Figure 1 represents a thermal transect from east to west across the middle of Cummings Pond, with the vertical scale greatly exaggerated. The mean temperature of the water under the ice, and the temperatures of the sediments to a depth of eight meters, are shown as related to the original bedrock bottom of the basin. The values shown for the temperatures are the means of the values obtained in making transects during the Februaries of 1967, 1969, 1973, 1978, and 1981. Other kinds of observations have also been made, at other times, which include supporting thermal records, but those values have not been incorporated into Figure 1.

Table 1 presents the mean temperatures, of air and sediments, for the years 1967 through 1977, down to a depth of seven meters, at the station in Nuangola Bog which is located fifty meters from the edge of the lake, and at which the depth of the original bedrock bottom is thirteen meters below the surface.

Reif (1969) reported the differences in vertical temperatures within the bog sediments during August of 1968 and February of 1969, as well as the difference between the temperature of the bog at seven meters and the lake sediments at seven meters, the two stations being one hundred and fifty meters apart. He suggested that the lake sediments were warmer because of the different capacities to be heated by insolation of bog and lake. The initial observations of the temperatures in Cummings Pond supported that suggestion and so the periodic observations have been continued.

Reif and Berryman (1978) presented their interpretation of the changes of temperature in the sediments of Nuangola Bog and suggested that in the progression from one meter to five meters, the months of temperature extremes occurred from one to three months later in the bog than in the air. At the seven-meter level the sediment was almost temporally isothermal and nearly agreed with the findings of Johnson and Likens in Stewart's Dark Lake (1967).

What this present study of Cummings Pond indicates is that the

CUMMINGS POND, LUZERNE COUNTY, PENNSYLVANIA

```
0 M          ICE              ICE                    ICE
        1.6  1.6  1.6  1.9  2.2  2.2  1.9  1.6  1.6   1.6  1.6
1 M     3.0  3.0  3.0  3.0  3.3  3.3  3.3  2.0  2.0   2.0  2.5
                          WATER
2 M     5.0  4.0  3.5  3.5  4.0  3.5  3.5  3.0  3.0   4.5
3 M     7.0  6.0  6.0  5.0  6.0  5.5  5.0  5.0  5.0   5.5
4 M     8.0  9.0  9.0  9.0  9.0  9.0  9.0  8.0  8.5           PRESENT
                                                              BOTTOM
5 M    10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.5
                          SEDIMENT
6 M    11.0 11.0 11.5 11.5 11.5 11.5 11.5 12.0               ORIGINAL
                          SEDIMENT                           BOTTOM
7 M    12.5 12.5 12.5 12.5 12.5 12.5 12.0
8 M              13.0 13.0 13.0 13.0
9 M  —WEST                                           EAST —
10 M                      SEDIMENT
11 M

O.M  30   60   90  120  150  180  210  240  270  300  330  360M
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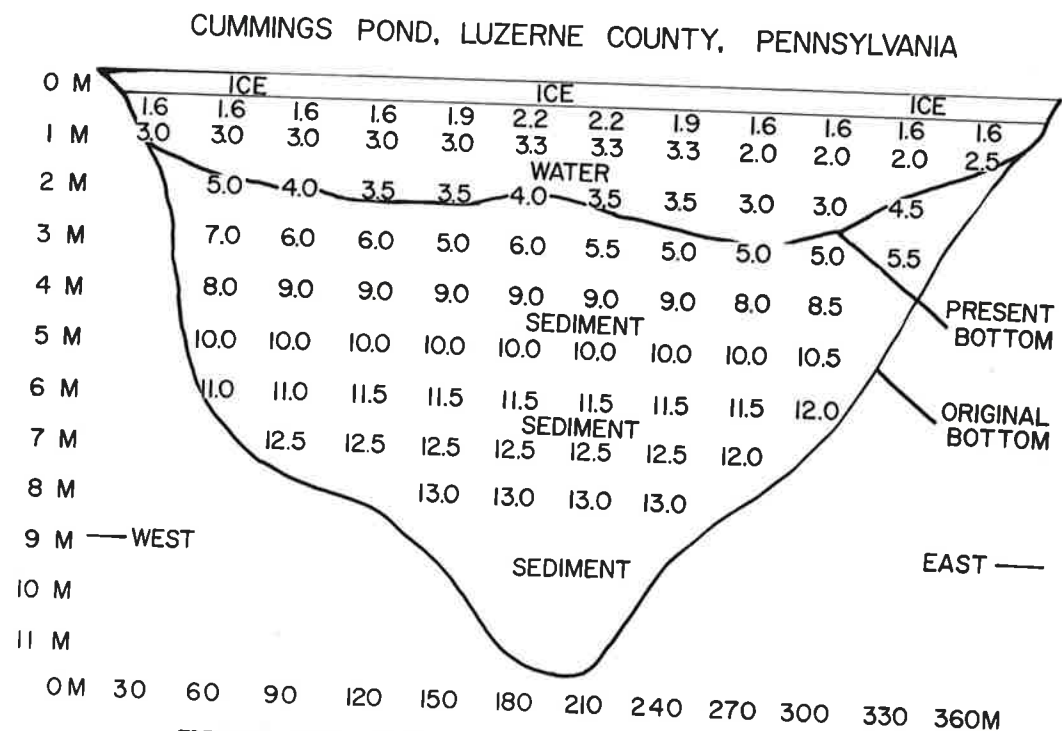
FIGURE 1. Thermal (C.) transect, Februaries, 1967, 1969, 1973, 1978, 1981.

TABLE 1

Mean monthly temperatures (C), 1967-1977, for air and depths 1-7 meters.

NUANGOLA BOG, LUZERNE COUNTY, PENNSYLVANIA

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
AIR	-4.2	-2.3	2.0	8.9	14.3	19.5	21.9	20.9	16.9	10.7	4.7	-1.8
1M	5.12	3.33	3.88	5.65	9.83	13.62	15.61	17.25	16.97	15.75	12.60	8.18
2M	7.21	6.06	5.65	6.23	7.75	10.16	11.38	12.66	13.46	13.75	11.87	9.82
3M	8.55	7.95	7.38	7.62	8.06	9.25	10.32	10.86	11.25	11.65	11.14	10.10
4M	9.12	8.83	8.52	8.66	8.75	9.25	9.87	10.08	10.41	10.43	10.39	10.03
5M	9.28	9.28	9.06	9.13	9.10	9.35	9.61	9.65	9.81	9.85	10.01	9.72
6M	9.40	9.45	9.46	9.47	9.54	9.65	9.56	9.59	9.63	9.62	9.75	9.58
7M	9.47	9.47	9.47	9.55	9.66	9.67	9.59	9.56	9.63	9.59	9.69	9.55

sediments at the eight-meter level in the center of the lake are probably almost spatially isothermal at thirteen degrees. Damping of geothermal influence is not as great in Cummings Pond at the eight-meter level as it is in Nuangola Bog at the seven-meter level. As has been noted for Lake Nuangola, the capacity of open water to absorb heat of insolation, transmit heat, and store heat in the bottom sediments is greater than that of the bog. The mean annual temperature of the air over Cummings Pond is approximately ten degrees and so the differential of three degrees, between the mean air temperature and the temperature at eight meters in the lake bottom, represents stored heat in the sediments.

Furthermore, one is probably safe in extrapolating and suggesting that the transfer of heat from the water of Cummings Pond and into the sediments follows more or less the same pattern as observed in Nuangola Bog, with a lag from upper sediments to the deeper sediments. Also, were sufficiently exact measurements possible at the eight-meter level, a seasonal fluctuation of temperature there might also be observed, possibly with a lag of at least one year.

Although the main thrust of this paper is to report the thermal similarities of the sediments of Nuangola Bog and the sediments in the bottom of Cummings Pond, also of interest are the water temperatures in the several parts of Cummings Pond, under the ice, and their possible relationship to patterns of circulation within the lake.

Likens and Ragotzkie (1965, 1966) propose a rotary circulation in ice-covered Tub Lake which is three times as deep as Cummings Pond. Tub Lake also differs from Cummings Pond in having neither inlet nor outlet. Cummings Pond has no inlet but vadose water must enter the lake during the winter since water is always flowing from the lake through the outlet. Tub Lake probably is ice-covered for a much longer period than is Cummings Pond. Likens and Ragotzkie do not specify that Tub Lake has a surrounding bog but other evidence they present suggests such is the case. If Tub Lake has a surrounding bog mat and probably sediments beneath the lake, the thermal properties of the bog and sediments could influence the circulation of the water in Tub Lake while ice is on the lake.

During March of 1962, strong currents were observed in Lake Nuangola. At a depth of one meter below the ice the water was moving in one direction at the rate of one meter per minute and at a depth of four meters, where the lake was five meters deep, the water was moving in the opposite direction at the same rate. Currents of such velocity have not been observed in Cummings Pond.

It is important that the same pattern of thermal distribution, both in the water and in the sediments, was present at the time of the observations in the last week of February of 1967, 1969, 1978, and 1981. In all of these cases the lake had had a seal of ice for at least thirty days. Thus the only factors which could have altered the pattern of circulation within Cummings Pond, under snow-covered ice and thus without insolation, were the influx of vadose water and/or the efflux of lake water through the outlet. It seems probable that any pattern which can become established in a sealed limnetic system can be maintained only as long as the causitive factors remain unchanged. Such a period could be much longer in Tub Lake than in Cummings Pond.

Without having actual measurements of currents in Cummings Pond, such as those made by Likens and Ragotzkie in Tub Lake, the author cannot substantiate a definite pattern. However, the distribution of temperatures as shown in Figure 1 suggests that a centrifugal movement of the water near the bottom and a centripetal movement of the water just under the ice are possible. Such a possibility supports the contention of Likens and Ragotzkie that mixing does occur under the ice.

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SOME OBSERVATIONS OF FOOD SELECTIVITY BY SMALL WALLEYE (STIZOSTEDION VITREUM) UNDER AQUARIUM CONDITIONS[1][2]

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ABSTRACT

Under aquarium conditions, the sublegal walleye *(Stizostedion vitreum)* tested consumed larger sunfish than minnows in terms of body depth. These walleye, however, were able to consume larger minnows with respect to total length and weight. In addition, these walleye preferred the smallest of the forage available to them; they also preferred minnows over sunfish. The preference for minnows seemed to increase as the walleye became larger. These data, along with data collected from food habit studies, indicate that the large numbers of sublegal walleye present in the Susquehanna River at the present time may be competing for a similar forage.

INTRODUCTION

The walleye population in the Susquehanna River, near Berwick, Pennsylvania, has been increasing in recent years. Strong year classes were produced from 1978 through 1980 (Buynak et al. 1981) as indicated by the large percentage (> 50%) of young-of-the-year observed in monthly electrofishing samples. By 1980, 99% of the walleye observed were sublegal (<381 mm) fish, representing specimens from the 1978 through 1980 year classes.

Buynak et al. (1980) found that sublegal walleye in the Susquehanna River consumed mainly minnows, sunfish, and tessellated darter *(Etheostoma olmstedi)*. Stomach contents indicated no major differences in the length, weight, or body depth of the forage fish consumed by age 0+ and I+ walleye, although I+ walleye consumed slightly larger forage. Age II+ walleye, however, consumed much larger forage. Despite differences in prey size, all sublegal walleye showed a preference for minnows over sunfish; an average of 54% of the food consumed by weight was minnows while only 12% was sunfish. Preference for minnows increased as walleye grew. Minnows composed from 48.4% of the total weight of forage consumed by age 0+ walleye to 70.4% in II+ fish, while sunfish decreased from 18.7% in 0+ walleye to 70.4% in II+ fish, while sunfish decreased from 18.7% in 0+ walleye to 0% in II+ fish.

This study was initiated to obtain additional information on the food habits of sublegal walleye. The purposes were to determine, under laboratory conditions, the maximum size of both soft and spiny-rayed forage that could be utilized, if there is a forage size preference, and if there is a forage preference between soft-rayed (minnows) and spiny-rayed forage (sunfish) for small walleye.

METHODS

Five indoor 190-liter aquariums and five outdoor 984-liter plastic wading pools were each stocked with a single walleye collected from the Susquehanna River. Fish used ranged in size from 99 to 423 mm total length (TL) and were conditioned to accept food in these artificial environments before being used in the various trials. Difficulty was encountered with larger walleye, first in getting them to accept food and second, keeping them alive after they began to feed.

Data presented for each trial represents only those walleye which completed each trial. Soft-rayed forage used were spotfin shiner *(Notropis spilopterus)*, golden shiner *(Notemigonus crysoleucas)*, and bluntnose minnow *(Pimephales notatus)*, while black crappie *(Pomoxis nigromaculatus)* and bluegill *(Lepomis macrochirus)* were utilized for spiny-rayed forage.

In trial 1, the maximum size of both soft and spiny-rayed forage that would be consumed by a walleye was determined. Body depth was used in determining maximum size (Lawrence 1958). Each walleye was offered a single forage fish; each forage was weighed (g) and measured (mm, total length and body depth). All walleye were checked at least twice daily to determine if the forage was consumed. If a prey had been eaten, it was replaced with a larger one. If after three days the forage was not consumed, a smaller one was added. If this one was consumed, a larger forage was then added. Forage killed, but not eaten by a walleye, were considered too large and were replaced by a smaller one. This continued until the maximum sized forage, based on body depth, consumed by each walleye was found. This procedure was utilized for both soft and spiny-rayed forage. A regression line was calculated comparing maximum body depth of the forage to the total length of the walleye.

Trial 2 consisted of determining forage size preference. For this trial, each walleye was presented with three soft-rayed forage. Forage added were placed into three size groups (small, medium, and large). The groups were based on the relative size of the prey; at least 1.5 mm difference in body depth separated the groups. All forage added were smaller than the maximum size determined for each walleye in trial 1. Each walleye was checked at least three times daily to determine what forage was consumed. On some days, the walleye consumed more than one forage between the times checked. To show preference, the forage consumed between checks were divided into eaten exclusively or eaten in combination with (Lewis et al. 1961). Forage consumed were replaced with similar sized specimens. A binomial test (Siegel 1956) was used to determine preference.

Trial 3 consisted of determining forage preference between soft-rayed and spiny-rayed forage. In this trial, each walleye was presented with three soft-rayed and three spiny-rayed forage. Forage used were as similar in size (body depth) as possible. All forage used were smaller than the maximum size determined in trial 1. Each walleye was checked at least three times daily to determine what forage was consumed. To show preference, forage consumed were separated into eaten exclusively or eaten in combination with. Forage consumed were replaced with similar sized specimens. A binomial test (Siegel 1956) was used to determine preference.

RESULTS

The maximum size minnow which would be consumed was determined from five walleye and from four walleye for sunfish (Table 1). The walleye used consisted of age 0+, I+, and II+ individuals. The walleye length-minnow body depth relationship obtained was $y = 8.0 + 0.0372 x$, where y = maximum forage body depth and x = total length of the walleye. The coefficient of determination for this relationship was 0.93. The walleye length-sunfish body depth relationship obtained was $y = 12.6 + 0.211 x$ with a coefficient of determination of 0.98.

Results were obtained from two walleye in the forage size preference trials (Table 2). A preference (P < 0.05) as tested by the binomial test was found for the selection of the smallest of the three forage placed into the tank by both the 99-mm (age 0+) and 166-mm (age I+) walleye tested. All forage used were smaller than the maximum size each walleye was able to consume in trial 1.

Forage preference was determined for two walleye (Table 3). No preference was found for the 99-mm (age 0+) walleye, however, more minnows than sunfish were consumed. A preference (P < 0.01) was found for minnows over sunfish for the 166-mm (age I+) walleye. Forage used were smaller than the maximum sized minnow and sunfish each walleye consumed in trial 1.

DISCUSSION

In most cases, walleye were able to consume a sunfish with a larger body depth compared to minnows. However, the maximum sized minnow which could be consumed was larger in both total length and weight. This resulted in a difference in the percent body weight consumed by forage type. In all cases, a larger minnow as a percent body weight was consumed. Thus, in terms of forage size, it would be more desirable

TABLE 1

Maximum size of both minnows and sunfish each walleye consumed.

Walleye			Minnow				Sunfish			
Length (mm)	Weight (g)	Year Class	Length (mm)	Weight (g)	Body Depth (mm)	% Body Weight	Length (mm)	Weight (g)	Body Depth (mm)	% Body Weight
99	7.6	0+	59.0	2.1	11.0	27.6	53.0	1.8	14.5	26.6
166	32.0	I+	80.0	4.9	13.0	15.0	54.0	2.3	16.0	7.2
169	40.0	I+	70.0	3.4	15.0	8.5	—	—	—	—
183	46.0	I+	80.5	6.4	16.5	13.9	54.0	2.3	17.0	5.0
310	188.0	II+	130.0	14.5	19.0	7.7	57.0	3.4	19.0	1.8

TABLE 2

Results of the forage size preference trial in terms of forage eaten exclusively or eaten in combination with. Total length, weight, and body depth are means.

Walleye Length (mm)	Year Class	Forage Size	Total Length (mm)	Weight (g)	Body Depth (mm)	Eaten Exclusively	Eaten in Combination
99	0+	Small	37	0.8	6.5	4	1
		Medium	50	2.0	8.0	1	1
		Large	53	2.2	9.5	0	0
166	I+	Small	49	1.1	7.4	6	5
		Medium	58	2.6	10.6	2	4
		Large	68	4.0	12.9	0	3

TABLE 3

Results of the forage preference trial in terms of forage eaten exclusively or eaten in combination with. Total length, weight, and body depth are means.

Walleye Length (mm)	Year Class	Forage Size	Total Length (mm)	Weight (g)	Body Depth (mm)	Eaten Exclusively	Eaten in Combination
99	0+	Minnows	56	1.5	9.2	5	1
		Sunfish	45	1.3	10.0	2	1
166	I+	Minnows	64	2.6	12.0	12	4
		Sunfish	55	2.2	13.1	2	2

for walleye to consume minnows. The body depth of a forage is the first limiting factor that the walleye encounters, but it seems that other factors are also important. If body depth was the only factor in the size of forage that the walleye could consume, then each walleye should have been able to consume identical sized minnows and sunfish. An additional factor may be total or overall size of the forage. The minnows that were consumed were much larger in total length and weight than the sunfish. The larger sized forage would not only be more difficult to catch, but also more difficult to consume. This was observed for all walleye when each fish made unsuccessful attempts at consuming larger (body depth) minnows. In these cases, scales were missing from the lateral body surface of the minnows. This would indicate that the walleye were able to catch them, but were unable to consume the larger minnow. The body depth of these minnows was between the largest minnow and largest sunfish consumed for each walleye.

When given a chance to choose between three different sized forage, the walleye tested had a preference for the smallest forage present. Similar results were observed by Lawrence (1958) in laboratory feeding tests of largemouth bass *(Micropterus salmoides)*. He observed that if bass had a choice of smaller fish, these were eaten in preference to sizes approaching the maximum size the bass were able to consume. In addition, Beyerle and Williams (1968) found that if accessibility was equal for all sizes of forage, northern pike *(Esox lucius)* preferred smaller forage organisms to larger ones.

In conclusion, under aquarium conditions, the sublegal walleye used were able to consume a larger sunfish than minnow in terms of body depth. The minnows, however, were larger in total length and weight. It would thus be more beneficial for the walleye to consume the heavier minnows. In addition, these walleye preferred the smallest of the forage available to them; they also seemed to prefer minnows over sunfish. The preference for minnows over sunfish seemed to increase as the walleye became older. These data indicate that the large numbers of sublegal walleye present in the Susquehanna River at the present time may be competing for a similar forage. The degree of competition and the affect the large number of walleye are having on the forage populations in the river at this time are not known.

ACKNOWLEDGMENTS

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EFFECT OF NEST BOXES ON POPULATION GROWTH IN CF-1 MICE[1]

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ABSTRACT

Two populations with and without nesting boxes were establishd and the populations monitored for a 5-month period. The population with nesting boxes had higher reproductive rate, lower nesting mortality and obtained a greater density than the population without nest boxes. Females from both populations, when offered a choice of where to nest, had a significant preference for nest boxes.

INTRODUCTION

Crowding associated with large population densities has been shown to affect nestling survival in microtine populations (1,2,3). An increase in population density usually is associated with increased aggressive activity, intermingling of the sexes, nest destruction, and communal nesting. As the number of adults at the nest site increases, there is a corresponding increase in nestling mortality. This, in association with a lack of parental care, has been shown to be important factors in increasing nestling mortality as a control of population density (2,3). Therefore, as the population increases and the number of nest sites decrease, there is a corresponding increase in litter mortality even with an excess of nesting materials (1,3). The disturbance of nests by adults in large populations has been shown to be reduced by the presence of covered nests (1,3) but, in populations containing open platforms, nestling survival of over 50 percent occurred only if one or two females were present at the nest site (3). The presence of more than two females or one male resulted in low nestling survival (18 percent) but when nesting structures were absent, there was a complete lack of nestling survival.

These previous studies were conducted with wild mice maintained under laboratory conditions. Thus, the variability in growth rates and population size was attributed to intrinsic factors including the genetic and social backgrounds of the mice (2,3). The present study investigated (1) the role of nest boxes on population growth in a genetically similar strain of CF-1 mice and (2) nest site selection by females raised in an environment with and without nest boxes to determine if being raised in an open or closed nest influenced their nesting behavior as adults.

METHODS

Two populations with and without nest boxes were established in 118L x 14W x 55H cm cages containing 2 cm of pine shavings as bedding. Both populations were provided food and water *ad lib.* The initial population consisted of 5 male and 5 female adult CF-1 mice and was allowed to grow freely for 150 days. The number of pregnant females and the total number of litters and young produced was determined for each population.

The choice of nesting location by pregnant females was determined according to whether or not they had been reared in habitats with and without nest boxes. The testing consisted of a cage containing nesting boxes (one/female) at one end and bedding at the other half of the cage. Two partitions were used to divide the arena into three equal sections. Pregnant females were released in the center section and, after a 48 hr. acclimation period, the partitions were removed and nesting locations recorded.

RESULTS AND DISCUSSION

The placement of covered nest boxes resulted in a significant increase in population density. The original population of 10 mice with covered nesting boxes available increased by a total of 83 mice over the 150-day period compared to only 35 individuals in the original population of 10 mice in the environment with only bedding available for nesting (Fig. 1). This was a 9.3 and 4.5 fold increase in the populations with and without nesting boxes, respectively. The resultant density was 16.5 mice/cm² in the population with nest boxes and 3.4 mice/cm² in the population with only bedding available as nesting material. A total of 16 pregnant females was present in the population without covered nests. The mean litter size was 4.9 ± 1.1 and 6.3 ± 0.88 for the populations without and with covered nests, respectively. However, when litter mortality of 1.0 and 12.2 percent for populations with and without covered nest was taken into account, the mean number of surviving young was 6.2 ± 0.85 per female when boxes were available for nesting compared with 4.5 ± 0.92 per female when only bedding was used for nesting for a difference of 1.7 per female. As in previous studies (1,2,3), litter mortality reduction in litter size and nestling mortality were the primary cause of lower population densities. The reduction in litter size may be a result of competition and increased aggressive behavior within the population without nest boxes as has been
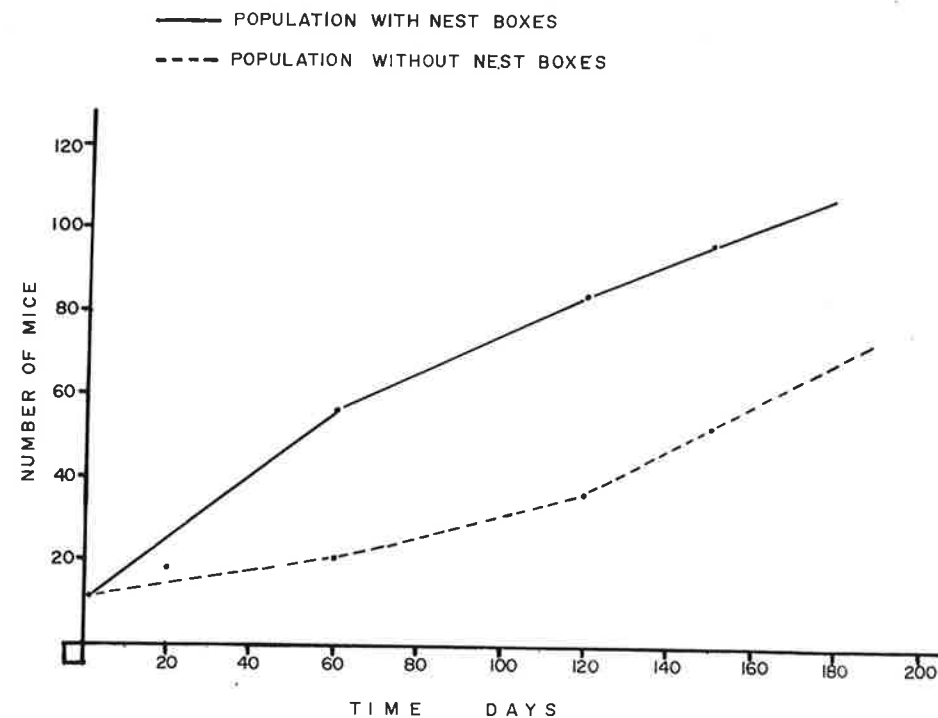
FIGURE 1. Growth of two populations of CF-1 mice with and without nest boxes.

shown in previous studies on microtine populations (4,5).

Females from both populations indicated a significant preference for nesting in boxes when they were offered a choice. A total of 9 of the 11 females or 81.8 percent of the females that had been raised for at least one generation in the population without covered nests used these structures when offered a choice. However, 15 of the 16 females or 93.8 percent of the females raised for at least one generation with nests used boxes for nesting when offered a choice between boxes and bedding for nesting. There may be a stronger tendency to use nest boxes if they were raised in such an environment, but sufficient data is not available at this time. The results of this study support the theory that covered nests will increase population densities by increasing litter size and reducing nestling mortality.

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INTERACTIONS OF POLYCHLORINATED BIPHENYLS AND Δ9-TETRAHYDROCANNABINOL WITH TESTOSTERONE HYDROXYLATION AND THE HEPATIC MICROSOMAL SYSTEM IN THE RAT[1]

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ABSTRACT

The combined effects of polychlorinated biphenyls (PCBs) and delta-9-tetrahydrocannabinol (THC) on the hydroxylation of testosterone and concentrations of cytochromes b_5 and P-450 in rat liver microsomes were investigated. All combined treatments of PCB and THC resulted in significant increases in polar metabolite formation as compared to untreated controls. In addition, the combined treatments with PCB and THC resulted in increased hydroxylation as compared to that occurring with either PCB or THC administered singly. Changes in the concentrations of cytochromes b_5 and P-450 paralleled corresponding changes in polar metabolite in only one of the three groups. It is suggested that disparities between the two parameters are a reflection of a qualitative rather than quantitative change in the cytochrome populations. It is postulated that the increase in polar metabolite formation is due to activation of the steroid hydroxylase system consequential to the increase in cytochrome P-450 by the PCBs, and the alteration of the lipid environment, perhaps through increased cytochrome b_5 levels, by both PCBs and THC.

INTRODUCTION

Polychlorinated biphenyls (PCBs) are a group of highly stable industrial compounds having many commercial uses. The pharmacological and toxicological effects of PCBs are numerous and diverse. PCBs may effect hepatic and gonadal changes. It was shown by Litterst (1, 2) and Street (3) that pretreatment with PCBs resulted in hepatic enzyme induction, while Sanders and Kirkpatrick (4) reported that PCBs caused decrease in testicular sperm numbers and seminal vesicle weight. It was suggested that exogenous induction of hepatic enzymes, notably the microsomal mixed-function oxidase system, by PCBs, enhanced steroid hydroxylase activity, thereby affecting the gonads in a circuitous manner (5, 6).

Delta-9-tetrahydrocannabinol (THC), the psychoactive principle in marijuana, is also known to adversely affect the reproductive system in various organisms. Studies in humans by Kolodny

(7, 8) showed that chronic usage of marijuana resulted in considerable decrease in serum androgen levels. Part of the decrease in testosterone levels was attributed to enhanced hepatic catabolism following THC induction of microsomal enzymes. In addition, a depression of testosterone formation by testicular microsomes was observed (9, 10). Schwarz *et al.* suggested that the reduction of testosterone synthesis may be the result of a THC-induced reduction in testicular microsomal cytochrome P-450 content (11).

Because of current environmental standards concerning the levels of PCB contamination, and the increasing frequency of marijuana use, it is almost certain that the two compounds will interact at some time in certain individuals. Since both PCBs and THC are known to individually decrease gonadal steroid levels by increasing the rate of their metabolism and affecting the site of their production, this study was initiated to investigate the effects of both compounds when administered simultaneously.

METHODS AND MATERIALS

Animals. Male Sprague-Dawley rats weighing 250-300g were maintained on Wayne Lab-blox and water *ad libitum,* with a 12 hour light/12 hour dark schedule. To control for variation in plasma testosterone, and its effect on hepatic enzymes, the animals were castrated before attaining a weight of 175g. Delta-9-tetrahydrocannabinol was suspended in a vehicle solution of 89% physiological saline (.9% NaCl), 10% propylene glycol, and 1% Tween 80, whereas the PCB (Arochlor 1260) was dissolved in pure corn oil (12). Intraperitoneal injections were limited to a volume of 0.2 ml (13). There were 10 experimental groups, each composed of four animals. Controls included a non-injected group which received no treatment and vehicle control groups for both the PCBs and THC treated groups. PCB dosages of 25 mg/kg/day were administered for four days to four groups of animals. Only one of these groups received PCB alone; the others were injected with either a single dose of 10 mg/kg of THC or 2 mg/kg/day of THC for 4 or 8 days. Rats receiving both PCB and THC began the THC injections 96 hours after the last PCB dose in the single and four-day group, and 24 hours after in the eight-day group. This time schedule was designed in accordance with Schwark and Ecobichon (14), who reported that maximum induction of hepatic enzymes occurred 96 hours after the last PCB injection. The remaining three experimental groups received the same three THC dosages without the preceding PCB injections. All animals were sacrificed between 9 AM and 10 AM, 24 hours after having received their last injection, to control for temporal variations.

Hydroxylation of Gonadal Steroids. This assay is a modification of the procedure described by Conney and Klutch (15). To control for glycogen in the microsomal pellet, rats were starved for 16 hours before sacrifice by decapitation. Livers were excised and wet weights determined. After mincing, tissues were homogenized individually in an ice-cold 0.15 M KCl solution using a Potter-Elvejhem type glass homogenizer. Nuclei and mitochondria were removed by centrifugation of the homogenate at 9,000 x g for 30 minutes. Microsomes were obtained by centrifugation of the resulting supernatant at 105,000 x g for 60 minutes in a Beckman ultracentrifuge. The resulting microsomal pellet was resuspended in ice-cold 0.1 M phosphate buffer (pH 7.4) so that 1 ml of the suspension contained the microsomes from 500 mg of liver.

A 0.5 ml aliquot of each microsomal suspension was added to individual 50 ml Erlenmeyer flasks containing the reaction medium which consisted of 12.5 μmoles MgCl 2, one unit glucose-6-phosphate dehydrogenase, 100 μmoles of trishydroxymethyl amino-methane buffer (pH 7.4), 50 μmoles glucose-6-phosphate, 14 μmoles NADPH and 2.8 mls of distilled-deionized water. Flasks and media were preincubated at 37° in a heated gyrotory water bath and shaken for 10 minutes. The reaction medium was then incubated for 10 minutes with 10 nanomoles of ^{14}C-testosterone and 491 nanomoles of unlabeled testosterone. The reaction was terminated by the addition of 25 mls of dichloromethane and allowed to continue shaking for 60 minutes before centrifuging at 2500 x g for 10 minutes in an RC-5 Sorval. Twenty ml of the organic phase was taken to dryness under a stream of dry nitrogen and the residue re-dissolved in 1.0 ml of methanol. Protein was determined by the method described by Lowry *et al.* (16), using bovine serum albumin as a standard.

Chromatography and Scintillation Counting. A 20μl aliquot of the steroid containing methanol solution and reference steroids were applied to pre-coated aluminum oxide TLC plates. The plates were chromatographed with a solvent of benzene:ethanol (9:1); the solvent was allowed to rise 10 cm. Fluorescence of metabolites required spraying with concentrated H_2SO_4 and heating for 15 minutes at 125°F. The testosterone bands were removed and added directly to scintillation vials containing 2 ml of distilled-deionized water and 15 ml of Biofluor (New England Nuclear). The bands containing the metabolites which were more polar than testosterone were removed and added to identical vials and solutions. The vials were shaken vigorously to ensure complete extraction of the labeled steroids from the aluminum-oxide gel before being added to the counter. Radioactivity was determined using a Packard liquid scintillation spectrophotometer. The quantity of polar testosterone metabolites formed was calculated from the radioactivity and was used as a measure of steroid hydroxylation.

Spectrophotometry. The microsomal solution that was used for the testosterone incubations was also used for cytochrome P-450 determinations. The final protein concentration was approximately 2 mg/ml in 0.1 M phosphate buffer (pH 7.4). Cytochrome P-450 concentrations were determined by the method of Omura and Sato (17) using a Cary model 14 spectrophotometer.

Materials. Radioactive (^{14}C) testosterone and Biofluor were obtained from New England Nuclear Company, reference steroids from Steroloids, TLC plates from Brinkman, and all other chemicals were obtained from Sigma Chemical Company. The Delta-9-THC was obtained through the courtesy of Biomedical Branch of National Institute on Drug Abuse, and Arochlor 1260 was obtained through the courtesy of Monsanto Chemical Co.

Data were analyzed using Students' t-test and Mann-Whitney test.

RESULTS

Hydroxylation of Testosterone. Rates of polar metabolite formation by hepatic microsomes are presented in Fig. 1. A significant increase in steroid hydroxylase activity occurred in the 2 mg/kg for 8 day treated group (p < .01), the PCB groups (p < − .05), and all three combined (THC and PCB) groups (p < .01 for 1 day; p < .001 for 4 days; p < .05 for 8 days). No significant alteration of the amount of testosterone hydroxylation was observed in treatment groups receiving 10 mg/kg of THC for 1 day or the 2 mg/kg of THC for 4 day group.

Of special interest are the combined (THC and PCB) groups which consistently showed greater polar metabolite formation (PMF) than either the PCB treated group, or any of the THC treated groups.
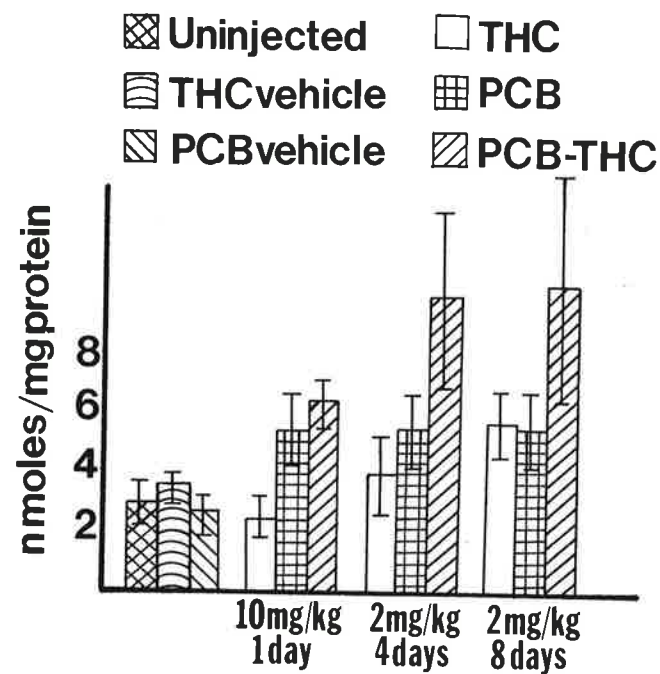

FIGURE 1. Polar metabolite formation (mean ± standard error) by liver microsomal fractions from male rats.

Cytochrome P-450 Levels. The concentrations of hepatic microsomal P-450 are represented in Fig. 2. A marked elevation of cytochrome P-450 content was observed in the 4 day combined (THC and PCB) group (p < .001) however, levels had returned to control levels by 8 days. The acute THC (10 mg/kg for 1 day) group had livers with significantly lower cytochrome P-450 concentrations than the livers of controls (p < .05), whereas the PCB group (p < .05) and the chronic 2 mg/kg for 8 day group (p < .001) had significantly increased concentrations.

Cytochrome b₅ Levels. The concentrations of hepatic microsomal cytochrome b₅ are represented in Fig. 3. Treatment with 2 mg THC/kg for 8 days (p < .01) and PCB for 4 days (p < .05) resulted in significant increases in cytochrome b₅ concentrations. Treatment with THC for 1 day (p < .01) and the combined group for 1 day (p < .05) had decreased levels of cytochrome b₅.

DISCUSSION

In the three groups where both THC and PCB were used, there was a significant increase in the amount of polar metabolite of
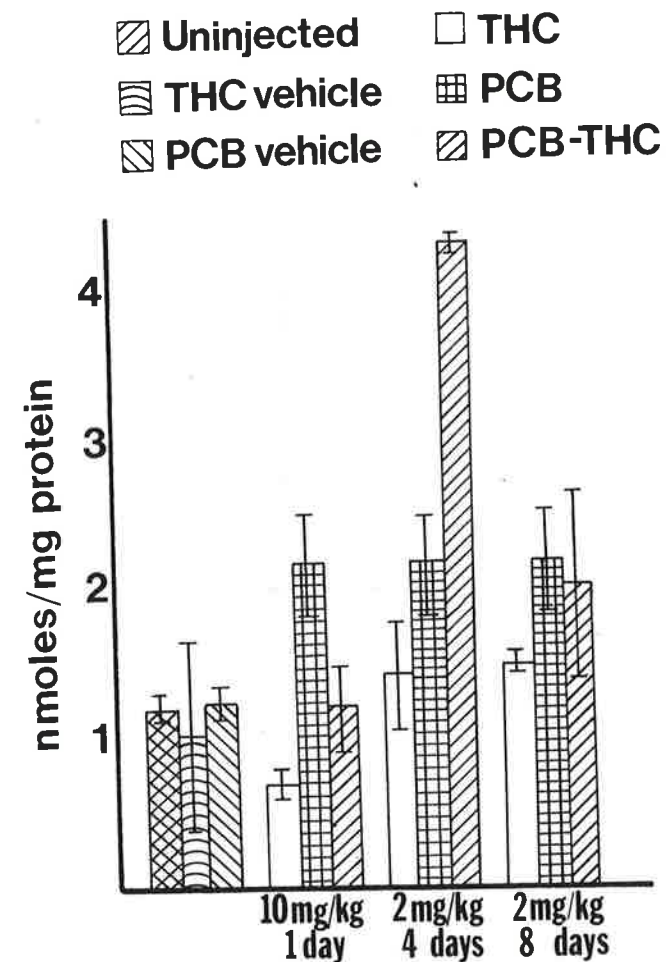
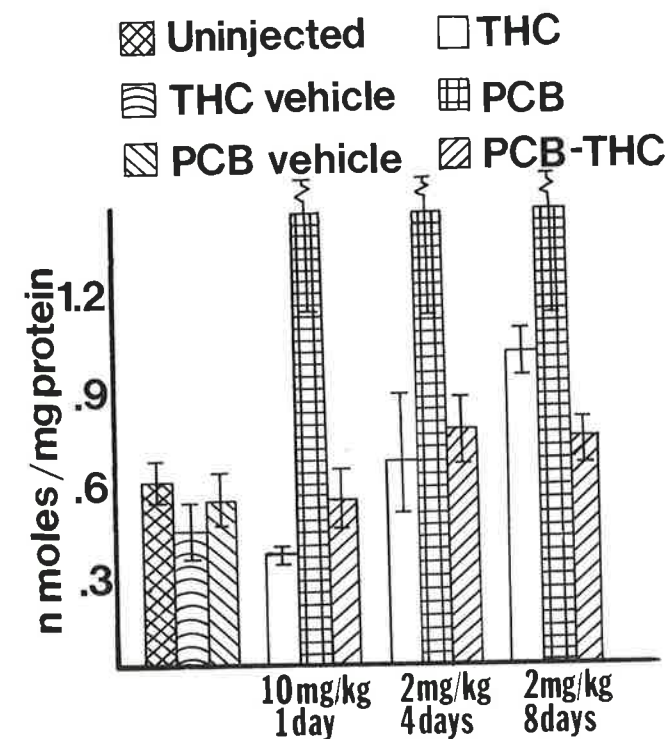FIGURE 2. Cytochrome P-450 content (mean ± standard error) in rat liver microsomes.

FIGURE 3. Cytochrome b₅ content (mean ± standard error) of rat liver microsomes.

labeled testosterone formed by liver microsomes compared to the uninjected group, with significant and highly suggestive increases over animals treated only with PCB. These data indicate that the two compounds used in combination exhibit a combined effect, to increase the rate of steroid hydroxylase activity above that observed using either drug separately.

Several investigators (18, 19, 20) have reported that increases in the formation of polar metabolites by a microsomal enzyme system are often accompanied by a corresponding increase in the concentration of cytochrome P-450. In this study, only one of the three combined treatment groups (PCB-THC 2 mg/kg for 4 days) demonstrated a significant increase in cytochrome P-450. These data suggest that cytochrome P-450 levels alone cannot determine the rate of polar metabolite formation.

Our data suggest that PCBs or chronic THC administration may result in an increase in cytochrome b₅ concentration contrary to that reported for other inducing agents (21). Cytochrome b₅ has been implicated (22) as a rate-limiting step in drug oxidation affecting the transfer of the second electron to cytochrome P-450. Lu *et al.* (23) believe that cytochrome b₅ may play an important role in regulation of the NADH-dependent hydroxylation pathway.

It is possible that the resultant increase in microsomal hydroxylation activity following treatment with PCBs and THC, as evidenced by an increase in polar metabolite formation, is partially due to increased levels of cytochrome b₅ and thus increased P-450 reduction. This may account for the apparent discrepancy between increased metabolite formation without increased cytochrome P-450 concentration.

Imai and Sato (24) state that since drugs possessing high lipid solubility react with the drug metabolizing system, the active area of cytochrome P-450 can be assumed to be embedded in a highly hydrophobic part of the cytochrome P-450 protein or in the lipids of the microsomal membrane. When the rate of drug metabolism does not parallel a rise in cytochrome P-450 as in two out of our three treatment groups, a qualitative difference may have occurred as a result of changes in the lipid environment which, in turn, could affect the activity of P-450. Membrane phospholipids play an important role in drug metabolism influencing enzyme-enzyme interaction in the course of the reduction of cytochrome P-450, in the binding of lipophilic substrates to the enzyme which reach the system by lateral diffusion within the lipid phase of the membrane, as well as in the chemical changes these substrates undergo (25). In addition, translation mobility of the cytochromes and their reductases within the lipid bilayer may be an important factor regulating the rate of catalysis (26, 27).

Bach *et al.* (28) have shown that THC affects the translation of phospholipids from crystalline gel to liquid crystalline states, possibly triggering a localized phase transition. Their observations strongly support the notion that the nonspecific effect of cannabinoids on microsomal activity is a result of altered fluidity of the lipid phase thus influencing the native environment of the protein. Cannabinoids and PCBs are both lipid-soluble neutral compounds with a very high membrane/aqueous solution partition coefficient (29).

Other studies (1, 30, 31) have shown that PCBs enhance the formation of hepatic lipid droplets and cause alteration of triglyceride and phospholipid levels in rat liver. This increase in lipid content was not due to stimulation of synthesis but to an inhibition of the catabolism of membrane phospholipids (32). PCBs have also been shown to affect the environment of membrane bound enzymes, including cytochrome P-450 (33, 34) and to act as labilyzers of lysosomal membranes (35).

At present, no conclusive studies monitoring possible PCB fluidization of the microsomal membrane have been published. However, our data indicate that pretreatment with PCBs results in an increase in hepatic cytochrome b$_5$ which is essential in fatty acid desaturation (36). Introduction of a cis $\triangle^9$ double bond into palmitic and stearic fatty acids by the mixed function oxidase system occurs in hepatic tissue. The net result is that cis unsaturation lowers the melting point and therefore increases the fluidity of biologic membranes (37).

It is suggested here that previously reported increases in membrane fluidity associated with PCB pretreatment (28) may be in part a result of the observed increase in hepatic cytochrome b$_5$ concentration which in turn effects a sequential increase in microsomal membrane fatty acid desaturation.

We also suggest that these drug-induced membrane changes by PCBs and THC may result in an increase in cytochrome P-450 - cytochrome P-450 reductase electron transfer thereby increasing drug oxidation. An increase in catalysis due to increased lateral translocation may occur in either of the two organization models that have been prosposed (25, 26, 27): "rigid" complexes might possibly relax, allowing localized cytochrome P-450 molecules to be acted upon by neighboring reductases, and "non-rigid" complexes would exhibit even greater mobility.

In view of the above investigations and the data obtained in this study, it is postulated that the increases in polar metabolite formation observed after pretreatment with PCBs and THC reflect a combination of events: the increase in cytochrome P-450 by PCB treatment, and the changes in microsomal membranes following PCB inhibition of lipid catabolism and PCB induction of cytochrome b$_5$. Evidence is presented that PCBs and THC administered together exert a combined effect of larger magnitude than the sum of their individual actions. The extent of these interactions was not conclusively determined. It is evident that continued research in this direction, especially at the level of the lipid-enzyme complex, would be of significance.

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DISTRIBUTION OF *CYZICUS MEXICANUS* (CONCHOSTRACA: CRUSTACEA) IN LEBANON COUNTY, PENNSYLVANIA[1]

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ABSTRACT

One hundred and twenty-five sites in Lebanon County were examined to determine the distribtuion of *Cyzicus mexicanus*. This conchostracan was found in small temporary pools at one site each in Union and East Hanover Townships, and at two sites in both Bethel and South Londonderry Townships. In the six sites where *C. mexicanus* was found, water quality could be characterized as neutral (pH 6.9 to 7.5), low in oxygen (1 to 5 mg/L), high in carbon dioxide (16 to 22 mg/L), and very turbid (430 to 2400 FTU). The distribution of this conchostracan appears to be limited primarily by dispersal of cysts and presence of predators rather than water quality. Several other bodies of water not containing *C. mexicanus* had physiochemical characteristics similar to those in which it occurred.

INTRODUCTION

The Conchostraca, or clam shrimp, are laterally compressed branchipods, having 10 to 32 pairs of appendages, sessile compound eyes, and a leathery bivalve carapace completely enclosing the body (Fig. 1). The body consists of a conspicuous head, whose anterior margin narrows to form a rostrum, and a trunk containing 10 to 28 pairs of similar appendages. The head also contains short sensory first antennae and long biramous second antennae used in swimming. Except in males where the first two trunk appendages are modified for clasping the female during copulation, all trunk appendages are flattened and used for feeding, locomotion and respiration (Kaestner, 1970). The trunk terminates in a broad telson that bears spines, claws, or filaments. Morphological characters used in taxonomy include growth lines of the carapace, size and shape of the carapace, segmentation of the second antennae, shape of the rostrum, clasper shape, and the number and arrangement of spines and filaments on the telson (Edmondson, 1959; Mattox, 1954; Mattox, 1957; Pennak, 1978).
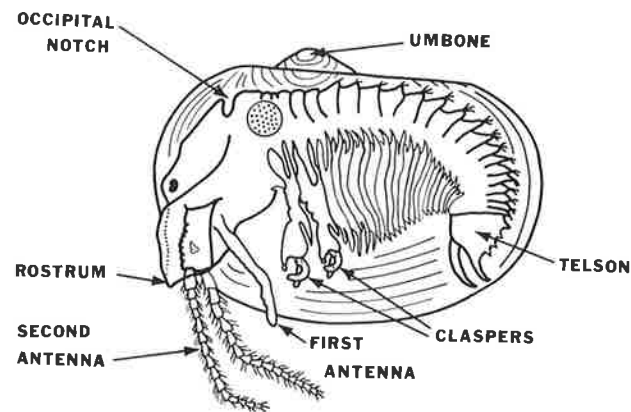
The range of conchostracan distribution extends across the entire United States from Canada to Mexico and from east to west coasts. Conchostracans have been reported in at least twenty-eight states, with the largest number of species occurring in the midwest (Edmondson, 1959; Pennak, 1978). Some conchostracans are endemic to a single location such as *Eulimnadia stoningtonensis* reported only from Connecticut, *Eulimnadia diversa* known only from a single pond in Illinois and *Eulimnadia oryzae* found only in the rice fields of Stuttgart, Arkansas (Mattox, 1954). Conversely, *Cyzicus mexicanus* has a wide distribution and is found in at least fifteen states.

Although the taxonomic keys of Edmondson (1959) and Pennak (1978) indicate the presence of *Cyzicus mexicanus* within Pennsylvania, no specific records of the exact location of these animals have been found. In 1842 Haldeman described a clam shrimp, *Limnadia coriacea,* from ditches along the Susquehanna River near Columbia (Lancaster County). This classification was questioned by Packard (1883) and subsequently, workers have revised the classification of *Limnadia coriacea* to *Cyzicus mexicanus*. The specimens collected by Haldeman are the only conchostracans from Pennsylvania in the Smithsonian Institute. All attempts to locate collections of conchostracans within museums or academic institutions in Pennsylvania have been unsuccessful. However, some researchers have indicated the possibility of conchostracans in their field samples from Luzerne, Delaware, and York counties (personal communications).

The present study was conducted to determine if conchostracans are still present in Pennsylvania and if any physiochemical characteristics could be used to predict their distribution. Since a geographically extensive survey was impractical, this study concentrated on the distribution of conchostracans within Lebanon County.

FIGURE 1. Male conchostracans, *Cyzicus mexicanus,* with the left valve removed. X5 (After Mattox from Edmondson).

TABLE 1

Physical, chemical and biological data for six sites in Lebanon County containing Cyzicus mexicanus

Site No.	Temp °C	pH	O₂ mg/L	CO₂ mg/L	PO₄ mg/L	N(NO₃) mg/L	Alkalinity as CaCO₃ mg/L	Turb FTU	Insects	Ostra-cods	Frogs
8	24.0	7.33	2	16	0.00	2.20	160	2400	+	+	+
9	26.0	7.50	2	22	0.00	2.20	240	900	+	+	
10	25.0	6.95	2	16	0.00	0.37	100	550	+	+	+
12	25.0	7.05	2	18	0.10	0.50	80	430	+	+	
64	16.0	7.15	5	18	0.00	0.70	60	650	+	+	
65	18.0	6.90	1	18	—	—	80	500	+	+	

MATERIALS AND METHODS

Samples were collected from one hundred and twenty-five sites in Lebanon County to determine the presence of conchostracans. The sites were selected primarily for their accessibility from roads and paths and ranged in size from lakes and ponds to roadside puddles.

Various physical, chemical, and biological data were obtained from sixty-five of the sites. Water temperature was recorded for each location. The pH of the water was measured with an Orion specific ion meter. Bausch and Lomb spectrokits were used to determine the dissolved oxygen, carbon dioxide, ortho phosphate, nitrogen as nitrate, alkalinity as $CaCO_3$, and the turbidity expressed in formazin turbidity units (FTU). Conchostracans were classified according to Pennak (1978). Other organisms collected were listed in the following groups—insects, molluscs, fishes, frogs, turtles and crustaceans, the last group subdivided into crayfish, amphipods, or ostracods.

RESULTS AND DISCUSSION

Geographically extensive surveys to locate conchostracans are impractical. The preferred habitats for these organisms are shallow, temporary pools or puddles which quickly disappear, especially during the dry summer months. Because of the ephemeral nature of these habitats and the logistics of sampling, geographically limited surveys are recommended. As a result, the present study concentrated on the distribution of conchostracans within Lebanon County.

As seen in Table 1 and Fig. 2, *Cyzicus mexicanus* was found in small temporary puddles at one site each in Union and East Hanover Townships, and at two sites both in Bethel and South Londonderry Townships. The water at these sites was neutral (pH 6.9 to 7.5), low in oxygen (1 to 5 mg/L), high in carbon dioxide (16 to 22 mg/L), and very turbid (430 to 2400 FTU). At each of these locations the substrate was muddy. Insects, ostracods, copepods, cladocerans, and rotifers were the only other animals found at all six sampling points. Frogs and tadpoles, the only vertebrates present, were limited to the sites in Union and Bethel Townships.

Several other bodies of water had physical and chemical characteristics similar to the six sites in which *C. mexicanus* was found. However, in more than half of these sites fish were present and many contained insects, especially aquatic beetles. In some areas three to five puddles were located within 20 meters of each other with conchostracans present in one or two puddles but absent in the others.
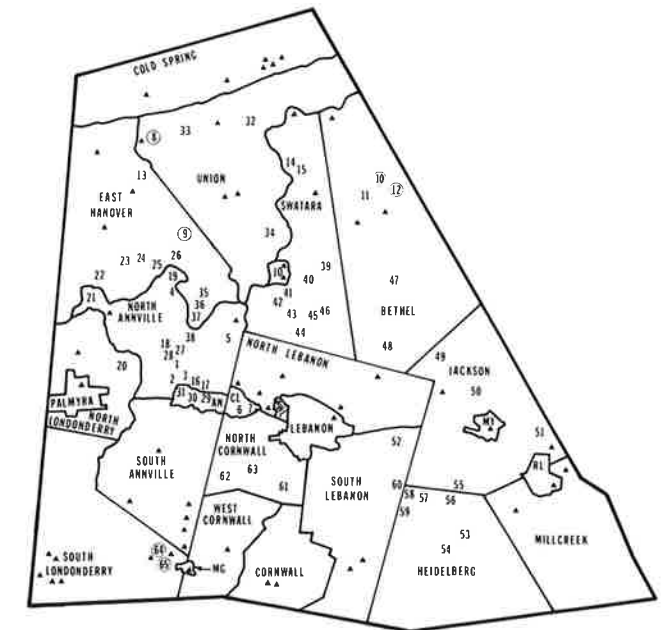

FIGURE 2. Map of Lebanon County showing sample site locations. Numbers correspond to sites in Table 1 and indicate no *Cyzicus mexicanus* found, but physical and chemical data were recorded. Circled numbers indicated the presence of *C. mexicanus* and data recorded and (▲) indicate the absence of *C. mexicanus* and no data recorded. The following municipalities are abbreviated: Annville (AN), Cleona (CL), Jonestown (JO), Mount Gretna (MG), Myerstown (MY), Richland (RL), and West Lebanon (WL).

The presence of *Cyzicus mexicanus* in only six areas of Lebanon County seems peculiar. However, workers have reported sporadic distribution patterns of conchostracans, including their absence from bodies of water exceeding one hectare in area and their presence in a particular pond for several successive years followed by a sudden unexplained absence (Packard, 1883; Kaestner, 1970; Pennak, 1978). The endemic location of several species adds to the confusion (Mattox, 1954).

Many bodies of water surveyed had similar physicochemical characteristics to the six in which *C. mexicanus* was found. The absence of conchostracans in these areas suggests that possibly predators or an unusual dispersal of cysts rather than water quality, accounts for the distribution of *C. mexicanus*. For example, fish were found in 35 bodies of water, none of which contained *C. mexicanus* indicating possible predation. Dispersal of conchostracan eggs or cysts is usually by the wind or by birds or insects (Pennak, 1978); all of which could lead to a sporadic distribution.

Although no studies have been conducted to prove the limiting role of predators, certain observations on the behavior and morphology of conchostracans should be noted. Clam shrimp have few, if any, adequate defense mechanisms; Pennak (1978) characterized this entire group as almost defenseless. The bivalve, leathery carapace is not a safe place to retreat like the molluscan shell. Despite the strong second antennae and the large number of trunk appendages for swimming, these organisms swim very slowly and could not escape most predators. The conchostracans also possess no apparent offensive structures to ward off predators.

As a result of this study, I think that the reported distribution of conchostracans is probably underestimated for several reasons. Clam shrimp usually inhabit puddles or temporary pools that are too small to attract the attention of most researchers. During superficial identification of routine samples, some clam shrimp are probably dismissed as molluscs. Finally, since the conchostracans frequently burrow into the mud (Kaestner, 1970), they may escape detection in routine pond and lake studies that concentrate primarily on the water column and the organisms dispersed within it.

Before a comprehensive distribution of conchostracans within Pennsylvania can be determined, further studies must be conducted throughout the state. Such studies could be supplemented by data from researchers examining substrate samples from lakes or ponds for conchostracans as well as from college and high school field trips and from naturalists and hobbiests who just like to look in puddles.

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THE IDENTIFICATION AND REPRODUCTIVE APPARATUS OF THE LAND PLANARIAN, *MICROPLANA ATROCYANEUS* (WALTON) FROM PENNSYLVANIA (*PLATYHELMINTHES: TURBELLARIA*).[1]

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ABSTRACT

This triclad terricola has an elongate, black cylindrical body, 20-25 mm long. It is found in moist soil in various localities of Eastern United States including Pennsylvania. A mature specimen found in a garden site at Carlisle, Pa. is described. It is compared with two other specimens known to represent the species. The identification of this species depends on having sexually mature specimens. Characters found in these specimens, considered typical of the mature condition as we know it, included the presence of only pre-pharyngeal testes, and well-developed penis bulb and papilla; the female system, with one pair of ovaries, has paired ovovitelline ducts leading posteriorily toward the reproductive apparatus; the narrow vagina gives rise to a short, simple genito-intestinal connection. The species is currently separated from other species of the genus by its external characters and the above simple features of its reproductive system. *Microplana rufocephalata* Hyman is discussed and compared.

INTRODUCTION

It was 70 years ago that Walton (1) described the new species of land planarian he called *Rhynchodemus atrocyaneus* from juvenile specimens, collected in Gambier, Ohio. In his brief description he stated:

> ". . . a much larger species approximately 20 mm in length and uniformly dark blue in color. . . .For this the name *Rhynchodemus atrocyaneus* is proposed." (1).

It was the dark bluish color, especially of juvenile specimens, that captured his imagination in assigning the specific epithet. The species was given a more complete description in 1943 by Hyman (2). She examined original serial sections labeled *Rhynchodemus atrocyaneus* of an immature specimen prepared by Walton. She also studied nine juvenile specimens collected in Eastern U.S. by Dr. Leslie Hubricht. As the result of this study, the main features of the species were expanded to include body form, color, eyes and histology. However, knowledge of the reproductive system was incomplete because the specimens were juvenile. Moreover, since the original Walton specimens were not sexually mature, their true identity could not be determined with certainty. As Dr. Hyman has indicated, we may never know the true identity of Walton's specimens. However, 42 years after the original description, Hyman (3) was fortunate to obtain two large sexually mature specimens collected by Dr. Leslie Hubricht (4). As the result, the features of the reproductive system and copulatory apparatus were finally added to the species description: viz., presence of a prominent penis bulb and penis papilla, simple vagina and tubular genito-intestinal system.

There have been several nomenclatoral changes within the family RHYNCHODEMIDAE resulting in changes of generic name of *R. atrocyaneus* Walton from *Rhynchodemus* to *Geodesmus,* to *Microplana.* The original genus *Rhynchodemus* of Leidy (5) and Graff (6) was used for a variety of species having a single pair of eyes and other common features. Following the redescription by Hyman (2), the species was assigned to the genus *Geodesmus* Mecznikow (10) since this was the genus recommended for species having weak subepidermal longitudinal musculature (2, 7, 8, 9). However, Pantin (11) by careful restudy of the type species, *Geodesmus bilineatus* Meznikow, 1866 (10), showed that *Geodesmus* had strong bundles of longitudinal musculature and was actually synonymous with the older genus *Rhynchodemus* (6), hence, was not available for use. As the result, another genus was required. Whereupon Dr. Pantin (12) recommended that the genus *Microplana* Vejdovsky, 1890 (13) was suitable for those species having weak longitudinal musculature and penis papilla in the copulatory system. The work of Marcus (14) summarized nomenclatoral changes and applied them in his discussion of species assigned to *Microplana* such as *M. terrestris* and mentioned the difficulty of precise placement of *R. atrocyaneus* Walton. At that time little was known about the mature reproductive complex of the latter. It was not until 1954 that Hyman (3) was able to make this clear by the description of the sexually mature condition of *R. atrocyaneus*. The presence of a well developed penis bulb and papilla in the male reproductive complex demonstrated the species belonged in *Microplana*. Thus, today the name *Microplana atrocyaneus* (Walton, 1912), expresses far more morphological knowledge, natural history and classification than was given in the original description by Walton. The name changes reflect growth in knowledge of the species and its place in the revised RHYNCHODEMIDAE.

MATERIALS AND METHODS

A juvenile black-bodied land planarian, 9-10 mm long was collected on July 15, 1958 in my garden at 119 Conway St., Carlisle, PA. Another accidental discovery on May 14, 1960 resulted in obtaining a larger apparently mature specimen, 19-20 mm long, in the same location (15). This large Carlisle specimen was processed

into stained anterior cross sections and posterior longitudinal sections for detailed study. The usual histological procedures were used for this and additional techniques are provided in Ogren (16, 17).

Also available for study were slides prepared by Dr. Hyman (3) of two sexually mature specimens classified by her as *Microplana atrocyaneus,* with lengths up to 25 mm. These had been used for her study of the species and had been collected by Dr. Leslie Hubricht at different times and localities. Hubricht Specimen, #26, was collected Feb. 1949 from Bachelor's Hall, Pittsylvania Co., Virginia; Hubricht Specimen #29, was collected Sept. 1940, from Roaring Gap, Allegheny Co., North Carolina (Hyman 3).

I was also able to examine slides from the type specimen of *Microplana rufocephalata* Hyman (3), kindly loaned by the American Museum of Natural History, New York City.

The collection of specimens of *M. atrocyaneus* largely from sites east of the Mississippi River in the United States and remarks on the biology were summarized recently by Ogren (17) for the land planarians found in Pennsylvania, and need not be repeated here.

Following the completion of these studies the prepared slides will be given to the American Museum of Natural History, New York, N.Y. so they may be available to other investigators as needed.

GENERAL BODY FEATURES

The body form was elongate cylindroid, rounded above, flattened below with a narrow, rounded anterior and slightly pointed posterior (17). The color was an intense black above and paler below on the ventral creeping sole, with gradation of shading along the sides. The body appeared more purplish following fixation. There were no markings discernable except some mottled areas along the lighter sides. The appearance and other features agreed with descriptions by Dr. Hyman for the species. During life the plump body glistened with mucus and small peristaltic waves moved over the surface. Individuals moved along the substrate surface with the short, narrow, rounded, anterior end lifted above the stratum, waving from side to side, resembling the profile presented for *M. terrestris,* in Dr. Pantins study of locomotion (11). The pair of minute eyes, located near the anterior tip, were visible as two black spots under favorable conditions during movement. The eyes were V-shaped as shown by Hyman (2). They were about as wide as deep measuring 27 μm in diameter for the Carlisle specimen; and 40 μm by 36 μm in the Hubricht specimen #29. The open end, located just beneath the musculature faced laterally toward the surface. The dense wall of the cup was composed of brown spheroid pigment granules presumably formed by pigment cup cells (18). The light sensitive cells, located outside, sent broad protoplasmic bulbs over the edge into the cup. The eyes were located just in front of the brain or were included in sections with anterior portions of brain tissue.

INTERNAL FEATURES

The body structure was that of a triclad land planarian and conformed to the descriptions of *M. atrocyaneus* provided by Hyman. The body had a marked cylindrical form in cross sections, with the ventral creeping sole being more flattened with a median ridge. The body covering consisted of a columnar epithel-

ium, basement membrane, subepidermal musclelayers and mesenchyma. The dorsal epithelium consisted of nonciliated cells with numerous straight to curved rhabdites about the height of the cells; rhabdites had one or both ends tapered; some had an S-shape Ciliation was restricted to the ventral creeping sole which formed a broad band in the middle and posterior body, but an ever narrowing medial band in the anterior body region; being absent near the level of the eyes. The brown body pigment granules formed a broad band concentrated beneath the longitudinal musculature in the dorsal region, thinning out along the sides and absent ventrally. The musculature beneath the epidermis consisted of a broad, uniform, outer circular layer, beneath which was a layer of longitudinal fibers about the same thickness as the circular layer, but with regularly placed fibers separated by distinct spaces. This closely resembled the illustrations of Pantin (11, 12) as typical of *Microplana*. In the tissue layers beneath the musculature and pigment band, there were abundant rhabdites and rhabdite-forming cells. The rhabdites and rhabdite-forming cells were most abundant in the dorsal body region and decreased gradually along the sides to finally disappear along the edge of the creeping sole. The paired nerve commissures occupied prominent ventral positions and served as land marks for locating testes, sperm ducts, and ovovitelline ducts.

THE REPRODUCTIVE SYSTEM

The general features of the reproductive system, and the copulatory apparatus in particular, agreed with the previous descriptions by Hyman (2, 3). However, the female system showed a slightly greater degree of maturity as compared to the Hyman specimens. In the *male system* all testes were pre-pharyngeal, about 20-30 in number with the last pair 0.49 mm from the base of the pharynx. The sperm ducts, collecting from the testes, ran parallel to the nerve commissures and continued posteriorly, around the pharynx. Behind the pharynx they expanded to serve as spermaducal vesicles. They narrowed, no longer containing sperm, to pass through the muscular bulbar tissue, and opened separately into the bulbar cavity. The columnar epithelium of the seminal vesicle was not greatly folded. It appeared glandular with goblet type cells having course granules. The moderate-sized lumen was also filled with coarse granules. The origin of this material was not clear since it resembled granules in the epithelial cells and coarse granules in the tissue surrounding the bulbus. The secretion was expelled from the cavity through the ejaculatory duct, which was a narrow nonglandular, ciliated passage within the large prominent conical penis papilla.

The *female system* included the single pair of ovaries and the numerous vitelline glands which passed their products posteriorly to the female complex by way of the ovo-vitelline ducts located parallel to the nerve commissures. Behind the level of reproductive organs, the ducts curved medially where they entered separately into a common ovo-vitelline chamber serving as the posterior region of the vagina. Each ovovitelline duct was enclosed by abundant eosinophilous glands releasing granules through the walls, for some distance before joining the common chamber. However, the vagina itself was without the glands. The funnel-shaped female antrum opening posteriorly into the vagina had non-ciliated columnar epithelium. The straight tubular vagina had columnar epithelium which was ciliated primarily in the posterior half. The lumen of the vagina, originally of large diameter, became a narrow tube posteriorly.
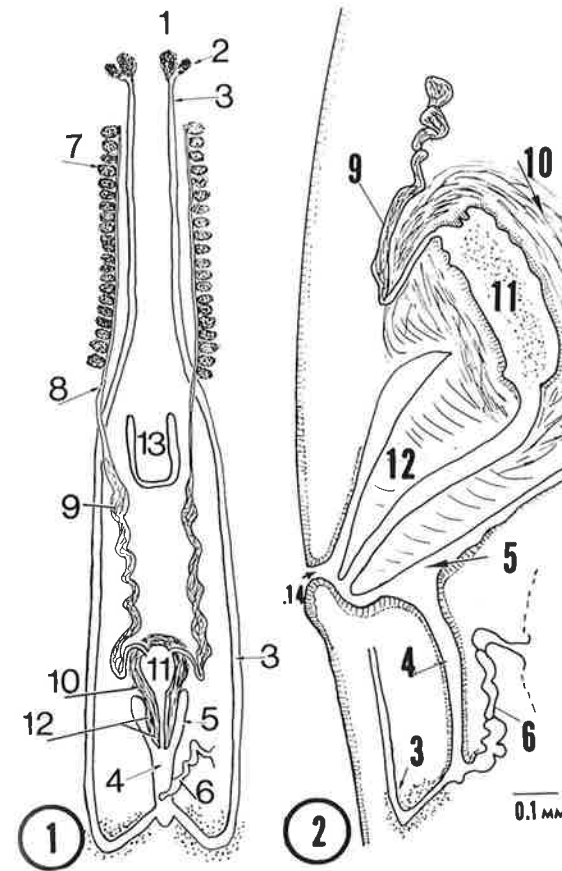
FIGURE 1. Reproductive system of *Microplana atrocyaneus;* a schematic dorsal frontal view.

FIGURE 2. Copulatory complex of *Microplana atrocyaneus* reconstructed side view profile.

Labels for Figures: 1. Ovary; 2. Paraovarium; 3. Ovo-vitelline duct; 4. vagina; 5. Antrum; 6. Genito-intestinal system; 7. Testes; 8. Sperm duct; 9. Spermaducal vesicles; 10. Penis bulb; 11. Bulbar cavity; 12. Penis papilla, enclosing ejaculatory duct; 13. Pharynx; 14. Genital pore. Anterior is toward the top of the page. In Fig. 2 Ventral is toward the left. Cilia have been omitted from the diagrams, but are found lining the cavities and on the creeping sole. The stippling around the terminal parts of the ovo-vitelline ducts represents the location of eosinophilous glands. The numerous serially arranged vitelline glands which open into the ovo-vitelline ducts, have been omitted to avoid confusion of detail in Figure 1.

The *genito-intestinal system,* essentially a winding canal, arose from the hind part of the vagina, and consisted of three regions. All were non-glandular, ciliated columnar epithelium. 1) The short *proximal connection,* evaginated from the dorsal vagina and had moderate diameter. 2) The *middle region,* an expanded, undulating canal with ciliated non-glandular epithelium, was directed anteriorly, had regional enlargements, then narrowed as it became the exit canal. 3) The *exit canal* of the genito-intestinal system was the narrow continuation of the G-I system. It turned laterally and anteriorly before reaching the wall of the common genital antrum, then continued some distance, whereupon it passed through the medial wall of intestinal epithelium to open into the digestive lumen. The opening was enclosed by portions of duct and digestive epithelial cells.

THE TWO SPECIMENS (#26, #29) STUDIED BY DR. HYMAN

These specimens were collected by Dr. Leslie Hubricht nine years apart and were from Virginia and North Carolina, thus sampling different local populations. Their general external and internal features were described by Hyman (3). My restudy of the actual slides supports her description in most respects. In the *male system,* the testes were all prepharyngeal, with the last pair in #29 being 0.6 mm anterior to the base of the pharynx. The sperm ducts passed posteriorly around the pharynx, enlarged as spermaducal vesicles, narrowed within the bulbar tissue and entered separately into the bulbar cavity. This space was of moderate size, the wall not folded, the lumen containing large amounts of coarse eosinophilous granules. The straight ciliated ejaculatory duct was enclosed by the heavy muscular walls of the conical penis papilla.

The *female system* included the pair of ovaries and numerous vitelline glands. Their products were carried posteriorly by the ovovitelline ducts, which passed around the pharynx, continued posteriorly behind the level of female organs, turned mediad to separately enter the enlarged ovo vitelline chamber, along the mid line behind the vagina. Numerous eosinophilous glands surrounded this terminal part of each ovo-vitelline duct. The opening of the vagina from the common antrum was funnel-shaped and lined with non-ciliated columnar epithelium, thrown into tall folds along the dorsal portion. In both specimens the tubular lumen of the vagina began with a moderate diameter, and within a short distance became a narrow tube. This considerable decrease, not clearly shown in Hyman's diagram (19) was most evident in specimen #26 by the narrow slit-like terminus, I concluded the vagina was not in full sexual maturity. Ciliation was evident in specimen #29 only in the posterior half of the vagina. My interpretation of the genito-intestinal system as found in these two specimens, differed slightly from that given by Dr. Hyman: 1) The tube was not straight as shown in her diagram, but undulating; 2) The diameter was not uniform, there were regional enlargements with a narrowing of the exit canal; 3) There was moderate division into three regions, viz., proximal connection, middle region slightly expanded, exit canal, the narrow terminal portion. Thus, the two Hubricht specimens showed a genito-intestinal system consisting of a short *proximal connection* that evaginated as a narrow to enlarged tube from the dorsal wall of the posterior vagina. The *middle region* was a long undulating tube bending anteriorly above the vagina and showing regional enlargements. In specimen #26 the greatest diameter was comparable to the enlarged part of the vagina. This was also the case for #29 but with the greatest enlargement near the vagina. The *exit canal* in both specimens was the narrow terminal part of the tube which turned laterally behind the wall of the common reproductive antrum to enter the medial wall of the intestine. The entrance into the lumen was slightly enlarged and consisted of segments of epithelium from the duct and digestive lining. The lining of the genito-intestinal system was non-glandular, ciliated, columnar epithelium. The enclosing musculature was moderately developed.

OBSERVATIONS ON *MICROPLANA RUFOCEPHALATA* HYMAN 1954

Slides of the type specimen were borrowed from the American Museum of Natural History and compared with other specimens

under investigation. The original material described by Hyman (3) was collected by Dr. Leslie Hubricht. Two worms measuring up to 35 mm long were found May 1952 on Pine Mountain at 2600 feet elevation, Harlan, Harlan County, Kentucky. Their color was black with a distinctive reddish brown anterior tip. My study of the sectioned specimen supports the main features of the description. The eye appeared to be V-shaped, about 40 μm diameter, but only one could be found cut diagonally; see the first slide top row of the cross sections. The sections through the copulatory apparatus were cut on a diagonal plane making visualization very difficult. I was not able to locate testes, even though the expanded spermaducal receptacles were full of sperm a feature noted by Dr. Hyman (3). The copulatory apparatus was located on slides 1.4 and 1.5 and somewhat distorted by reason of the diagonal profile. The genital pore was difficult to locate, a feature Dr. Hyman did not find with certainty. However, on slide 1.5 there was a prominant invagination into the large female antrum that appeared clearly to be the genital pore. It divided what may have been interpreted as the long vagina, into two parts. One turned posterior as the ciliated tube of the vagina, the other turned anterior as the female antrum which contained distinctive colloidal material. Nevertheless, the vaginal part remained quite enlarged and elongated. Near the posterior end the vagina gave rise to the narrow *proximal connection* of the genito-intestinal system, then received the vitelline chamber surrounded by abundant eosinophilous gland cells.

The genito-intestinal system was equal to the length of the vagina. All portions were lined with a non-glandular, ciliated columnar epithelium. Three regions were evident. 1) The *proximal connection* was a curved tube of moderate diameter that bent forward. 2) The long *middle region,* dorsal to the vagina, nearly parallel, extended anteriorly nearly straight, not undulating. Dr. Hyman did not describe the extent of the lumen of this region. It occupied several sections and appeared as a flattened sac with the largest lumen in the middle; not as a long tube of equal diameter. 3) The distal *exit canal* was narrower than the middle region and continued forward to open into the intestine. The terminus was expanded and funnel-shaped as it opened from the epithelium.

DISCUSSION

This Carlisle specimen represents the third most mature example available for study. It conforms to the major characters of the species, as given in Dr. Hyman's descriptions. (2, 3). There are slight differences in the reproductive system suggesting that the Carlisle specimen is slightly more advanced in sexual maturity than the Hubricht specimens. For example, the last testis is 0.49 mm from the base of the pharynx in the Carlisle specimen, whereas this is 0.6 mm in one Hubricht specimen, suggesting that there were more testes in the former, which would correlate with a greater degree of sexual maturity. The vagina was also larger and the GI canal more expanded in the Carlisle specimen. The interpretation of the genito-intestinal system has become important here, since this feature represents the major structural difference between the species *M. atrocyaneus* and *M. terrestris.*

The specimens of *Microplana atrocyaneus* can be distinguished from members found in Europe as given by Minelli (20). *M. atrocyaneus* specimens differ in body color and morphology of reproductive system from *M. scharfi* and *M. brittanicus;* the latter being considered a synonym of the former (23). There is distinction from *M. humicola,* type species of the genus (13), which has a pale, unpigmented body, small size and individual features of its reproductive system. *M. giusti* has distinctive features of its male reproductive apparatus with testes placed between pharynx and genital atrium. *M. atrocyaneus* does not have the rust colored body with dorsal stripes of body or folds in the genital atrium as are present in *M. henrici*. The yellowish body of *M. pyrenaica,* its large size over 50 mm, its very small penis papilla, as well as unique features of the female system, separate it from *M. atrocyaneus.* It is, however, more difficult to separate *M. atrocyaneus* from two similar european black planarians, viz., *M. mahnerti* Minelli and *M. terrestris* (O.F. Muller). These two species, nevertheless, have a distinctive sac-like seminal bursa (seminal receptacle) as part of the genito-intestinal system which appears to make separation from our study specimens possible.

In the United States *M. rufocephalata* Hyman is distinguished from *M. atrocyaneus* by possessing a distinct rufus colored anterior tip, possession of a very long vagina and genito-intestinal system that is longer, straight and a larger lumen. The species *M. terrestris* has been described from Wisconsin, U.S.A. by Hyman (21) and a paper being prepared by the writer (22) describes a specimen from New York State. Both these specimens have a distinct seminal bursa as part of the copulatory apparatus, hence, with this character can be separated from *M. atrocyaneus.* Otherwise the species are quite similar. Dr. Hyman (3) considered the presence of a seminal bursa to be a feature of generic rank and proposed the genus *Orthodemus* for those microplanids having a bursa. The genus *Microplana* would be limited in this suggestion to those species with a simple tubular genito-intestinal system. However, if the seminal bursa represents the degree of sexual development and the absence of it is merely failure to attain this level of development, then the generic distinction may not be too valid. I prefer to retain the use of *Microplana* until more developmental information is known. In a recent short account of *Microplana* in Ball and Reynoldson (23) *Orthodemus* is listed as a synonym of *Microplana.*

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THE TMI POPULATION: A CLOSER LOOK[1]

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ABSTRACT

In the aftermath of the accident at Three Mile Island (TMI), considerable effort was expended to assess the potential health impact on the surrounding population. To provide baseline demographic and dosimetric information on the 36,000 individuals residing within approximately 5 miles of the nuclear station, a comprehensive computerized data-base which includes a special census documentation on each individual has been developed. The location of residence of each of 13,000 households is superimposed on a digitized map of the area. Each individual within a given household can thus be identified.

This report provides a general description of the comprehensive data-base and cites some examples of its use. Selected data are extracted from the data-base including residential location in terms of distance and direction, and movement into and out of the five mile area during the ten days following the accident. Examples are given to illustrate how the computerized link-up of population and geographic data can be employed in analysis. (The linking of population data with radiation dosimetry will be covered in a separate report.) Variations in movement patterns (temporary evacuation) were found between different sectors around TMI.

INTRODUCTION

During the weeks following the accident at the Three Mile Island (TMI) Nuclear Station a major effort was mounted to assess the potential impact on the surrounding population. The primary and immediate concern was the possible health impact from the radiation dose delivered to the population (1-3). A great deal of public uncertainty arose over the severity of the accident and whether the situation was controllable. Though no official order was given, a substantial portion of the nearby population temporarily evacuated their homes. As management of the accident progressed and radiation measurements were refined, it became evident that the population-integrated radiation exposures was very low (4-5). From this knowledge, public anxiety in the vicinity of TMI declined somewhat, yet was higher than that in comparison communities up to one year after the

accident (6,8). The early uncertainties concerning the consequences of the accident, and the evacuation of the area by a significant segment of the local population were important stresses which could well result in detrimental health changes (2,6).

All early dosimetric studies used population estimates from the 1980 offsite population projections presented in the 1972 Metropolitan Edison Company Final Safety Analysis Report (FSAR) (7). These projections were based on the 1970 census data in conjunction with information from state and county planning boards. In order to provide improved baseline data for future evaluation, the Pennsylvania Department of Health, in cooperation with the National Center for Disease Control and the U.S. Bureau of the Census, conducted a special census of the TMI population in June, 1979. Those included in the census resided within approximately five miles of the plant at the time of the survey (9). Information collected on each individual included basic demographic data such as age, sex, marital status and occupation, a brief health history, residential address and selected information on movements into and from the five mile zone (FMZ) during the ten days following the accident.

In an effort to document all essential information related to the TMI population, a computer-based, digitized map of the
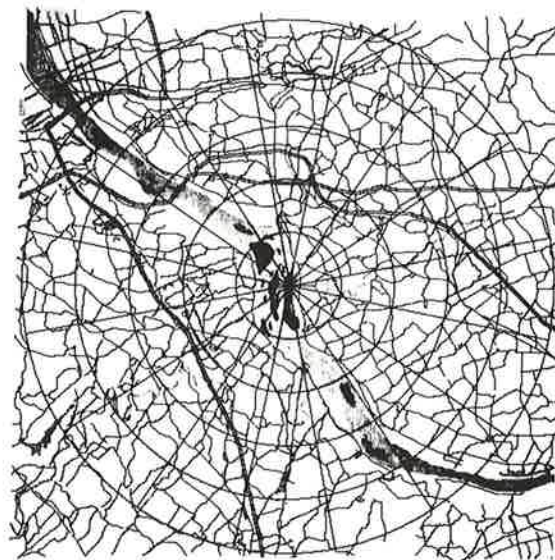

FIGURE 1. A computer plot of the digitized map of the TMI area 0-10 miles from the plant. Densely populated regions (towns) are indicated by the shaded area. A grid divides the area into sixteen sectors whose midlines are along the N, NNE, NE, . . . etc. directions. The map is further subdivided by concentric circles spaced two miles apart.

area was developed and the census data superimposed onto the map. The location of residence in relation to TMI (distance and direction) and information on movements in and out of the area during the 10 days following the accident can be used in conjunction with estimated time dependent dose rate distributions to assign likely and maximum possible dose to members of the 13,000 households residing in the 5 mile radius. This work is being carried out and will be the subject of a subsequent report.

This report addresses the types of information that may be extracted from the data base, focusing on the linkage of population and geographic data. Examples are given on evacuation (movement in and out of the FMZ during the ten days following the accident) as a function of distance and direction from the plant.

METHODOLOGY

A. Geographic Data

A regional map covering approximately 400 square miles centered on TMI was digitized into a 512 x 512 array. This map can be displayed on a high resolution computer graphic display system and is shown in Figure 1. The display consists of general features such as paved and unpaved roads and highways, rivers and streams, and population centers. A grid divides the area into 16 sectors of 22.5° each. The sectors are centered respectively on the directions N, NNE, NE, ENE, E, etc. The area is further subdivided into concentric rings. Any particular sector can be selectively displayed and investigated. Other display options such as zoom capabilities for magnifications of two, four and eight are also available.

B. Population Data

The TMI census was conducted in late June, 1979, approximately three months after the accident. One hundred and twenty-nine enumeration districts (E.D.'s), comparable to
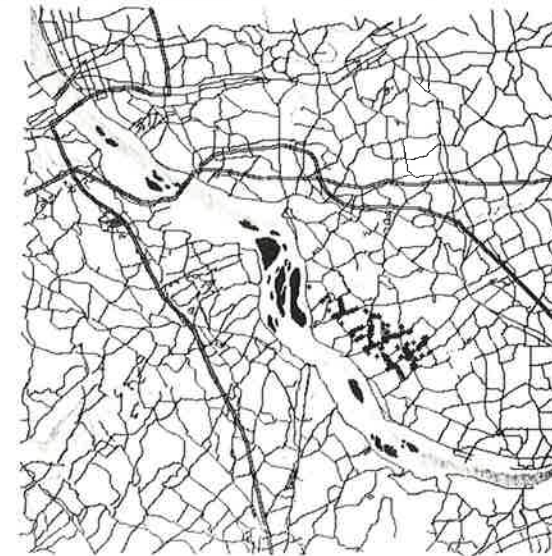

FIGURE 2A

FIGURE 2. Computer-generated display of population data. (a) View of households in an arbitrarily chosen 22.5° sector 0-5 miles from the plant. (b) A magnified view within the same sector. (c) The exact location of residence of one individual (see arrow) along with coded information pertinent to that individual: census enumeration district number, household number, individual number, age, sex, and movement patterns (roster) for the ten days following the accident.

those used in the 1970 U.S. census were thoroughly canvassed. The TMI Population Registry resulting from the census effort has been estiamted at 96% complete (9). The geographical boundary followed during the TMI census extended occasionally beyond five miles to conform to township lines or natural contours of the land. In this report, the *exact* five mile boundary is used to define the FMZ, thus reducing the study population size from 35,962 to 33,988.

The population registry has twenty-eight items of data for each of the 33,988 persons (13,000 households). Data on evacuation is utilized in this report. Distance and direction coordinates, derived from address data, in conjunction with original census enumeration maps, are also utilized.

The estimated location of residence of each of the 13,000 households participating in the speical FMZ census was superimposed on the digitized map. Each household can be identified by a household number within one of 129 E.D.'s. Individuals within a given household can be further distinguished by a person number in the household. With the assistance of these identification numbers, the residential location (distance and direction coordinates) and other demographic attributes of any individual within the FMZ can be easily retrieved. The superposition of the census data on the TMI map and the associated display capabilities are illustrated in Figures 2a-2c.

FIGURE 2B
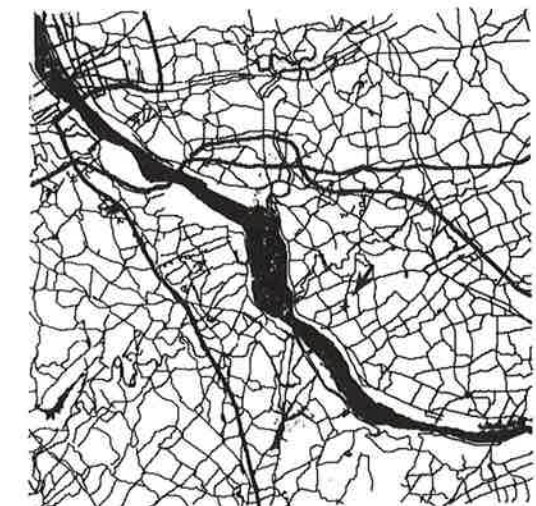
FIGURE 2C

C. Validation Procedures

The validation of the data used in this report was carried out in four different phases:

1. The TMI population registry was validated by the Pennsylvania Health Department. Details of this comprehensive validation process can be found in a separate report (9).

2. The digitized map was validated by visual comparison to a 1 inch/mile map (Pennsylvania Department of Transportation, 1972). In addition, 35 locations (primarily road junctions) were manually measured to determine the distance and direction from TMI and compared to the same locations on the digitized area map. Only minor errors were found, all of which have been corrected. The accurate location of paved roads is important because most individuals reside near these roads.

3. Field validation of road patterns near 30 road junctions in the area was performed by comparisons of actual patterns to both standard and computerized maps. All junctions were found to be satisfactory. Only one road construction after the issue date of the road map had to be added.

4. One hundred actual household in 40 locations around TMI were randomly selected and field validations of the location of residence of these households were carried out independently from all other validation procedures. Initially, ten of the 100 households could not be found on the census data files. However, additional investigation revealed that four houses were temporarily vacant during the survey and six had moved into the area after the survey. All 90 identified households were located by the computer within 0.3 miles of the actual location of residence.

DATA ANALYSIS

Several computer programs have been written to extract relevant information from the comprehensive data-base. These programs use, search, identify and test routines to selectively study any particular attribute of interest.

TABLE 1

Estimated FMZ Population Distribution by Sector and Distance. FSAR (7) Population Estimates are Shown in Parenthesis.

Sector	Distance (miles) 0-1	1-2	2-3	3-4	4-5	Total
N	0	141	5226	4564	282	10,213 (9388)
NNE	15	98	268	662	145	1188 (1152)
NE	45	109	226	367	192	939 (1061)
ENE	90	50	154	551	618	1463 (1022)
E	57	39	5	295	527	923 (830)
ESE	0	53	81	110	1033	1277 (641)
SE	13	69	79	325	423	909 (765)
SSE	54	130	136	81	30	431 (523)
S	0	0	118	1074	1328	2520 (2270)
SSW	0	31	517	268	722	1538 (1735)
SW	25	96	387	751	199	1458 (1150)
WSW	11	164	137	671	408	1391 (1452)
W	0	329	222	1397	704	2652 (1343)
WNW	0	57	147	80	286	570 (813)
NW	0	0	25	315	2203	2543 (1427)
NNW	0	0	958	1329	1686	3973 (4249)
Totals	310 (658)	1366 (2017)	8686 (7579)	12,840 (9676)	10,786 (8891)	33,988 (28,821)
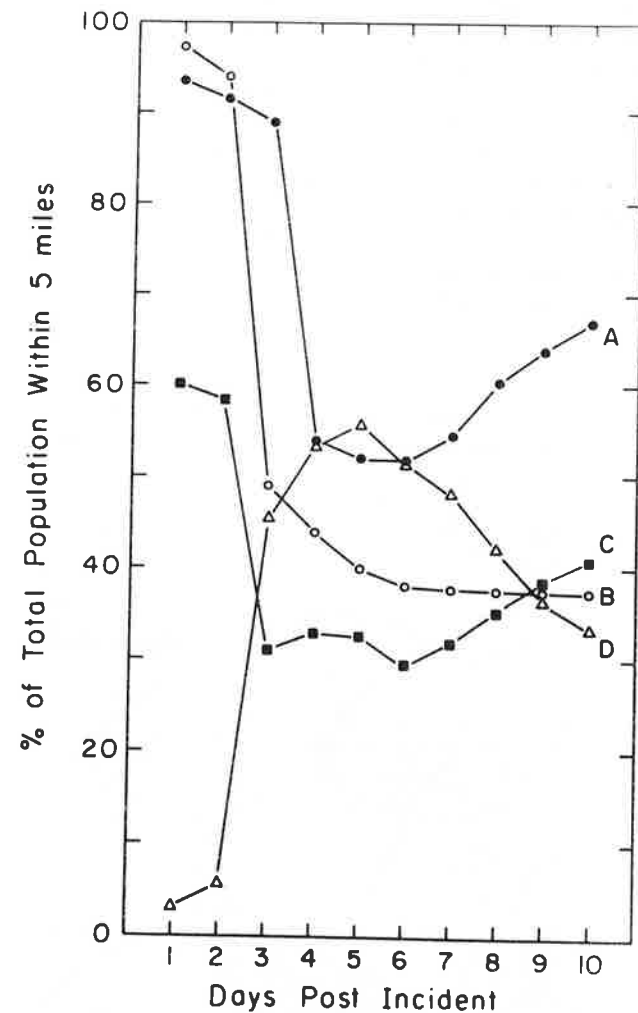
FIGURE 3. Movement patterns of the total population within five miles of TMI for the ten days following the incident. March 28, 1979 is "Day one". The curves represent the following: (A) percentage of the total population that was within the five mile area on the given day; (B) percentage of the total population whose movements into and out of the five mile region up to the given day, was not influenced by the incident; (C) percentage of the total population who did not leave the five mile area on a given day; (D) percentage of the total population who left the five mile area on a given day because of the incident.

A. Population Distribution

The total participating population in the FMZ was 33,988. The estimated distribution of this population at the time of accident, by sector and distance from TMI, is given in Table 1; the projected population (FSAR(7)) used by all earlier studies is shown in parentheses.

B. Evacuation Patterns by Sector and Distance

One of the interesting uses of the computerized data-base is the analysis of evacuation patterns in terms of residential location. The movements, into and out of the FMZ, of the total population as well as those within selected sectors and at selected distances are illustrated in Figures 3-5.

The curves in Figure 3 represent the day-by-day movements of the total population residing in the FMZ. Curve A represents the percent of the total population that was in the FMZ at some time (and, therefore, at some risk of exposure) on each given day. Curve B represents the percent of the population whose movements, up to a given day, were not influenced by the accident. It, therefore, includes persons who might have left the area but not because of the accident. Curve C represents the percent of the population who did not leave the FMZ at any time on each given day. Therefore, this type of information on individuals can be used in assigning likely radiation dose to each person. Curve D represents the percent of the population whose movements were influenced by the accident. It includes those who were not in the FMZ at all a given day because of the accident and those who left on that day, also because of the accident.

Patterns of movement (whereabouts; evacuations) were analyzed within sectors around TMI and then compared to that of the total FMZ population. Some sectors showed radically different behavior from others. Figure 4 shows the movement patterns for three selected sectors. These represent the typical and extremes of evacuation behavior. The curves show the percent of the population within a given sector whose movements, up to the given day, were not influenced by the accident. The population counts within these sectors, ESE (curve 1), N (curve 2) and W (curve 3) are shown in Table 1.

Movement patterns were also analyzed by distance from TMI. The results for three different distances are shown in Figure 5.
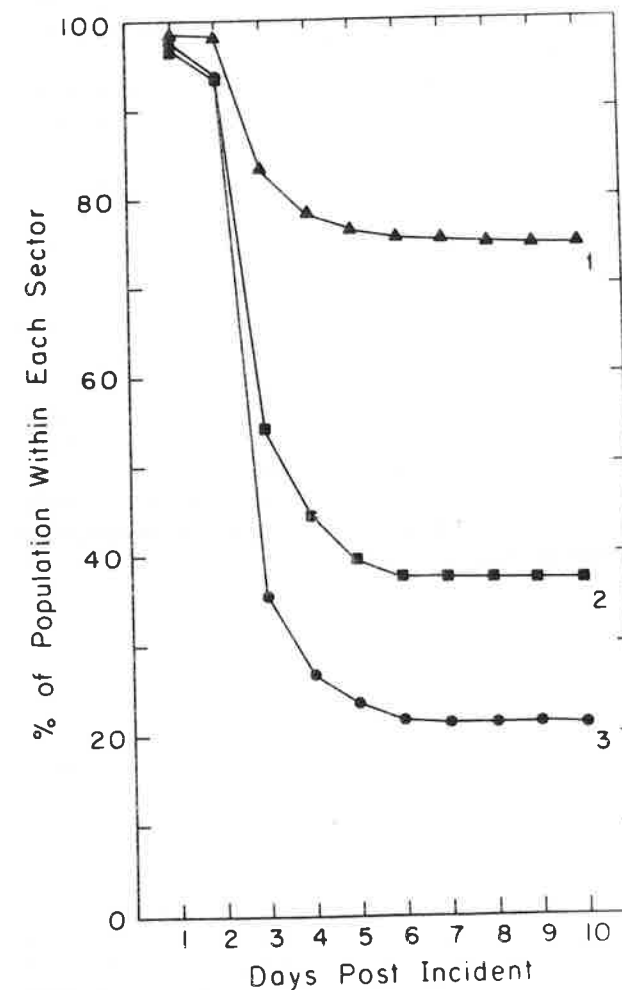
FIGURE 4. Movement patterns of the population within three selected sectors. These represent the typical and extreme behaviors. The sectors are: (1): East Southeast, (2): North and (3): West. The movement patterns shown are the percentage of population within a given sector, whose movements into and out of the five-mile region was not influenced up to the given day by the incident.
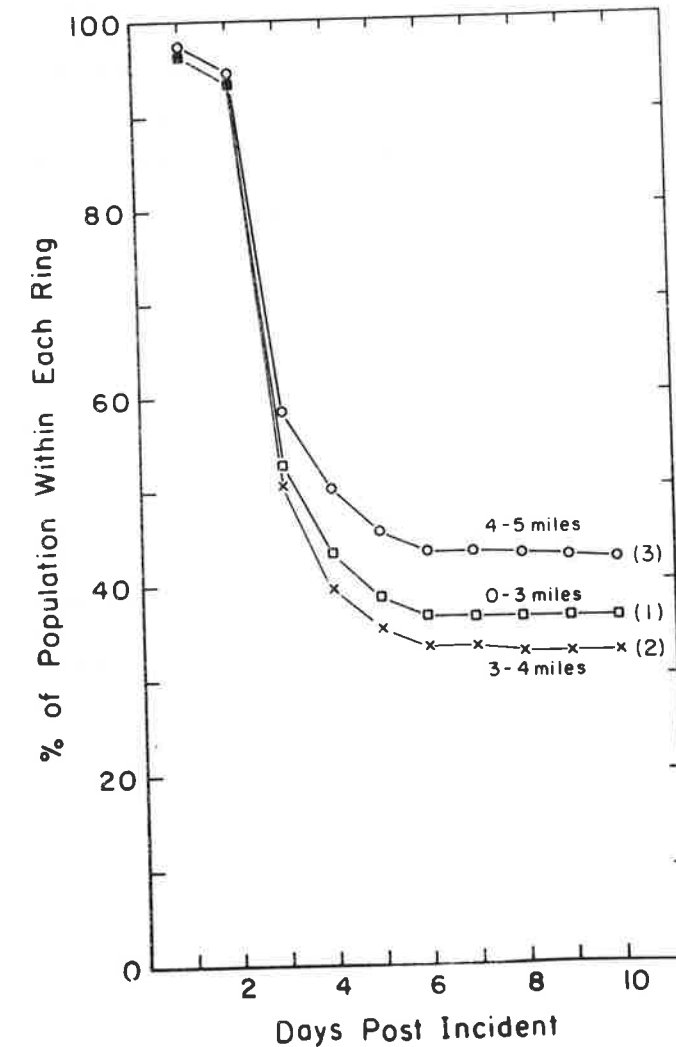
FIGURE 5. Movement patterns of the general population residing within the (1) 0-3 miles, (2) 3-4 miles, (3) 4-5 miles from the TMINS. Each curve represents the percentage of the general population, residing within a given ring, whose movements into and out of the five mile zone up to the given day was not influenced by the incident.

DISCUSSION

This paper describes elements of a comprehensive data-base which was developed as a consequence of the nuclear accident at TMI. The data-base includes population and geographic data, all of which have been programmed into a computerized graphical display system. Information about any of the 36,000 persons in the data-base can be retrieved easily by specifying a unique identification number. The location of residence of any person can be graphically displayed along with characteristics of age, sex and whereabouts during the ten days following the accident. Any elements of this data-base can be assessed in terms of direction and distance from the plant.

In this report population frequency counts, derived from the special census conducted three months after the accident, are compared to earlier projections (FSAR(7)). The population enumerated within the five mile zone exceeded the FSAR projections by about 15%. A part of the difference is due to a genuine increase in the population of the area. However, some of the discrepancy may be due to the inclusion, in the five mile zone, of persons residing just beyond the five mile limit. For instance, in the east-by southeast (ESE) sector, the residents of a large nursing home were included in the data-base. Part of the nursing home is located just beyond the five mile border. The census population distribution by sector and distance agrees reasonably well with the FSAR projections.

It is interesting to note the variation in evacuation patterns for different sectors around the plant. The ESE-sector is influenced the least by the accident, while the W sector is influenced the most and the N sector (with the largest proportion of the population) is typical of the entire five mile zone. Although these observations in themselves do not explain why there is a difference, they do suggest further investigation (10). There are no significant differences in the evacuation patterns of the populations residing at different distances from Three Mile Island within the five mile area.

The above examples cite two uses of linking geographic and population data: (1) verification of population counts at various directions and distances from TMI, (2) evacuation patterns at selected directions and distances from TMI. Other uses can be envisioned. For example, this type of data-base can be used in conjunction with estimated dose-rate distributions to assign maximum possible and likely exposure estimates to individuals within this population. This work is being carried out and will be the subject of a separate report.

ACKNOWLEDGEMENT

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FLOW-THROUGH BIOMONITORING APPLIED TO A POWER PLANT EFFLUENT, WITH EMPHASIS ON ARSENIC BIOACCUMULATION[1]

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ABSTRACT

Continuous flow-through effluent biomonitoring studies were conducted at a steam electric station (SES) for 128 days with 300 fathead minnow *(Pimephales promelas)* and 300 bluegill *(Lepomis macrochirus)*. Fishes were exposed in a mobile environmental research lab ("MERLin") to three water types: 1) *Control*—from the receiving stream; 2) *Effluent*—undiluted SES wastewater; and 3) *Mixed*—from the receiving stream below the point of SES discharge. Various physico-chemical and biological parameters were measured. During the study, subsamples of fishes were removed at 30-day intervals to assess condition and growth and for whole-body arsenic analysis by neutron activation techniques.

At the end of 128 days control mortalities were 13% and 24% for fathead minnow and bluegill, respectively; while *Effluent* mortalities were 8% and 24%, respectively. Significant increases in growth occurred in both species over the 128 days, and for both *Effluent* vs. *Control* waters. Whole-body analysis for arsenic indicated *Effluent* fishes contained higher levels than did *Control* fishes and fathead minnow accumulated arsenic to higher levels than did bluegill.

Both fish species survived and grew in the undiluted SES effluent and mixed waters, and did not appear adversely affected by effluent water or arsenic bioaccumulation. Higher bluegill mortalities in both *Control* and *Effluent* waters appeared to be related to dominance behavior.

INTRODUCTION

Concern about toxicants in the environment has increased interest in the development of new and efficient methods to test the effects of effluents. Recent water quality standards for most chemicals or effluents have been derived from biological monitoring or bioassay (1). Gruber *et al.* (2) described biomonitoring as a means of assessing the strength of toxicants by using living organisms as sensors, while Morgan (3) referred to biomonitoring as the process of measuring repeatedly the physiological reactions of organisms to "environmentally induced conditions."

Most toxicity tests that have been conducted and from which water quality criteria have been derived were under controlled laboratory conditions. Such tests were usually limited because they did not take into account the possible synergistic or antagonistic interactions of toxicants that occur in the natural environment. Sexton (4) stated that what is currently known about chemical interactions is not enough to predict effects of a chemically complex effluent upon organisms and/or their systems. Testing organisms with a continuous-flow-through system utilizing effluent and control waters approximates the "real world", and thereby the characteristics of the effluent and the natural environment are incorporated into the bioassay (5). Gerhold (6) reviewed several mobile laboratory test units, concluded that these were excellent research tools for flow-through tests, suggesting their potential for on-site testing has not been fully realized.

The overall objective of this research was to develop an onsite biomonitoring facility which provided test conditions closely resembling the receiving stream and to apply this approach to better understand the aquatic impacts of a power plant effluent on selected "indicator organisms". Arsenic, a trace element of concern at the plant chosen was also to be specifically studied with regard to bioaccumulation.

Arsenic, found in all living organisms, water, soil and geological stuctures, is estimated to be present in the earth's crust at a concentration of 2 mg/kg (7). It was reported to be present in 67% of the coal ash samples tested (8). Its distribution in aquatic organisms tends to mimic the distribution in surrounding water—i.e., when high local arsenic concentrations exist on a continuing basis, exposed tissue concentrations of arsenic tend also to be elevated (9). The cause is related to the distribution of arsenic concentrations per se; and a host of biological factors including habitat and trophic relationships (10), osmoregulatory functions (11) and uptake mechanisms.

The specific purposes of this paper include: 1) introduction of the mobile environmental research laboratory as an appropriate research tool, and 2) discussion of effects (growth differences, mortality, and bioaccumulation of arsenic) observed in two species of fishes during 128 days of continual exposure to an industrial effluent.
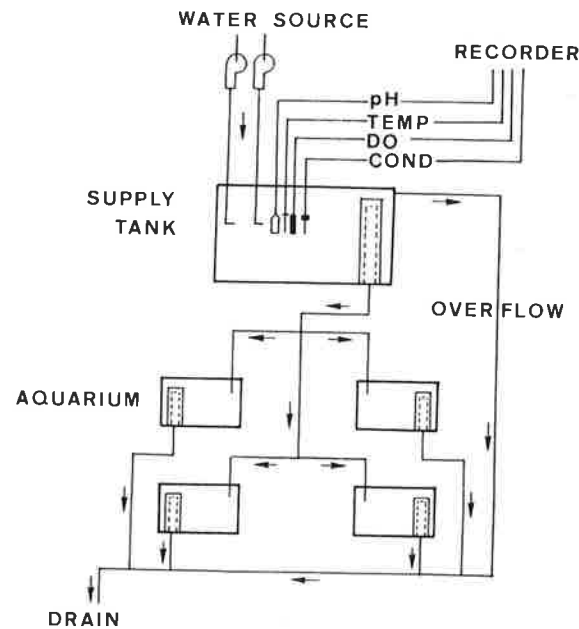
FIGURE 1. MERLin experimental system.

METHODS AND MATERIALS

A mobile environmental research laboratory ("MERLin") was designed and built by Pennsylvania Power & Light Company (Allentown, PA). It consisted of an 2.4 m x 2.4 m x 9.8 m (8 ft. x 8 ft. x 32 ft.) trailer housing four experimental flow-through systems. Each system (Fig. 1) consisted of one 378 l (100 gal.) fiberglass supply tank connected to four 109 l (20 gal.) fiberglass test aquaria with viewing windows. Water was pumped to the supply tank by positive displacement pumps. In the event of primary pump failure a secondary pump was automatically started for a continuous supply of testing waters. Each supply tank was also equipped with a float switch which regulated pumping to maintain prescribed levels. Flow into each tank was regulated by PVC valves and exited via a modified under-flow standpipe system (12). A custom-designed aquarium illumination system, utilizing clock circuitry and Durotest "Vitalite" fluorescent tubes, approximated ambient lighting conditions (light quality, day length, twilight). The laboratory was also equipped with microscopes, freezer, air conditioner, electric heat, dehumidifier, potable water, work counter and storage space (Fig. 2).

A water quality monitoring system using a multipoint recorder provided a continuous record of dissolved oxygen, pH,
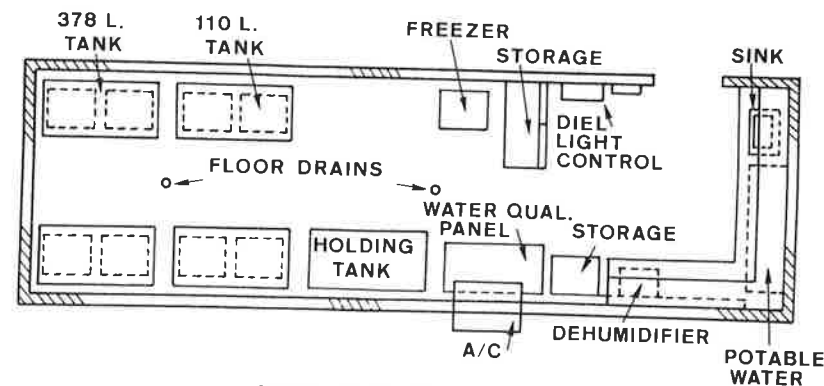
FIGURE 2. MERLin floor plan.

temperature, and specific conductivity in the incoming water to each supply tank. These four parameters were also monitored periodically using portable instruments.

MERLin was located adjacent to Pennsylvania Power & Light Company's Montour Steam Electric Station (MSES) in Montour County, Pennsylvania. MSES is a 1500 MWe coal-fired electric generating station which produces an effluent containing the mixed discharges of a fly-ash settling basin, cooling tower blowdown, coal pile runoff, and miscellaneous plant waster water. The effluent is discharged to Chillisquaque Creek, a tributary of the West Branch-Susquehanna River. Our investigation utilized three water "types": 1) *Control*—from the receiving stream; 2) *Effluent* — undiluted (100%) MSES effluent; and 3) *Mixed*—from the receiving stream below the point of MSES discharge. In addition this research enhanced a broad environmental assessment program relative to MSES effluent impact upon Chillisquaque Creek (13-15).

Fathead minnow (*Pimephales promelas*) and bluegill *(Lepomis macrochirus)* are recommended warmwater fishes for bioassay studies (12) and are resident species in Chillisquaque Creek (13). Young fathead minnow and young bluegill were received from Kurtz Fish Hatchery on 12 July 1979. Upon receipt at MERLin the shipping bags containing fish were floated in holding tanks within each system, 70 fish per tank. Fish received a 72-hour acclimation after which numbers were reduced to 50 per tank. Excess fishes were measured, weighed, examined for parasites, and a sample frozen for tissue analysis. Because pumps and external piping were not freeze-protected, the long-term biomonitoring began on 16 July 1979 and was terminated on 20 November 1979 (= 128 days).

One experimental system was regulated to receive *Effluent* water, and one system to receive *Control* water. Due to a minor mechanical problem, a third system received *Control* water instead of *Mixed* water through day 30. After day 30, valves were opened allowing *Mixed* water to enter. Flows in all systems were regulated to allow 95% replacement (approximately 104 l) in 3 hours. Fishes were observed several times daily and fed twice daily a diet of crushed Agway's "Strike". Accumulations of periphyton, excess food, fecal material and sediments were removed, at least weekly, by scraping and siphoning. Thus the long-term biomonitoring study exposed 100 fathead minnow and 100 bluegill to *Control* and *Effluent* waters. In addition, 100 fathead and 100 bluegill were exposed for 98 days in *Mixed* water.

Dissolved oxygen, pH, conductivity, and temperature were monitored and recorded continuously and via grab samples. Intake sources, supply tanks and aquaria were also tested for the above parameters. Supply tanks were analyzed weekly for tur-

bidity, total and suspended solids, total alkalinity and hardness. Aquaria were analyzed weekly for total, suspended and dissolved solids, ammonia and sulfates; and weekly composite samples from aquaria were analyzed for selected trace elements.

At 30 day intervals a sample of five fish was removed from each aquarium (total of 10 of each species from each system), weighed, measured, and frozen for tissue analysis. Composite whole fish samples, after being frozen, were analyzed for the presence of arsenic in tissues by neutron activation analysis as described in Comparetto (16). All aquaria were checked several times daily for mortalities which were removed, examined for cause of death and recorded. Statistical and qualitative comparisons of percent mortality, condition factor (17), and growth were made upon completion of the study.

RESULTS AND DISCUSSION

The *Mixed* water system was purposely delayed until day 31 due to parts shipment and a minor mechanical problem. Because results from this system were 30 days "out of phase" they could not be compared directly or statistically with results from the *Control* or *Effluent* systems.

Mortality:

Results from replicate tanks were combined because there were no significant differences (t-test, p ≤ .01). The known percent biological mortality (i.e., that resulting from toxic or other "natural" causes) at each 30-day interval was based upon total number at the beginning of that interval minus any physical mortalities (i.e., those related to mechanically-induced body damage). The sum of the two gave a conservative estimate of cumulative percent mortality within *Effluent* or *Control* groups. Cumulative percent mortality for both test species, are shown in Fig. 3. On day 128, 88% of fathead minnow had sur-
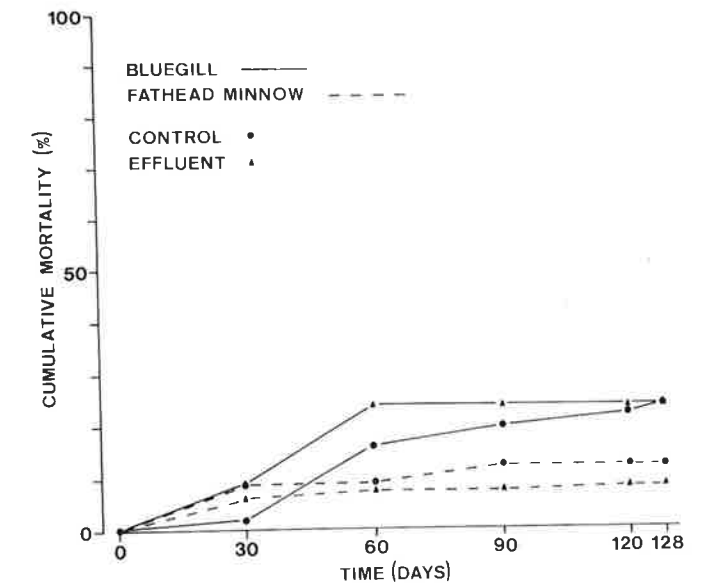
FIGURE 3. Cumulative mortality (%) in bluegill *(Lepomis macrochirus)* and fathead minnow *(Pimephales promelas)* during 128-day exposure to *Control* and MSES *Effluent* waters.

vived in control and 92% survived in *Effluent* waters. Calculations for bluegill showed 76% survived in both *Control* and in *Effluent* after 128 days exposure.

Most bluegill mortalities occurred between day 20 and day 60, whereas fathead minnow mortalities occurred gradually over the 128 days (Fig. 4). Bluegill were usually dispersed and displayed dominance, especially while feeding. They were observed to establish a heirarchy, some individuals driving others from food. This competition may have resulted in stressed (weakened) individuals, accounting for the fact that most mortalities were smaller specimens (probably because they

TABLE 1

Comparison of biological data from 128-day biomonitoring

		Control			Effluent			t-test[2] (p > .01)
	n[1]	Mean ±1 S.D	Range		n	Mean ±1 S.D.	Range	
Fathead Minnow								
Length (mm)								
Day 0	73	34.2 ± 2.4	29 - 39	...	...	...	...	...
Day 128	46	44.1 ± 2.8	38 - 49		45	48.0 ± 2.1	44 - 52	E > C
Weight (gm, damp)								
Day 0	73	0.42 ± 0.12	0.2 - 0.7	...	...	...	...	...
Day 128	46	1.14 ± 0.21	0.7 - 1.6		45	1.30 ± 0.19	0.9 - 1.7	E > C
Condition Factor (K)								
Day 0	73	1.03 ± 0.16	0.56 - 1.34	...	...	...	...	...
Day 128	46	1.32 ± 0.16	1.01 - 1.65		45	1.17 ± 0.08	0.92 - 1.34	C > E
Bluegill								
Length (mm)								
Day 0	80	35.5 ± 2.2	29 - 41	...	...	...	...	...
Day 128	37	39.1 ± 2.7	32 - 44		38	43.4 ± 5.8	37 - 60	E > C
Weight (gm, damp)								
Day 0	80	0.60 ± 0.14	0.4 - 1.1	...	...	...	...	...
Day 128	37	0.97 ± 0.24	0.5 - 1.6		38	1.41 ± 0.67	0.7 - 3.4	E > C
Condition Factor (K)								
Day 0	80	1.33 ± 0.24	0.86 - 2.04	...	...	...	...	...
Day 128	37	1.59 ± 0.16	1.18 - 1.88		38	1.64 ± 0.16	1.18 - 2.00	N.S.

[1] sample size
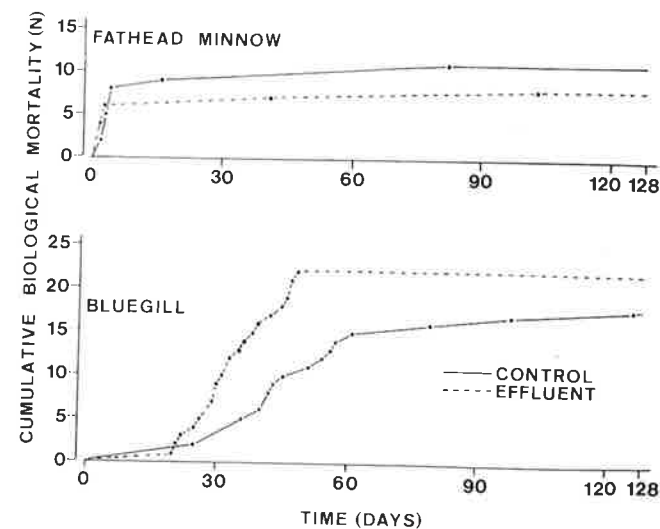[2] C = Control, E = Effluent, N.S. = not significant

FIGURE 4. Cumulative number of biological mortalities in bluegill (*Lepomis macrochirus*) and fathead minnow (*Pimephales promelas*) during 128-day exposure to *Control* and MSES *Effluent* waters.

were out-competed for food). Mean condition factors for bluegill biological mortalities measured in the first 60 days of experimentation were 1.22 in *Control* and 1.33 in *Effluent,* both of which were below the mean condition factors (1.38 and 1.45 respectively) for fish (apparently healthy and larger) sampled for tissue analysis during that same time period. Early (first three days) fathead minnow mortalities could not be related to any observed stress. Throughout the remaining 125 days, this species tended to school during and between feeding periods without apparent intraspecific competition.

Growth:

Sprague (18) stated that growth is only one of many parameters used in determining sublethal effects, but can be measured easily and thus is an important indicator of fish success. The difference in response between our test species could also be seen in mean length (Fig. 5). Bluegill and fathead minnow were approximately within the same mean and range in
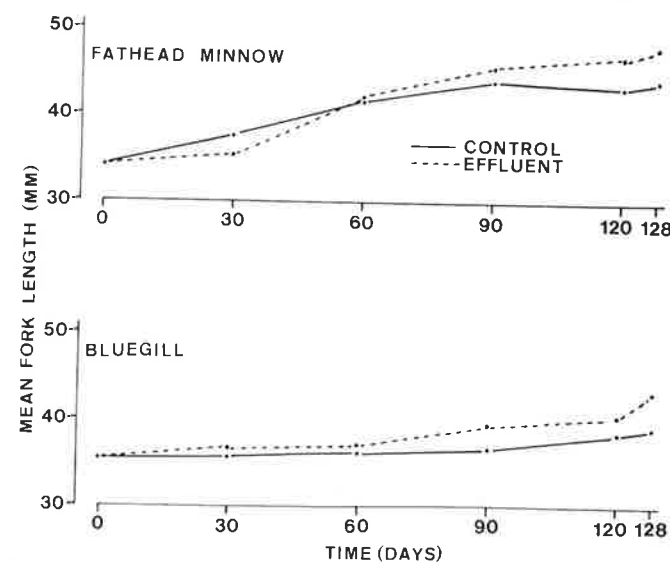
FIGURE 5. Mean fork length (mm) of bluegill (*Lepomis macrochirus*) and fathead minnow *(Pimephales promelas)* at 30-day intervals during 128-day exposure to *Control* and MSES *Effluent* waters.

fork length at experiment initiation. After 128 days, the range in bluegill length was greater and the mean was less than for fathead minnow length (Table 1). These differences may be reflective of dominant (larger) and submissive (smaller) individuals within the bluegill hierarchy.

Measurement of growth in this study showed that fathead minnow and bluegill significantly increased in length and weight (t-test, p ≤ .01) in *Effluent* and *Control* waters after 128 days of exposure (Table 1 and Fig. 5). Data from subsamples of fathead minnow showed significant increases in mean length, weight and condition factor from fish exposed to *Effluent* waters compared to those exposed to *Control* waters. Bluegill from *Effluent* waters were also significantly longer and heavier but there was no significant difference in condition factor. These increases in length and weight of *Effluent* fishes could not be associated with additional natural food sources (scarce or absent during the 128 day study) or any physicochemical parameter measured without additional detailed research. It was possible that some unmeasured parameter either slowed (in *Control*) or enhanced (in *Effluent*) growth.

Physicochemical mean values (Table 2) for most measured parameters were greater for *Effluent* water; however total alkalinity, pH, suspended solids, chromium, iron and nickel were greater in *Control* water. Relatively high levels of ammonia-nitrogen ($\bar{x} = 4.197$) were attained in the effluent with no discernible effect upon the exposed fathead minnow and bluegill. Comparable threshold values, i.e., the concentration at which a given percentage of the test species would die during an infinite exposure, are apparently non-existent for bluegill and fathead minnow. However, 96 hr. TL_m's of 23.7-24.4 mg/l for bluegill in hard water and 8.2 mg/l for fathead minnow in hard water have been reported (19). Warmwater species are apparently more able to tolerate higher levels of ammonia than coldwater species, and may, in fact, exhibit some degree of acclimiation to ammonia (20).

Bioaccumulation of Arsenic:

Throughout the study fathead minnow from *Effluent* water

TABLE 2

Mean ± 1 S.D. of physicochemical measurements during during 128-day biomonitoring

| Parameter[a]	Control	Effluent
pH (S.U.)	7.02 ± .11	6.92 ± .37
Total Alkalinity (as CaCO₃)	36.64 ± 5.75	17.38 ± 4.71
Total Suspended Solids	7.03 ± 2.04	6.27 ± 1.66
Hexavalent Chromium	0.0066 + .0061	0.0051 ± .0071
Total Iron	0.641 ± .431	2.233 ± 3.808
Total Nickel	0.057 ± .032	0.054 ± .013
Dissolved Oxygen	8.67 ± .98	8.76 ± .48
Specific Conductance (μmhos/cm)	221.1 ± 14.6	717.7 ± 59.1
Temperature (C)	15.4 ± 1.9	18.8 ± 1.9
Total Hardness	89.7 ± 9.1	304.5 ± 39.0
Total Solids	152.4 ± 24.8	503.3 ± 87.2
Total Dissolved Solids	144.6 ± 23.2	496.7 ± 87.5
Sulfate	37.90 ± 7.65	315.50 ± 44.00
Total Arsenic	0.00142 ± .000248	0.00220 ± .00268
Total Manganese	0.057 + .016	0.370 ± .073
Total Selenium	0.0084 ± .0062	0.0104 ± .0060
Total Zinc	0.027 ± .029	0.069 ± .060
Ammonia Nitrogen (as N)	0.283 ± .329	4.197 + 1.386

[a]Values in mg/l unless otherwise noted.
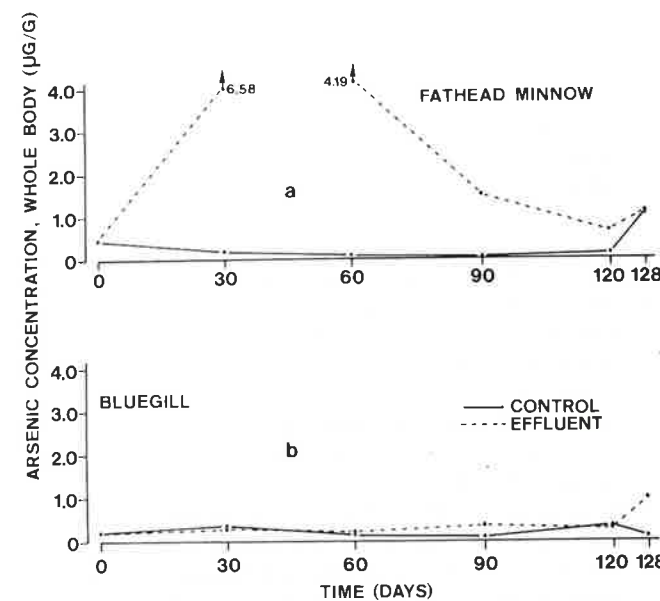
FIGURE 6. Whole body mean arsenic concentration (μg/g) in bluegill (*Lepomis macrochirus*) and fathead minnow (*Pimephales promelas*) during 128-day biomonitoring.

contained more total arsenic than those from *Control* water (Fig. 6). An interesting initial increase in concentration (Fig. 6a) followed by a trend of decreasing values to day 120 was observed. This suggested a possible metabolic pathway for arsenic removal in fathead minnow (either natural or fluctuating in response to some environmentally induced mechanism such as temperature, metabolic rate, water chemistry, stress, etc.). Bluegill, in contrast, showed little variation over the first 120 days (Fig. 6b), suggesting species differences in arsenic absorption.

A peculiar variation occurred between day 120 and 128. *Control* and *Effluent* fathead minnow and *Effluent* bluegill contained increased amounts of arsenic, while *Control* bluegill decreased in arsenic content. We were unable to relate this deviation to any water quality or other parameter measured. Analysis of specific tissues (liver, bone, etc.) rather than whole body homogenate may have given different results.

Arsenic has been found to bioaccumulate in some aquatic organisms and its degree of toxicity is determined by species, age, water temperature, dissolved oxygen, exposure time, pH, and concentration and form of arsenic (21). Jones (22) observed that although arsenic is known to be toxic to most forms of life, it does not appear to be particularly toxic to fish, and Farley (23) noted that fish are less susceptible to the toxic effects of sodium arsenate that are cattle or humans. Likewise Spehar et al. (24), citing other investigators, stated that rainbow trout and "other fish species" are relatively tolerant to arsenic (96 hr. LC50 values of 10.8 to 100 mg/l). Becker and Thatcher (19) reported work by Surber (24) in which he reported "no kill" in bluegill at concentrations ≤ 5.0 mg/l sodium arsenite, and on research by Eipper (26) where sodium arsenite at a concentration of 4 mg/l had no observed effect in fathead minnow. Fish in general were also reported not to accumulate arsenic at rates measured for lower organisms (24, 27, 28). Some fishes may be able to remove arsenic from the body after short periods of time by excretion in the feces (29-31).

Through 128 days of continuous exposure to a power plant wastewater effluent and a receiving stream control, bluegill and fathead minnow survived and grew with apparently no adverse effect attributable to the body burden of arsenic. There was no significant difference in mortality between *Control* and *Effluent* for either species. In contrast, both species exposed to *Effluent* displayed significant increases in growth over those in the *Control*.

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AVIAN EGG SHELL PHYSIOLOGY: A REVIEW[1]

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ABSTRACT

The avian egg shell serves as much more than just mechanical protection for the developing embryo. It is also an antimicrobial defence; a reservoir of calcium for the embryo; acts in exchange of respiratory gases; prevention of asphyxiation; slows dessication; and is often camouflaged. This paper reviews three aspects of the avian eegg shell. 1) Shell structure - covers formation, composition, and construct of the shell. 2) Shell physiology -discusses O_2, CO_2, and H_2O exchange across the shell. 3) Environmental adaptations - presents extreme environmental conditions and the physiological adaptations of the egg shell to compensate for these conditions.

In the last 15 years research in egg shell physiology has expanded to explain many functional and ecological phenomena. The 1981 Coues award (presented by the American Ornithologist Union) was presented to Ar, Paganelli, and Rahn for their advances in egg shell physiology. This paper brings together and reviews 1) avian egg shell structure, 2) shell physiology, and 3) physiological adaptations to extreme environments. Due to the abundance of information in the area of pesticide effects on egg shell structure and physiology they will not be dealt with in this paper.

SHELL STRUCTURE

Formation

During egg shell formation in birds, a great deal of calcium is taken from the mother's body. For example, chickens, which can lay one egg per day, have a 10% daily calcium turnover rate from their bodies (1). To accommodate this calcium requirement the plasma calcium triples during egg formation. For storage of calcium on a day-to-day egg-to-egg basis, the female's body produces and destroys medullary bone (1,2).

When the follicle is released from the ovary it enters the oviduct. The oviduct can be divided into several sections: the infundibulum, magnum, isthmus, uterus (shell gland), and vagina. It is interesting to note that most bird species have only one ovary and oviduct, the other having degenerated in the embryo. This probably resulted because egg production from two ovaries may deplete the female's body of calcium to too great an extent (3). Taylor defends this by stating that with calcium defi-

cient diets, chickens cease egg production.

In the infundibulum the egg is fertilized. It then passes into the magnum, where layers of albumin are layed down. This protein surrounds the yolk and zygote. The isthmus forms two membranous layers which surround the albumin. The final section of oviduct before the egg is released through the vagina is the uterus. The uterus is where the actual shell is formed from calcite deposits. It has also been shown that as much as 1/3 of the protein in an egg is added in the uterus (4). The last layer to be formed before the egg enters the vagina is the cuticle. The egg shell represents from 9-15%, depending on the species, of the total weight of the egg (5).

The completed egg has formed within 24 hours of the release of the follicle, and is laid during the day. Tests have shown that varying photoperiods do not affect the shell strength (6). The laying cycle, extensively studied in chickens, has been studied in quail, also for economic reasons (7).

Composition

As stated earlier, the primary constituent of egg shell is calcium carbonate (3). Additional components of the shell include magnesium, phosphorous, sodium and nitrogen. Brooks and Hale (8) found more magnesium in strong shells than in weak shells, and hypothesize a connection between egg shell strength and magnesium content. Tyler (9), however, found greater nitrogen contents in thinner shells. So it appears that shell strength and thickness may be influenced by the presence of several substances.

The final constituent of egg shells to be discussed is that of pigment. Pigment granules are found in the outer structure of the shell, forming pigment layers. These granules are deposited on the surface of the shell and enclosed in calcite crystals. Pigments are not found in every species, but exist where a camouflage is necessary, such as in the loons and grebes (10), and possibly for thermal regulation.

Construct

When considering the avian egg shell, many people think of a single layer composed of calcium. We have already discussed the composition of the egg shell, and as will be seen, the shell construct is of four distinct layers, with two membranous layers below. Going from the inner to outer surface of the shell the layers are as follows: inner then outer shell membrane, basal caps, palisade layer, surface crystalline layer, and the cover. Shell structure has been studied extensively by Becking (11), and much of the information presented is from his work.

The inner and outer membrane adhere to each other, except at the broad end of the egg where an air space is formed. These

membranes are composed of fibers which are oriented randomly over the contents of the egg. The inner membrane is finer, and of smaller mesh than that of the outer. In all species studied, except the European starling, there is a correlation between the size of the egg and the diameter of the fibers of the outer membrane. Attached to the outer surface of the outer membrane are the basal caps, the first layer of true shell.

The next layers out are the basal caps and cone layer. Located on the outer surface of the outer membrane are the centers of crystallization, the mammilary cores. From these cores crystals of calcite grow radially in all directions. They totally enclose the membrane fibers, and thus bind the calcified part of the shell to the shell membrane. The calcite crystals which grow inwardly and radially produce the basal caps. Those which grow outward to meet the crystals from the mammillary cores form the cones. Crystals become larger as they grow outward from the egg. The columns which form the cones are collectively known as the palisade layer.

The palisade layer is primarily composed of calcite crystals. This layer represents 2/3 of the thickness of the entire egg shell. It is responsible for the main strength of the shell. Characteristic of the palisade layer are pit-like holes. These are called vesicular holes, and are actually pores lined with organic matter.

The surface crystalline layer is superimposed on the palisade layer. It is a layer of compact, vertically-oriented crystals. This layer is variable from species to species, and forms the characteristic surface texture of egg shell. An important feature of this layer is that it contains vertical pores. These pores are formed when the calcite cones fuse, but do not mesh exactly (12). Most are plugged with granular pore plaques or other organic proteins from the cuticle.

Becking (11) claims the pores are distributed evenly across the shell's surface. However, other work has shown differential distribution of pores, being more concentrated at the blunt end of the egg than at the equator or sharp end (13, 14). It is important to note that the shell thickness at the blunt end is less than that at the equator or sharp end of the egg (9). The pores act as a direct connection between the outside environment and the spaces between the cones. Board (15) shows evidence that the pore acts as a resistance network against molecules (i.e. O_2), with the major areas of resistance at the cuticle, the palisade layer, the pore is invaluable for the survival of the embryo.

The cover, or cuticle, is of varying thicknesses in different species (some species may even lack a cuticle). It is composed of organic substances, mostly proteins, fats, and polysaccharides. The cuticle can be rubbed off the egg shell through mechanical action, and is very prominent when the egg is first layed. The fucntion of this layer is for protection of the contents of the egg against penetration of micro-organisms by closing the pores (16).

Egg shell content and construct has been studied in many species. Tyler has done work with Sphenisciformes (penguins) (17), Falconiformes (birds of prey) (18), and Gaviiformes (loons) and Podicipitiformes (grebes) (10). Tyler and Simkiss (19) studied the egg shells of some odd birds, including the emu; cassowary; rhea; ostrich; kiwi; tinamau; and moa. The emu egg shell has also been studied by Board and Tullett (20), and Board and Perrott (21) have studied the tinamau and jacana.

PHYSIOLOGY

The most important structure concerning the physiological function of the avian egg shell are the pores—their number, size, length, distribution, and whether they are open or plugged. These gas-filled pores represent the only connection with the developing embryo has with the outside environment, and through these structures pass O_2, CO_2, and H_2O (22). There are three major physiological functions which will be discussed here. Probably the least important of the three is 1) the function the egg shell plays in retaining and dissipating heat. A problem arises in gas exchange through diffusion across the egg shell, in that O_2 molecules are larger than H_2O molecules. Therefore, a means of regulating gas exchange to some degree must be found. 2) O_2 and CO_2 exchange across the shell is discussed in the second section of this unit, while 3) water vapor transmission is presented in the final section.

Thermal Regulation

There are basically three means of regulating the internal temperature of the egg: varying the 1) thickness of the shell, 2) amount of time per day the parent(s) spend brooding the egg, and 3) pigmentation (this refers to evolutionary means set over many generations, not immediate responses of the parent to the environment).

The thickness of the egg shell may have a minor effect on thermoregulation within the egg. This idea is supported by El-Boushy, et al. (23), where it was shown that egg shell thickness within a species varied with seasons, being thicker in the winter and thinner in the spring and summer.

Two problems can arise from exposure due to egg neglect: overheating and chilling (depending on the environment). It has been shown that an embryo can tolerate chilling better than being overheated (24-27). The storm petrel's egg can tolerate chilling for long periods of time (28,29). This is necessary because the petrel must travel for long distances for food, and must neglect its nest. Adelie penguins cannot leave their eggs for more than short intervals because the temperatures are so low the embryo quickly perishes (30). This penguin broods almost continuously, feeding only after the chick has hatched. Problems can also arise in warmer climates, due to overheating the egg (i.e. weaver bird, (31)). The parent overcomes this problem by regulating the amount of time spent brooding. With the adult shading but not insulating, the egg can release built-up heat.

Pigments, although probably most important in camouflage, may also serve a function in thermo-regulation of eggs. When the parent is not brooding, a darker pigment could function in heat gathering in colder climates. A shell with little or no pigments could reflect some heat, and may be useful in warmer climates. I found no literature to support or deny this hypothesis.

Oxygen and Carbon Dioxide Exchange

For an embryo's survival the acquisition of O_2, and release of CO_2 must occur. This is accomplished across the egg shell by passive diffusion (32), and the gradient is set up by the metabolism of the embryo (33). The nest micro-climate is constantly ventilated by activity of the parent(s), removing CO_2 and replenishing O_2 through convection and diffsion (32). The exchange of gases is not so simple as an exchange from the ambient air into the interior of the egg. Air is exchanged from the nest micro-climate to the outside atmosphere, and before that from the atmosphere isolated in the tubules of the egg shell to the nest micro-climate (20).

Romanoff (34) gives a good review of general egg shell porosi-

ty characteristics, and how they change with time and brood size. The permeability of the egg shell has no relationship to shell strength or thickness. As will be discussed, the shell is more permeable at the blunt end than at the sharp end, and this unequal exchange increases as brood size increases (presumably because the eggs are oriented blunt end outward, and increased brood size would reduce air space around the sharp end). The permeability increases with increases in egg size (intraspecific), and the egg is more permeable to CO_2 than O_2.

Wangensteen, et al. (35,36), reported no change over time in the permeability of egg shells to gases. They state that since the membranes are dry they are not an effective barrier to diffusion, and that pore geometry is the only means of regulating gas exchange. It has been found, however, that the membranes are not dry, and that over time the inner shell membrane dries, increasing permeability of the egg shell to O_2 and CO_2 (37,38). The amount of gas exchange is not constant during incubation. Lomholt (39) has shown that in chickens, there is a 10 fold increase in O_2 uptake in the first seven days of incubation. This is due to increased water loss from the membranes, which increases the number of gas-filled channels in the membrane. O_2 uptake plateaus in chickens, a few days before pipping, when mechanical activity of the soon-to-be chick is at a maximum. This is not the rule across the board, though, as some species (i.e. ostrich) peak then actually decrease in O_2 uptake before pipping (40).

Permeability of the shell is also increased due to increased effective pore area (38). As the egg is touched and moved by the parent(s), some of the cuticle is rubbed off, increasing the number of exposed pores.

Tazawa, et al. (41) said there is no difference in egg shell permeability between the sharp and blunt ends. This has been disproven, and it is now known that there is greater gas conductance at the blunt end of the egg (14). Because of this differential permeability, an air space is readily formed at the blunt end of the egg. This air cell is formed between the outer and inner shell membranes (42). In chickens, the air space of the egg increases in volume from less than 1cc at the start of incubation to 11cc before pipping (43). This extra O_2 is needed to supply energy for the increased mechanical activity involved in hatching. The O_2/CO_2 ratio within the air space is different from the ambient ratio. At the time of hatching O_2 may be three times as abundant as CO_2 in the air space (44).

The last topic of discussion concerning O_2 and CO_2 regulation is the role of the boundary layer. The boundary layer of an egg is a layer of still air around the shell, which may affect respiration. It has been found that as air speed increases, the boundary layer becomes less effective (45). Consequently, the boundary layer is not considered to be a barrier to respiration in any manner (45, 46, 47). These researchers have shown that this layer is also ineffective at preventing water loss.

One factor determining the amount of O_2 taken up by the embryo depends on whether the bird is precocial or altricial. On the average precocial birds need much more O_2, which makes sense since they are much more developed at hatching than are altricial birds (48).

Water Loss

Water loss from the avian egg shell is essential for proper embryo and air cell development (49, 50). Water loss serves two functions: 1) the space formed by water loss within the egg shell provides room for the air cell to form (51), and 2) to reduce condensation in the shell as the egg temperatures change during incubation (13). The water, as in O_2 and CO_2 exchange, is lost through diffusion across a gradient. This gradient is maintained by ventilation by the parent(s), which keeps the nest at a constant humidity (52, 53).

On the average 13-20% of the total egg weight is lost through water conductance (52, 54, 55). Many researchers feel that this water loss remains relatively constant throughout incubation (43, 52, 53, 56). However, there has been suggestion that water loss from the egg increases as incubation progresses (57, 58). Clearly more work must be done determining interspecific and intraspecific differences in the rate of water loss by the egg.

Many factors affect the rate of water loss through the avian egg shell. First of all the egg shell itself is slightly hydrophobic (15). This may explain how water, the smaller molecule, is retained more readily than O_2. The next line of influence is the number of pores in the shell (39,59), their length (58), and their actual geometry (60). The mass of the egg is an indirect effector in that it is directly related to the porosity (59, 61, 62).

The micro-climate of the nest also plays a role in water loss. As mentioned earlier the water diffuses passively across a gradient out of the egg. This diffusion is into the nest, which is more humid than the ambient atmosphere (39,57,63). This allows some control by the parent, and protects the egg from sudden fluctuations in ambient humidity. Rahn et al. (60) have also shown an effect on water loss as influenced by internal-egg temperature.

Another factor in water loss is the rate of development of the embryo (64). The final effector of water loss through the egg shell is incubation time. The later the stage of incubation, the greater the water loss (38,57,58).

The next section will discuss environmental extremes to which nesting birds' eggs have adapted.

PHYSIOLOGICAL ADAPTATIONS

Some species of birds are known to nest under conditions which are considered severe. Three such environments, and the birds' physiological reactions in egg formation, will be discussed here. They are: 1) underground nesting, 2) high altitude, and 3) nesting in contact with water.

Underground

Underground nesting takes place in primarily two manners, that of tunnel nesting (e.g. bank swallow) and mound nesting (e.g. brush turkey). Underground nesters enjoy greater protection from predators, and a buffer against sudden extreme climatic changes (especially temperature) (65,66). This underground nest also protects the eggs from mechanical stress, allowing the bird to invest less calcium in producing a thinner shell (51, 67).

There are, however, some problems in subterranean nesting. Being in a burrow, the eggs have less ventilation, and are subject to high humidity and CO_2, and low O_2 levels (66). There are also sanitation problems caused by microorganisms resulting in a build up of NH_3 (65). These problems can be acute when 1) the soil is of low porosity; 2) the occupants have a high rate of metabolism; 3) the total mass of the occupants is large relative to the volume of the tunnel; and 4) when there is poor ventilation.

There are five characteristics inherent to the system which aid in solution to these problems: 1) gases diffuse through the soil

surrounding the walls of the nest; in tunnel nesters, 2) diffusion of gases through the tunnel, 3) mixing caused by wind blowing across the tunnel opening, 4) mixing caused by the piston effect of adult birds moving rapidly through the tunnel, and 5) density currents flowing down tunnels as a result of temperature differences from outside to inside the tunnels (65).

The megapodes (some Galliformes, i.e. brush turkey) bury their eggs under a mound, and allow incubation heat to come from decaying vegetation. These eggs have the unique property that they do not form an air cell within the egg. This precludes water loss, and these eggs lose only 2-3% of the total egg weight in water (67). Their response, as in tunnel-nesters, is to increase the permeability of the shell. This is done by increasing the effective pore area.

Altitude

Nesting at high altitudes presents interesting problems. There is reduced barometric pressure, temperature, O₂, and increased diffusability of water vapor (57, 68).

The rate of diffusion of water molecules through air is inversely related to atmospheric pressure. This means greater diffusivity at higher altitudes (69). The altitude also reduces the barometric pressure, which enhances diffusion of gases (22, 61).

To combat the reduced ambient temperature, incubation time and pigmentation (for neglected time) may increase (70). There are several physiological methods for diminishing the threat of dehydration caused by reduced pressures. 1) The conductance of the egg shell to water vapor can be reduced. 2) Increasing the initial water content of the egg allows more water to be lost and still allow the embryo to develop normally. 3) Increased shell thickness will also prove a barrier to water loss. 4) By altering the water vapor pressure in the nest microenvironment, or the incubation temperature by variation in parental behavior (71). Reduced porosity reduces water transport (72).

Packard, *et al.* (68), showed two methods of reducing permeability of O₂. Swallows were shown to reduce porosity, while chickens merely reduced the size of their egg. This shows that porosity is heritable. The swallow is adapted to high altitude; while the chicken, which is not adapted, must resort to reduced egg size. Black and Snyder (73) have found an additional adaptation to high altitude by the chicken. The hemoglobin-O₂ affinity in the embryo is increased in eggs born at high altitudes.

Another physiological adaptation, which also appears in the embryo is that at high altitudes the embryo has been found to have a reduced metabolism (74).

Aquatic

There are several birds which build nests which float on water (i.e. loons, grebes, coots). The eggs of these nests are often in contact, and even surrounded by liquid water during incubation. Sotherland (75) and Ackerman *et al.* (76) have shown that these eggs exhibit an extremely high conductance of water. In fact water in the liquid form is often transported.

Shell structure, egg size, and pore geometry play key roles in avian adaptation to harsh environments. These physiological adaptations of the egg shell allow successful hatching of young in areas which would not otherwise accommodate avian populations. Physiological plasticity has allowed many species of birds to invade adaptive zones, increasing animal diversity in these areas. The work performed in recent years exposes many questions for new research, particularly in the area of ecological physiology.

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TOPOGRAPHIC MAP COVERAGE OF PENNSYLVANIA: A STUDY IN CARTOGRAPHIC EVOLUTION[1]

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ABSTRACT

The effective topographic mapping of the Commonwealth began in the late 1800s, shortly after the establishment of the U.S. Geological Survey. The spatial-temporal pattern of expansion for the state's topographic coverage reflects the replacement of plane table surveying by modern photogrammetric mapping as well as Pennsylvania's internal priorities and its support of base mapping through a fifty-fifty federal-state cost-sharing program. Major mineral and metropolitan regions were generally mapped before less inhabited, more remote and more agricultural regions. At one time, the sparsely inhabited northern tier of counties had the generally most accurate and up-to-date coverage. The present pattern of publication dates reflects a shift from a 15-minute to a 7.5-minute quadrangle and from 1:62,500 to 1:24,000 as the principal scale, the need to revise more frequently where landscape change has been more pronounced, the development of new products such as the orthophotoquadrangle map, and the efficiency of procuring aerial photography for large areas.

INTRODUCTION

Regional planning and public administration, geographic and geologic research, and small- and intermediate-scale thematic mapping require a complete series of accurate, large-scale topo-
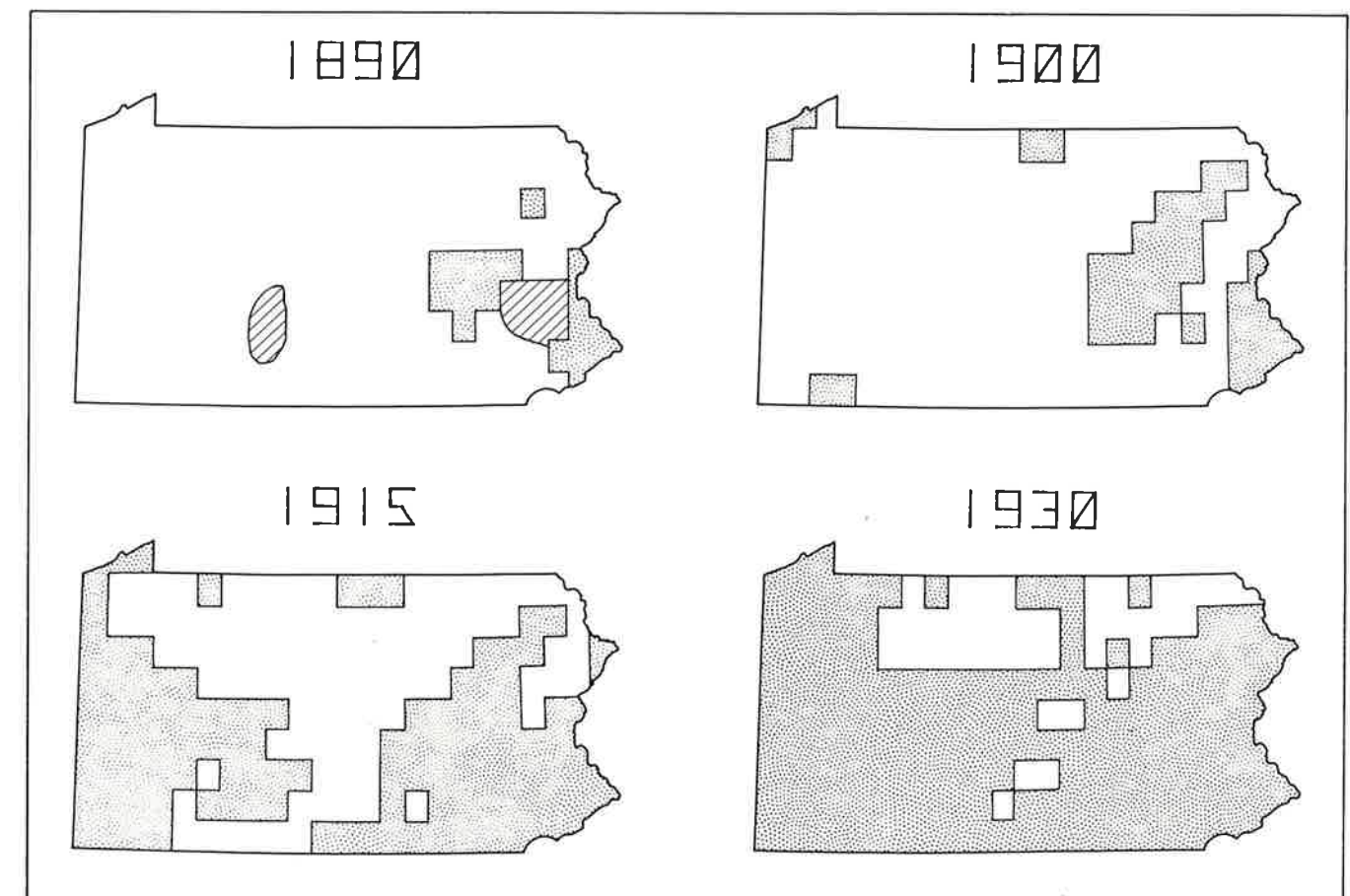
FIGURE 1. Area surveyed for topographic maps, 1890, 1900, 1915, and 1930. Zones shaded with diagonal-line pattern on map for 1890 were not surveyed by the U.S. Geological Survey.

graphic maps. To be most useful and cost effective, topographic mapping demands some federal funding and coordination, and nationwide standards. Yet private firms also have a role, as local and regional contractors for photogrammetric and drafting services and as compilers and publishers of such derivative products as the urban street map. In the United States the interdependence of public- and private-sector cartography is combined with co-operative agreements between state and federal governments to provide a mapping program responsive to local as well as national priorities.

This paper examines the geographic development of systematic topographic mapping in one state, the Commonwealth of Pennsylvania. It complements earlier papers on private-sector cartography in Pennsylvania (1). It is intended also to further the effective use and administration of geographic information through a fuller understanding of mapping policy and cartographic decision-making. Although the facts presented here are unique to Pennsylvania, they are also general observations, applicable elsewhere, about federal-state cooperation and the geographic pattern of map revision. This study derives added significance from the early cooperative involvement of the Commonwealth in sharing the costs of topographic mapping.

Primary data are from the annual reports of the U.S. Geological Survey and its parent agency, the Department of the Interior, as well as from more recent index maps distributed by the Geological Survey (2).

DEVELOPMENT OF THE 15-MINUTE SERIES

Topographic mapping made little progress in Pennsylvania until the end of the nineteenth century. Writing in the *Scottish Geographical Magazine* in 1892, Henry Gannett, first Chief Geographer of the U.S. Geological Survey, stated that, "Until recent years, the United States has been one of the most backward of all civilised nations in the matter of procuring good maps of its territory (3)." Pennsylvania was among the states mentioned as having "surveyed small parts of their areas." The Geological Survey's report for 1890 locates two areas mapped prior to its own activities, one on the Allegheny Plateau near Altoona and the other in the east, including part of the anthracite belt (Figure 1, upper left). According to Gannett, few states were more extensively mapped, most notably New Hampshire, New Jersey, Massachusetts, California, and Minnesota (4).

The systematic mapping of the Commonwealth's topography began several years after the establishment of the Geological Survey in 1879. Maps published at a scale of 1:62,500 covered quadrangles spanning 15 minutes of both latitude and longitude. Field surveys were controlled by theodolite triangulation, with secondary and minor control by plane table, and topographic detail sketched by skilled topographers (5). The first project areas were in the anthracite region and the vicinity of Philadelphia (Figure 1, upper left). Indeed, the eastern coal mining area received principal attention during the 1890s, and was completely mapped by 1900 (Figure 1, upper right). Attention then turned to the bituminous coal regions west of the Allegheny front. By 1915, 15-minute quadrangle maps covered much of the southwestern part of the Commonwealth, together with the anthracite belt and parts of the southeast (Figure 1, lower left). More rugged areas with lower population densities and without significant coal deposits received lower priority. By 1930, substantial parts of the northern tier of counties were not yet mapped (Figure 1, lower right).
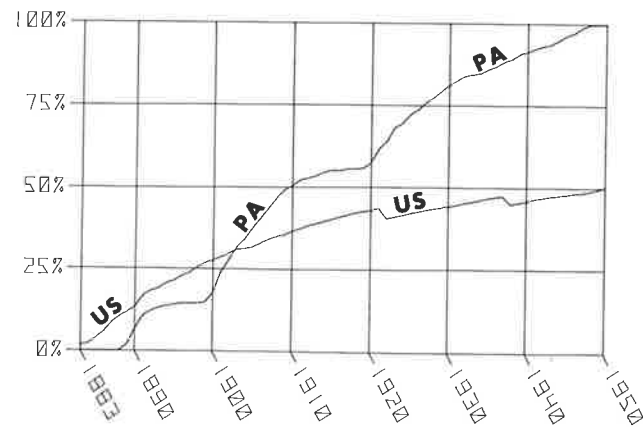
FIGURE 2. Proportions of Pennsylvania and the conterminous United States surveyed for topographic mapping, 1883-1950. The two reductions in the proportion for the United States reflect revisions of the accuracy standard.
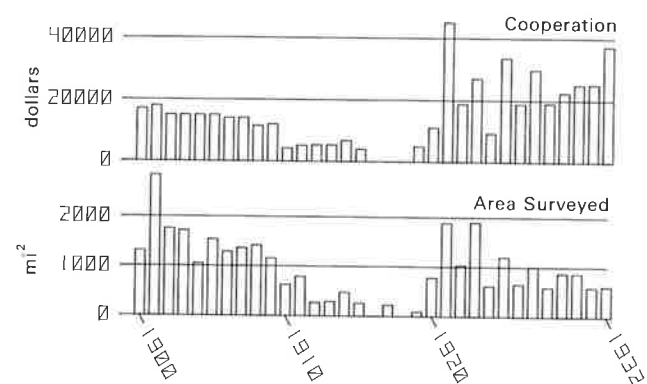
FIGURE 3. Correlation for Pennsylvania between state support, or cooperation (in unadjusted dollars), and land area surveyed, 1900-1932.

Topographic mapping in Pennsylvania progressed steadily and vigorously (6). The Commonwealth registered minor gains around 1890, made little progress during the 1890s, and advanced rapidly during the first decade of the twentieth century (Figure 2). By 1903, the proportion of Pennsylvania surveyed exceeded the proportion of the nation surveyed. By 1910, 15-minute quadrangle maps covered over 50 percent of the Commonwealth's land area. A period of stagnation followed, between 1910 and 1920, after which date coverage expanded more rapidly for Pennsylvania than for the nation. Publication in the late 1940s of several quadrangles in the north completed the state's topographic coverage.

The uneven progress of base mapping in Pennsylvania is not an accident. There is a strong correlation between land area surveyed and financial support, or "cooperation," by the Commonwealth (Figure 3). Pennsylvania began to share costs on a fifty-fifty basis with the Geological Survey in 1900. It has contributed financially to topographic mapping for all subsequent years except 1916 through 1918, and has a record of cooperative topographic mapping exceeded only by New York State (7). The Commonwealth demonstrates that fifty-fifty cost sharing is an effective method for states to hasten the mapping of areas of special interest. Cooperators help choose areas to be mapped or revised, the federal government absorbs the full cost of publication, and the cooperator receives the recognition of a credit heading at the top center of the map sheet (8).
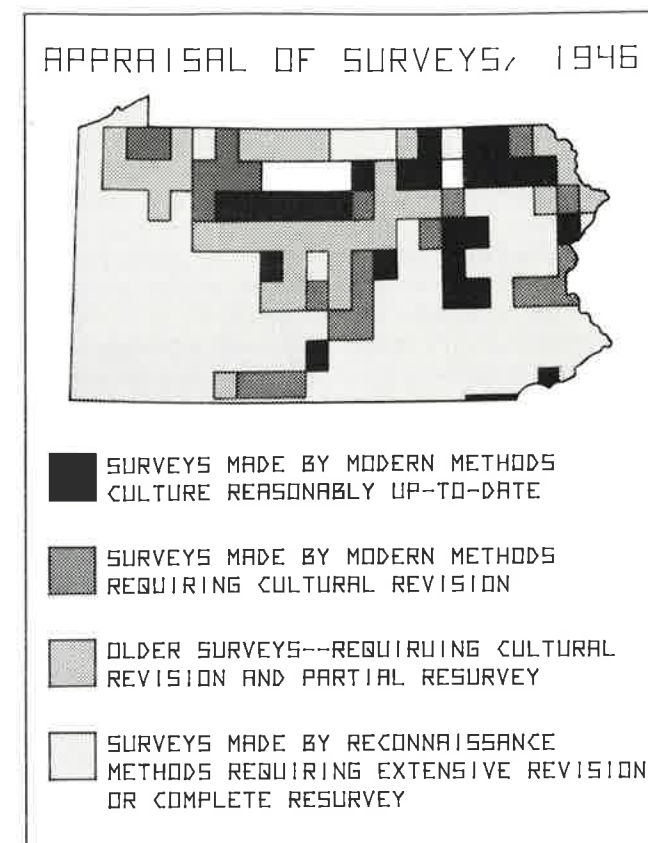

FIGURE 4. "Tentative Appraisal" of topographic surveys, September 1946.

tember 1946, described as substandard the maps of many Pennsylvania quadrangles, particularly in those areas mapped early: the anthracite belt, the southwest bituminous region, and the southeast (Figure 4). The accuracy of reconnaissance maps could be judged only by the reputation of the topographer, whose name appeared on the map sheet. Less extensive areas in the central and northern parts of the Commonwealth were mapped with somewhat higher accuracy yet required revision for man-made features, or "culture," and in some cases partial resurvey. Less than ten percent of the state was judged "reasonably up-to-date."

The post-World War II era saw renewed activity in topographic mapping, with emphasis on 7.5-minute map sheets, each covering one-quarter of the area of a 15-minute quadrangle. The 1:24,000 scale of this new series was more than twice the 1:62,500 scale of the older series, and both terrain and culture were more detailed. The transition was swift: Figure 5 shows almost no coverage at 1:24,000 before 1946 and comparatively little mapping at 1:62,500 after 1950. As suggested by the 1946 appraisal, post-war topographic revision leading to publication in the new, 7.5-minute series was carried out earliest in the anthracite belt, the southwest, the southeast, and parts of the north central section, including several quadrangles that had never been mapped until about 1950 (Figure 6, upper). By 1965, this new series covered over half the Commonwealth (Figure 6, lower). By then the older, substandard reconnaissance maps covered less than half the state, and few other pre-1930 maps were still in print (Figure 7). Several additional 15-minute quadrangle maps were published in the 1950s, mainly for northern Pennsylvania, as 1:62,500-scale combined versions of four 7.5-minute maps with the same publication
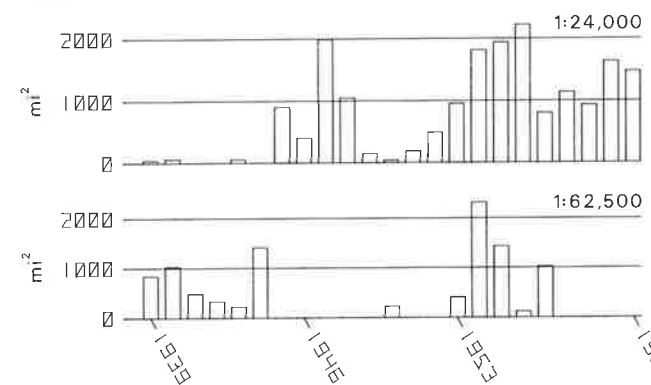

FIGURE 5. Transition between the 1:62,500, 15-minute series and the 1:24,000, 7.5-minute series, 1939-1961. Histograms show land area covered by completely new or revised maps.

LARGER SCALE, IMPROVED ACCURACY

Plane table, alidade, transit leveling, and topographic sketching can yield useful maps, but these techniques are markedly less accurate and more time consuming than modern photogrammetric methods. Standards of accuracy for topographic maps were expressed mathematically for the first time in the early 1900s, developed further in the 1930s by committees of the American Society of Civil Engineers and the American Society of Photogrammetry, and formalized as the National Map Accuracy Standards in 1941 by the Bureau of the Budget (9).

The Commonwealth's earliest topographic maps did not meet these modern standards and had to be revised. A "Tentative Appraisal" of topographic mapping in the United States, dated Sep-
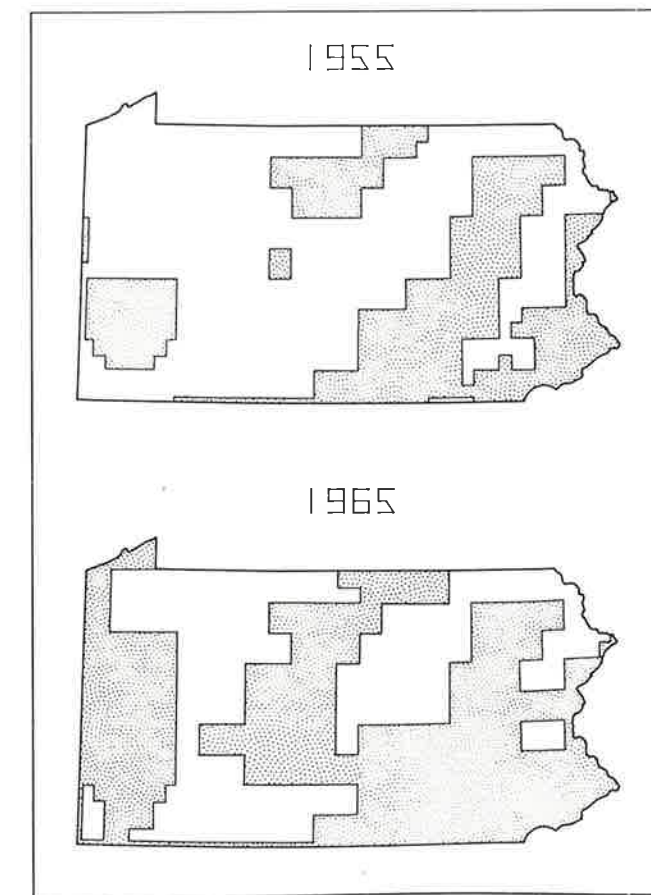

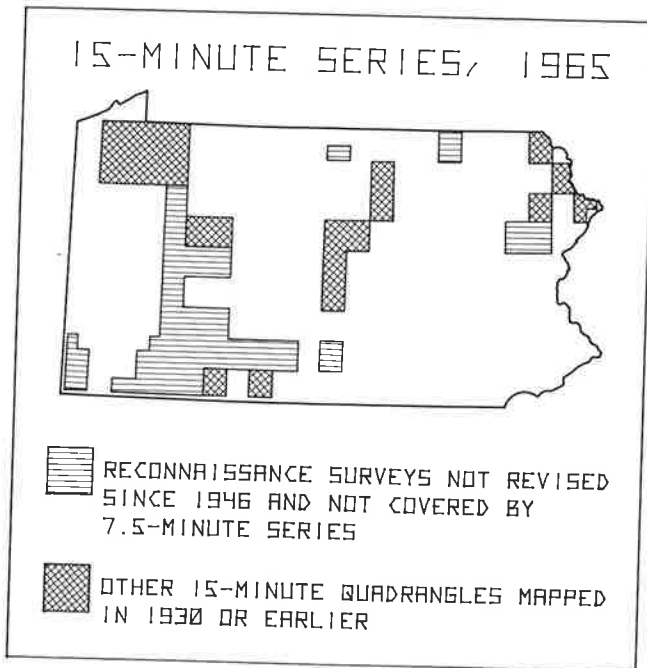FIGURE 6. Area covered by 1:24,000, 7.5-minute maps, 1955 and 1965.

FIGURE 7. Substandard 1:62,500, 15-minute quadrangles still in print, 1965. Some quadrangles were still covered exclusively by 20-year-old reconnaissance surveys.
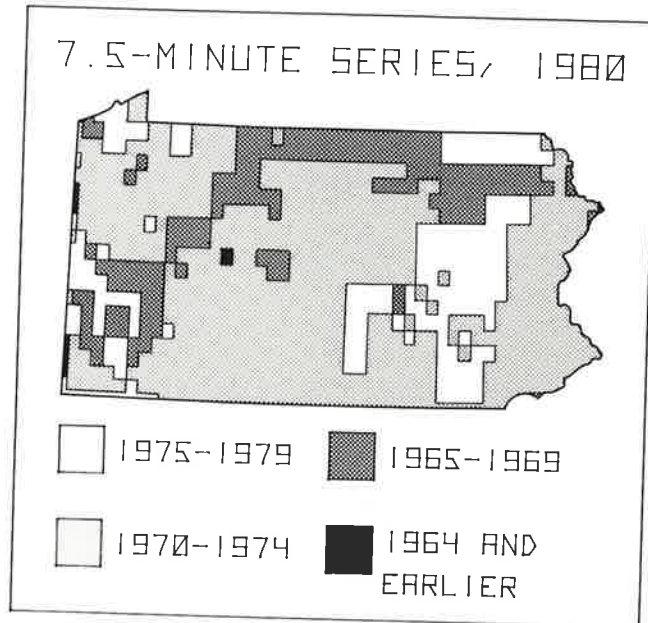

FIGURE 8. Pattern of publication dates for 1:24,000, 7.5-minute topographic maps available in 1980.

date (not shown in Figure 7). The last 15-minute map for the Commonwealth bore a 1957 publication date.

TOPOGRAPHIC COVERAGE IN 1980

Despite vigorous mapping, remapping, and revision, in 1980 the pattern of publication dates for the 7.5-minute series still showed a few traces of earlier trends (Figure 8). Maps published during the 1970s covered most of the Commonwealth, but sheets produced after 1974 were concentrated principally in the eastern coal regions, the southeast, and the southwest. Older sheets, published before 1970, largely covered quadrangles in the northern

tier of counties and parts of the Allegheny Plateau, as well as along Pennsylvania's borders. In general, these older sheets are for areas covered early by the 7.5-minute series and not yet revised. Pittsburgh is a notable exception.

In future years the pattern of publication dates will reflect to a greater degree two factors. First, more remote, less rapidly changing areas will not require as frequent revision as more rapidly developing areas. Second, revision generally affects contiguous groups of quadrangles because aerial photography is acquired economically for areas much larger than the roughly 150 square-km of the typical 7.5-minute quadrangle.

The interaction of a revision cycle based on change and a photo-procurement policy based on contiguity should lead to a more complex pattern of publication dates. A quadrangle sheet can be continued without revision as a *photoinspected* map if insufficient change occurred to justify a revised edition (10). In the United States quadrangles are generally inspected every 5 to 20 years. Because of the Geological Survey's policy of photoinspection, the accuracy of cultural information for Pennsylvania's 7.5-minute series (Figure 9, lower graph) is somewhat better than that implied by the dates of publication of the latest revisions (Figure 9, upper graph). In 1980, most of the Commonwealth's quadrangles were no more than eight years out of date, and only a few were more than twelve years out of date. Nonetheless, the Commonwealth would prefer a five-year revision cycle, rather than the apparent ten-year cycle, which the State Geologist attributes to shortages of manpower and insufficient federal support for the U.S. Geological Survey's mapping program (11).
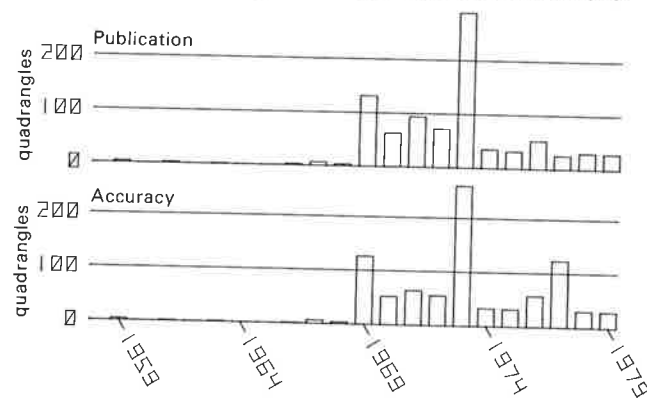
FIGURE 9. Frequency histograms showing that the most recent editions of 7.5-minute, 1:24,000 maps listed on the 1980 index map generally had publication dates (above) no older than 7 years. Accuracy appears to be even better for frequencies based on publication date or date of photoinspection, whichever is more recent (below).

Aerial photography can also be used to produce orthophotoquadrangle maps, called orthophotoquads. These are planimetrically accurate, quad-centered photographic maps with a reference grid and selected place names. Orthophotoquads can be produced more expeditiously than and can sometimes substitute for a revised map. Orthophotoquads available for the Commonwealth in 1980 covered parts of the eastern coal fields for which revised maps were recently published or still in process, as well as a second project area in southwestern Pennsylvania (Figure 10, lower).

Future patterns of publication dates are likely also to reflect longitude. In the late 1970s, a revision project area covered all of the Commonwealth west of the 78th meridian, as well as a portion in the east (12). The 78th meridian, shown clearly in the contiguous pattern of photorevised quadrangles, reflects Pennsylvania's interim revision program (Figure 10, upper). For the sys-
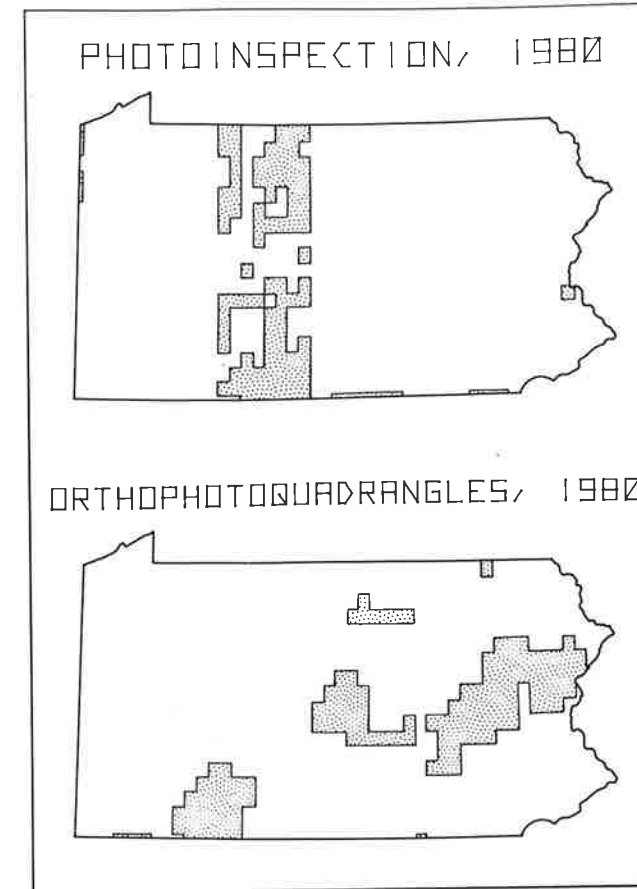
FIGURE 10. Coverage by 1:24,000, 7.5-minute photoinspected topographic maps not in need of revision (above) and orthophotoquadrangle maps (below), 1980.

tematic procurement of aerial photography, the Commonwealth is divided roughly along meridians into five zones, approximately equal in area. One zone is photographed every year, so that the state could, federal and state support permitting, maintain a five-year photorevision cycle (13).

In addition to supporting surveys and compilation for the 7.5-minute series, Pennsylvania also cooperates with the Geological Survey in producing county topographic maps at 1:50,000-scale. These intermediate-scale base maps are similar in detail to the 7.5-minute quadrangle sheets but have a format more convenient for local public administrators. The 1:50,000 scale is also more appropriate for the inevitable adoption of metric units of measurement than the older 1:62,500 scale, on which one inch conveniently represents approximately one mile. The first county sheets were published in 1973, and by early 1980 maps were available for 23 counties, with two sheets each for Centre and Lycoming, the Commonwealth's largest counties (Figure 11). Although these intermediate-scale maps are readily derived from 1:24,000-scale quadrangle sheets, there is no obvious correlation between the geographic patterns of publication dates for these two series (Figures 8 and 11). Apparently topographic information is derived from the larger-scale series but cultural information is updated and revised from the most recent aerial photography. Some longitudinal clustering is suggested by similar publication dates for, say, the Adams, Cumberland, Dauphin, Lebanon, Lycoming, Montour, Sullivan, and Union sheets, all published in 1973 or 1974. Yet the impression of longitudinal zonation is far from blatant. (14)
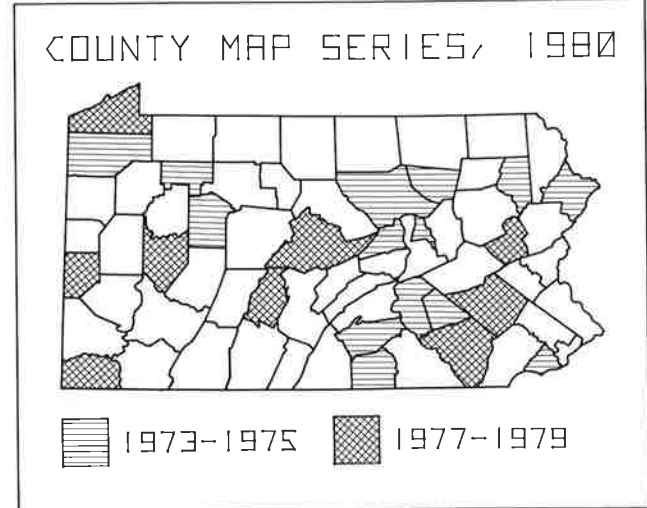

FIGURE 11. Pattern of publication dates for 1:50,000 county map series, 1980.

CONCLUDING REMARKS

Developing and maintaining a series of base maps for an area as large as Pennsylvania requires time and money. Continual revision is needed as the landscape changes, standards of accuracy become more rigorous, and user expectations increase. Horizontal and vertical accuracy have been improved markedly since the Geological Survey initiated its topographic program over a century ago. Modern photogrammetric survey and cartographic production methods have reduced considerably the cost of providing up-to-date geographic information.

Mapping is not a static field, and further, more marked changes are imminent. Computer-assisted cartography, geographic information systems, remote sensing, and geodetic positioning systems based on man-made satellites will increase the flexibility, accuracy, information content, and accessibility of our national spatial data base. Federal-state cooperation should continue to provide an important mechanism for serving local needs while maintaining national standards of accuracy, symbolization, and content.

ACKNOWLEDGEMENTS

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JOB ACCESSIBILITY AS A DETERMINING FACTOR IN EXPLAINING RESIDENTIAL PROPERTY VALUES[1]

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ABSTRACT

One of the most important aspects of property value is location. Location can be defined in terms of accessibility to a variety of public and private services as well as job opportunities. The purpose of this study was to develop a method for measuring the monetary value of job-accessibility to residential property. A Job Accessibility Measure was tested using multiple linear regression analysis. Job accessibility was determined to be an important component of residential property value. Results are compared with traditional measures of accessibility.

INTRODUCTION

Many economists, social scientists, assessors, and appraisers believe that the most important aspect of property value is its location. It has been facetiously said that the three most important determinants of property value are location, location, and location. The location of a property may mean different things to different people. For example, to a grain farmer it may mean the rich soil of Iowa; to the manufacturer of machinery it could be a location in the industrial east; and for a fast food store it might mean a location on a busy corner near a large office building. Thus, location can mean a fertile field, a good market, or a variety of other things.

The value of a parcel of land at any given time is determined by many factors operating simultaneously in the real estate market. A large number of the collective activities of government and private enterprise have brought about conditions which can lead to an increase or decrease in property value (1, 2). Economists and others have recognized that a change in accessibility is one of these conditions (3, 4, 5, 6).

While property value can be measured by sale price, the value of accessibility cannot be observed directly. Thus, it is difficult to separate from the sale price of real property that portion which reflects the effect of accessibility.

In general terms, accessibility means being in proximity to the transportation system which, in turn, makes a particular property accessible to a variety of public services as well as to specific job opportunities within the area. There is an array of public services which are available as a result of accessibility; for example, shopping, recreation, doctors, education, government services and the like. One of the most important measures of accessibility for the residential property is in terms of proximity to job opportunities. The available transportation network and the travel time to and from work are often critical factors in an individual's decision to permanently locate or reside in a given area (7).

The purpose of this study is to develop a practical methodology for measuring the monetary value of accessibility to residential properties. A job accessibility measure (called JAM) is tested using multiple linear regression analysis and the results are compared with a traditional measure of accessibility (distance to the Central Business District).

METHODS AND DESCRIPTION OF STUDY AREA

Researchers have developed theories on the various aspects of accessibility (8, 9). Some theories relate land value and accessibility only in terms of the savings in transportation costs because of location (10). Other researchers have expanded the idea of accessibility to include other amenities (11). New dimensions have been added to the concept of accessibility in that the value which an individual is willing to pay for a certain location may be far different from the cost of transporting himself to various amenities.

Most measures of accessibility are concerned with distance or travel time to activity points such as jobs, shopping areas, market areas and the like. In many studies of property values, accessibility is measured by the distance to the Central Business District and/or to the nearest freeway access point (12).

These measures are sometimes extended into accessibility indexes which utilize the intensity of a particular activity and the distance or travel time between that activity and the location for which accessibility is being computed. With this concept of accessibility, it is possible for accessibility to increase or decrease without any improvement in a given transport network. For example, the establishment of a new shopping center would increase the number of stores available to nearby residents; hence, accessibility for the residents would normally increase, unless congestion, resulting in increased travel time, more than offsets the gain in new shopping opportunities. Thus, it appears that much attention is being given to developing a general theory of location and accessibility.

Most studies involving accessibility measurement and property values have used secondary data such as assessed values and census tract averages instead of actual individual property sales. This is because actual sales data were not readily available or were costly to obtain. In recent years, better real estate assess-
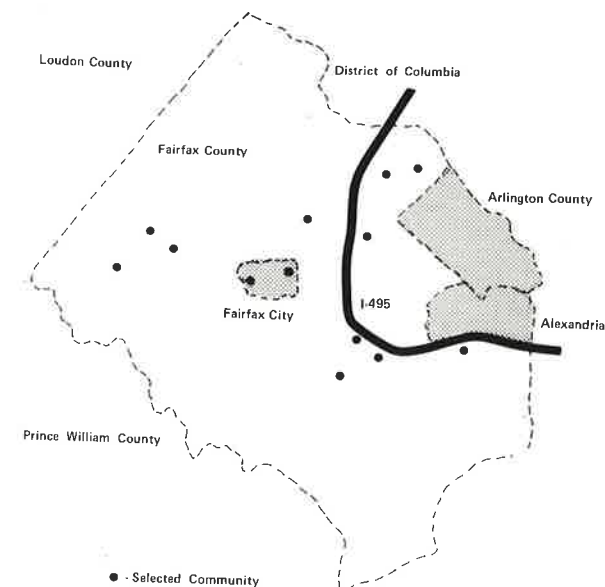
FIGURE 1. Map of Fairfax County, Virginia, Showing the Study Area Consisting of Thirteen Selected Communities.

ment practice has required the collection of primary sales data which, under the right-to-know laws, is now available.

Concurrently, in most major metropolitan centers, transportation planners concerned with the efficiency of transportation systems have developed measures of accessibility. These measures involve travel time or distance since a major objective of transportation planning is minimizing the travel time to places of employment, given various economic constraints.

Thus, it is no longer necessary to use distance to some central location as a measure of accessibility. A more refined measure can be obtained by using travel time or distance to available employment opportunities.

Statistically, there are basically three ways in which accessibility can be measured using property sales. In the time series approach, the sales value of property in a given location is measured over time along with the changes of accessibility due to external factors such as new highway construction. A second approach is a cross-sectional analysis in which accessibility is measured at one point in time at various locations, with varying levels of accessibility. A third method involves a mixture of the cross-sectional and time series approaches.

In our study, 13 residential areas were selected in Fairfax County, Virginia (See Figure 1) in order to represent varying levels of accessibility to job opportunities. That is, a cross-sectional approach was used.

One of the steps used in selecting residential properties for this phase of the study was visual inspection from the roadway of each property tentatively selected. This was necessary since the property record cards in the Fairfax County tax office could not be examined because of their confidentiality (as upheld by several court cases). Therefore, there was no way of determining the relative size, style, or other features of a home which are so important in determining its value and which were necessary for this analysis.

Each property selected was photographed and these pictures later examined. From the photographs obtained, it was possible to compare the approximate sizes and styles of the houses. Five classes of homes (House Type I, the smallest, to House Type V, the largest) were ultimately identified. Since the photographs
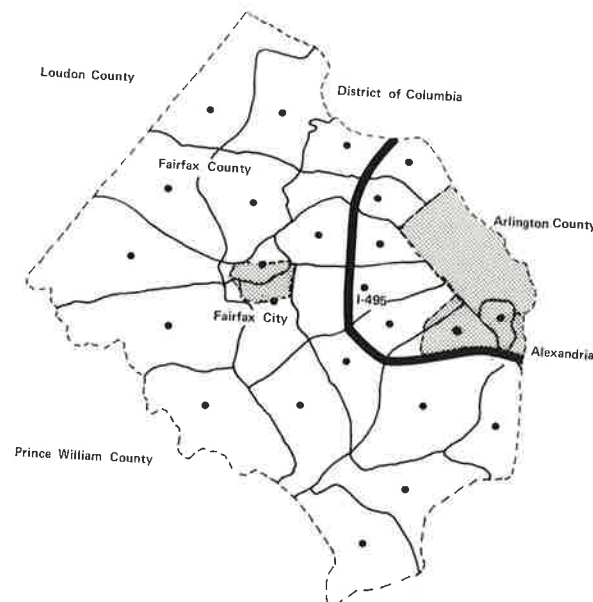
FIGURE 2. Map of Fairfax County, Virginia, Showing the Calibration Districts Developed by the Metropolitan Washington Council of Governments, Transportation Planning Board (1968) and the Employment Accessibility Points for each District.*

*The employment accessibility value reported for each district was assumed by the authors to occur at the indicated points for purposes of developing an accessibility contour map.

were taken at approximately the same distances, the finished photographs were approximately the same scale. Hence, the five classes were developed by visually planimetering the photographs.

The index of accessibility used in this study was the percentage of jobs in the Washington, D.C. area which can be reached within 45 minutes travel time from a particular location using the quickest means of transportation.

These accessibility values were calculated for various calibration districts by the Metropolitan Washington Council of Governments, Transportation Planning Board. The calibration districts used in our study are shown in Figure 2.

Since some of the districts were very large and undoubtedly varied in accessibility from one end to the other, a method of linear interpolation was deemed necessary for the accessibility points indicated in Figure 2.

ANALYSIS

A computer program SYMAP was used to make the interpolation and produce a contour map of points of equal accessibility (13). The contour map is shown in Figure 3. An arbitrary gradient of 10 between contours was used. Hence, it is possible to obtain a measure of job accessibility for any property within the 13 selected communities by using an overlay of this contour map. The least squares multiple linear regression model was used to obtain estimates of the share that accessibility contributes to total residential property values.

The dependent variable in the model is the valid sales price of a residential property. In nearly all studies of this type, the property records have to be examined for the validity of the sale. Valid or economic sales are those in which the price stated is the actual price paid for the property with no extra financial ar-
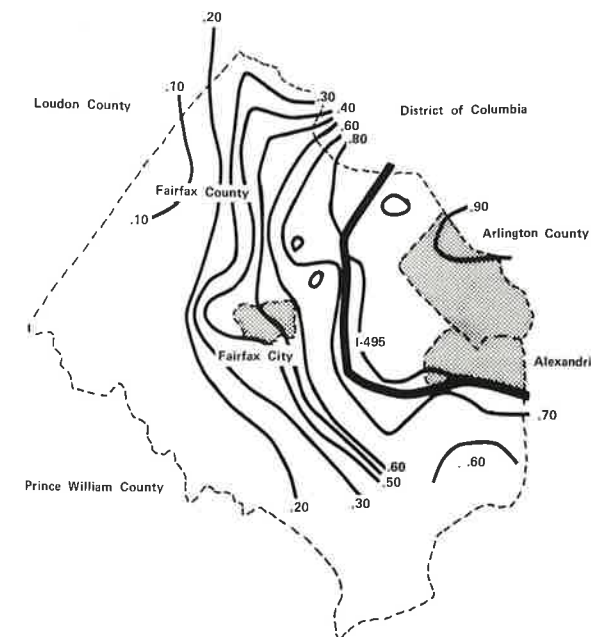

FIGURE 3. Employment Accessibility Contour Map Showing the Proportion of Regional Employment that Can Be Reached within 45 Minutes Travel Time.

TABLE 1

Independent Variables Used in the Multiple Linear Regression Analysis

Independent Variable	Unit of Measurement
JAM*	Percentage of jobs available within 45 minutes travel time
Age of House	Years
House Type I**	Yes = 1, No = 0
House Type II	Yes = 1, No = 0
House Type III	Yes = 1, No = 0
House Type IV	Yes = 1, No = 0
House Type V	Yes = 1, No = 0

*Job Accessibility Measure developed from data supplied by Washington, D.C. Council of Governments, Transportation Planning Board.

**House types are based on the relative size of the house; Type I being the smallest, Type V the largest.

rangements concerning the property included. Some of the usual exclusions of properties on the basis of unknown extra financial conditions are (1) sales between people with the same last name, (2) properties that involve the sale of things other than the property itself, (3) sales between individuals and non-profit corporations, and (4) properties which are condemned by the county authorities. Sometimes properties sold between individuals who meet all the above criteria are still considered invalid sales. Such sales may involve people undergoing divorce, or they may involve partnerships. These sales are excluded by applying the "high or low value test." When ranges are such that the price is double that of the average for one house in the area, or if it is one half of the average price for houses in the area, there is usually some reason why the sale is invalid. Properties that sold for such values were excluded.

Actual property sales data for 84 residential properties in the 13 selected communities were used as inputs in the regression

model. One of the independent variables was the measure of accessibility developed in the study, JAM or Job Accessibility Measure.

The regression coefficient associated with this independent variable is an estimate of the marginal monetary contribution of accessibility to residential property value. A list of the independent variables used in the final multiple linear regression model is presented in Table 1. In preliminary regression analyses, additional independent variables were considered, including distances to parks, junior high and elementary schools and hospitals. The nearness of these amenities was found to be statistically insignificant once accessibility to employment opportunities and type of house were accounted for.

The results of the final linear regression analysis are presented in Table 2.

TABLE 2

Multiple Linear Regression Results Using a Refined Measure of Accessibility

Dependent Variable = Price Per Lot of Residential Property
Number of Observations = 84
Multiple Coefficient of Determination R^2 = .68
F-Ratio = 24.26

Independent Variable	Regression Coefficient	Student 't'
JAM	197.34*	6.6
Age of House	−487.58	3.1
House Type I	20682.08	7.8
House Type II	26465.08	12.2
House Type III	29078.11	16.5
House Type IV	33481.69	17.6
House Type V	40484.80	16.9

*The marginal contribution of a one-unit increase in the JAM index (say, for example, from 75% to 76%) was $197.

The regression coefficients representing estimates of the parameters of the model were all statistically significant at less than the one percent level. The multiple coefficient of determination indicated that approximately 68 percent of the variation in residential property values was explained by the independent variables. Since all house types were included in the equation using the "dummy (0-1 variable)" technique, no constant term (intercept) could be included.

The regression coefficient of $197.34 is an estimate of the marginal monetary value of accessibility as measured by the JAM index. This regression coefficient should be a reasonable estimate since the study sites and independent variables were selected to minimize the problem of multicollinearity.

A comparison of JAM with a traditional measure of accessibility, distance to the central business district, was made. Specifically, the distance to downtown Washington, D.C. was substituted for JAM in the regression model and the results showed a drop in the coefficient of multiple determination to .57. While the regression coefficients were statistically significant, the decrease in explained variation from 68 to 57 percent appeared to be substantial.

In addition to the greater explained variation using the JAM accessibility measure, there appears to be wider applicability of the measure since it is associated with the number (or proportion) of job opportunities throughout a given area and not with any particular central business district.

DISCUSSION

In this study, a methodology for obtaining monetary estimates for accessibility was given. A job accessibility measure (JAM) was proposed as a practical index with wide applicability that could be developed rather easily from census tract data. A multiple linear regression analysis revealed that the JAM index was a highly significant factor in explaining residential property values.

The regression coefficient associated with the index provided an estimate of the marginal monetary contribution of accessibility to residential property values. The magnitude of this estimate suggests that accessibility is an important factor and can account for a large percentage of the value of a residential property. Thus, models which attempt to predict or explain variations in property values should include a measure of accessibility.

Several limitations exist in this study. First, models that measure accessibility are subject to specification error. In the case of JAM, an increase in the number of job opportunities also may mean an increase in population and the number of potential buyers of residential property. Hence, it is extremely difficult to differentiate between being close to job opportunities and the effect of having more potential buyers (higher demand) for the particular property. To further complicate the analysis, housing supply can also change in response to changing demand.

Second, the sampling procedure was not entirely random in that quota sampling was employed in order to have all five types of houses and varying levels of accessibility represented. Hence, tests of statistical significance are not strictly valid.

Finally there may have been a difference in the estimate of the effect of accessibility on property values if a time series rather than a cross sectional approach had been used. Complete data were not available for our accessibility measure in order to use a time series approach.

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RECENT TRENDS IN THE DISTRIBUTION OF PENNSYLVANIA'S BLACK POPULATION[1]

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ABSTRACT

A recent demographic phenomenon has occurred throughout the United States but is especially evident in the nine northeastern states. This "population turnaround" is described as the redistribution of population generally from metropolitan areas to nonmetropolitan areas. This paper, concerned with the racial aspects of such trends, examines black population trends in Pennsylvania from 1970 to 1980, compares them to national trends, to earlier changes, and to variations in the white population's distribution. Counties are the primary areal units studied although metropolitan areas and their component parts are examined as well. Results suggest that, although trends were insufficient to actually change the black population's primarily metropolitan residential focus, losses in the largest cities and gains in several counties best described as metropolitan-suburban might herald black residential shifts to come.

INTRODUCTION

Recent events suggest that a major reversal in population trends is underway, one less publicized than the Snow Belt-Sun Belt shift but perhaps of equal importance—the growth of nonmetropolitan areas often at the expense of the metropolitan centers. One observer cites a turnaround since 1960 favoring the nonmetropolitan areas among Pennsylvania's minor civil divisions (1). A recent Census Bureau study describes a national reversal of migration toward the nonmetropolitan areas and away from the now traditional migration from rural and smaller urban places to the great metropolitan centers (2). Perhaps nonmetropolitan growth is a logical extension of the search for residential amenities beyond the suburbs of our great cities, suburbs now developed well beyond their residential function to include industry as well as a wide array of commercial activity. The perpetuation of the search for less-urban circumstances, whether to suburban fringe or outward to nonmetropolitan and rural areas, suggests an anti-urban bias of increasing importance and continuing problems for many of our central cities. A comparison of metropolitan-nonmetropolitan trends during the fifties and seventies among the nation's Census regions revealed significant reversals of both growth and net-migration. Whereas metropolitan growth and net-migration exceeded nonmetropolitan in all four regions in the 1950s, the metropolitan population of the Northeast actually de-clined in the 1970s and net out-migration prevailed in the Northeast and North Central regions in the 1970s. This study examined trends in the counties of the Northeast, as well, and found that 71 of the region's 217 counties reported a turnaround—in-migration in the 1970s replacing the out-migration of the 1950s (3).

Thus, it is clear that in general the nation's population has ceased to be oriented so primarily toward urban areas. The white majority's trends are well represented by this observation, but what about our greatest minority—the black inhabitants? In a paper published almost a decade ago in which black distributional trends in the Commonwealth were compared to white, the findings were straight forward—cities had evolved as the foci of black residence and growth and, given the white flight from major urban centers primarily to metropolitan suburbs, the black-white geographic association was negative (4). This study re-examines black trends over the 1970 decade at the county and SMSA levels, and compares trends among black inhabitants to white change and to earlier distributional events.

DATA AND METHODS

Data for this study are from the U.S. Bureau of the Census, Census of Population, 1970 and 1980. As for methods, aside from counts and the use of percentages to compare trends among places within and outside of Pennsylvania, the study employs location quotients to measure the degree to which black populations in a variety of civil divisions were proportional to each of their total populations as well as to the Commonwealth's black residents and inhabitants of all races. To assess geographic association, simple correlation techniques were applied to 1970 and 1980 location quotients as well as to black-white trends. Finally, to compare the aggregate of differences in location quotients over the period, absolute deviations were summed and reported for counties, SMSAs, central cities, and non-central city portions of SMSAs.

RESULTS AND DISCUSSION

Table 1 reveals that neither black nor white populations of Pennsylvania increased at rates as high as those recorded nationally in the 1970s, although "other" racial groups in Pennsylvania gained significantly, their numbers remained quite small nonetheless. The general pattern of growth by race was somewhat similar in the nation and Pennsylvania—black rates of change exceeding white and being exceeded by the other races, although the white

TABLE 1

Population Growth by Race, Pennsylvania and the United States, 1970-1980

	1970		1980		Change 1970-1980	
	No. (000s)	%	No. (000s)	%	No. (000s)	%
			Pennsylvania			
Black	1,017	8.6	1,048	8.8	31	3.1
White	10,738	91.0	10,654	89.8	-83	-0.8
Other[1]	40	0.3	165	1.4	125	315.5
Total[2]	11,794	100.0	11,867	100.0	73	0.6
			The United States			
Black	22,580	11.1	26,488	11.7	3,908	17.3
White	177,749	87.4	188,341	83.2	10,592	5.9
Other[1]	2,973	1.5	11,676	5.2	8,703	292.8
Total[2]	203,302	100.0	226,505	100.0	23,203	11.4

Source: Computed by the author from U.S. Bureau of the Census data.

[1]Other races identified by the Census publication include American Indian, Eskimo, Aleut, Asian and Pacific Islanders. In Pennsylvania the major "other" races in 1980 were 15,212 Asian Indians, 13,291 Chinese, 12,503 Koreans, 9,257 Vietnamese, 9,173 American Indians, and 8,267 Filipinos.

[2]Columns and rows may not sum correctly because of rounding.

TABLE 2

Black Population Growth, Selected Counties, 1970-1980

	1970		1980		Change 1970-1980	
	Number	%	Number	%	Number	%
Philadelphia	653,791	64.3	638,878	61.0	-14,913	-2.3
Allegheny	144,545	14.2	150,246	14.3	5,701	3.9
Delaware	43,574	4.3	49,989	4.8	6,415	14.7
Dauphin	26,271	2.6	31,275	3.0	5,004	19.0
Montgomery	22,560	2.2	30,864	2.9	8,304	36.8
Chester	21,119	2.1	23,085	2.2	1,966	9.3
Six Counties	911,860	89.7	924,337	88.2	12,477	1.4
Pennsylvania	1,016,514	100.0	1,047,609	100.0	31,095	3.1

Source: Computed by author from Census data.

population actually declined by more than 80 thousand whereas the white population increased nationally by more than 10 million. Moreover, the growth of Pennsylvania's total population was quite modest compared to the national gain, which exceeded 11 percent.

As was the case in the 1960-1970 period, the black population was heavily concentrated in a very few counties. Indeed, as Table 2 illustrates, Philadelphia's black population amounted to more than 64 percent of the Commonwealth's black total in 1970 and 61 percent in 1980, having declined by nearly 15 thousand during the decade. After Philadelphia, Allegheny County ranked a distant second, with a little more than 14 percent of the black total in both years. Except for Dauphin, the remaining counties listed in Table 2 are suburban to Philadelphia. Although their black populations are minor in number when compared to Philadelphia's and Allegheny's, they gain stature by virtue of the fact that no other county had as many as 13 thousand blacks in residence in 1980 and most had even fewer in 1970.

Concerning growth among counties, there were some changes but the pattern of black population distribution remained essentially the same. Among counties with 500 or more blacks in 1970, only Armstrong, Beaver, Blair, Cambria, Huntingdon, Philadelphia, and Washington reported declines, and those were relatively insignificant (Armstrong's 5.4 percent being the greatest). Gains ranged widely for those with at least 500 black inhabitants—Lehigh's 82 percent standing alone as Monroe reported the second highest percentage increase at 59. Given the state's gain of just 31 thousand, it would be surprising to find large swings in either direction among counties with sizeable black populations. As for the 34 other counties—those with less than 500 blacks—the trends were much more volatile, as small-base populations responded to modest numerical trends in big relative ways. Of the group, 24 counties reported increases and 10 losses, ranging from a gain of 1,000 percent (Forest's black population grew in number from 1 to 11) to a loss of almost 75 percent (Wayne's fell from 318 to 82).

The overwhelmingly metropolitan nature of the black population is verified on Table 3, a comparison of metropolitan-non-metropolitan population trends by race, 1970-1980, as more than 97 percent resided in SMSAs in both years. Moreover, within SMSAs black Pennsylvanians are much more likely than whites to reside in central cities (5). Non-SMSA residence is thus shown as a predominantly white mode. Concerning change, however, the growth of the black population across the state occurred in SMSAs but in those sections outside of central cities, a strong suggestion of black gains in suburban areas. By contrast, a loss of black numbers in central cities, however small the declines, represents a distinct departure from the 1960-1970 events when Phila-
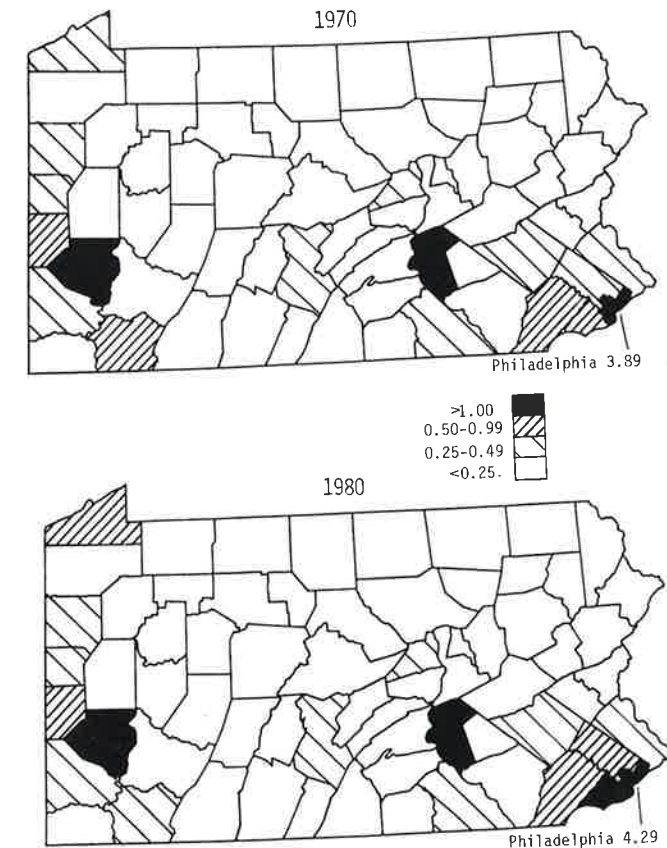
FIGURE 1. Location quotients for the black population, 1970 and 1980.

delphia alone reported black gains of almost 125 thousand, 76 percent of the Commonwealth's black increase. Thus, black growth was modest overall (some 31 thousand), most occurred in SMSAs (28 thousand), and central city losses (8 thousand) were more than offset by gains recorded in SMSA territory outside central cities, which exceeded the statewide gain for SMSAs (36 thousand). Furthermore, non-SMSA growth of black population, though not great (3,000 or so), amounted to an increase of almost 12 percent, well above the white percentage gain in non-metropolitan areas of the Commonwealth. As an additional note, although not shown in Table 3, the individual SMSAs were rather consistent, as only Altoona and Johnstown registered black declines in non-central city sections of their metropolitan areas. As for the others, they all recorded gains in non-central city populations which were well in excess of their central city trends. Only Philadelphia and Pittsburgh reported black declines within central cities. Despite these different events, however, the reader is reminded that Pennsylvania's black inhabitants remain not simply an urban population but one essentially resident in Pennsylvania's greatest cities.

Figure 1, location quotients (6) for the black population in 1970 and 1980, verifies both findings mentioned earlier—little change in the distribution and the primarily metropolitan nature of the black population. Indeed, the maps depicting the distribution of black inhabitants are practically identical, the coefficient of correlation for 1980 location quotients regressed on 1970's is over 0.99 (7). Moreover, only four counties actually changed map categories from 1970 to 1980—Delaware, a county suburban to Philadelphia, moved into the highest class from the second; Montgomery, also suburban to Philadelphia, rose to the second class from the third; Erie, found in the extreme northwest, moved up from third to second class; and Fayette, south of Pittsburgh, fell from second to third class. As for the metropolitan quality of

TABLE 3

Metropolitan[1]-Nonmetropolitan Population Growth by Race 1970-1980

	1970		1980		Change 1970-1980	
	No. (000s)	%	No. (000s)	%	No. (000s)	%
			Black			
Pennsylvania[2]	1,017	100.0	1,048	100.0	31	3.1
12 SMSAs	989	97.3	1,017	97.1	28	2.8
Central Cities	815	82.4	807	79.4	-8	-1.0
Outside Cities	174	17.6	210	20.6	36	20.8
Non-SMSA	27	2.7	31	2.9	3	11.7
			White			
Pennsylvania[2]	10,378	100.0	10,654	100.0	-83	-0.8
12 SMSAs	8,306	77.4	8,021	75.3	-285	-3.4
Central Cities	2,535	30.5	2,020	25.2	-516	-20.3
Outside Cities	5,771	69.5	6,001	74.8	230	4.0
Non-SMSA	2,431	22.6	2,633	24.7	202	8.3

Source: Computed by the author from Census data.

[1]All non-Pennsylvania SMSA parts were excluded and, to permit direct comparison between 1970 and 1980, the boundaries were changed in a few SMSA to conform with their 1970 status as follows: Allentown-Bethlehem-Easton—Carbon Co. was omitted, Northeast Pennsylvania—the Scranton and Wilkes-Barre-Hazleton SMSAs were separated and Monroe Co. was omitted. In addition, the new SMSAs —Sharon, State College, and Williamsport—were omitted. Finally, Susquehanna Co., officially part of the Binghamton, N.Y. SMSA since 1970, was omitted as a metropolitan county.

[2]Columns and rows may not sum correctly because of rounding.

the black distribution, Philadelphia stands alone with location quotients of 3.89 and 4.29 in 1970 and 1980, respectively. Allegheny and Dauphin counties are the only others to occupy the top category in both years and, as just stated, Delaware joined them in 1980.

A perusal of the maps reveals that *all* counties in the over 0.25 categories are metropolitan except for Mercer, Lawrence, Fayette, Huntingdon, and Union (8). Of these, in 1980 almost 81 percent of Mercer County's approximately 5,400 black inhabitants resided in Farrell City and the City of Sharon; likewise, almost 80 percent of Lawrence County's blacks lived in New Castle City. Fayette's black residents were more widely distributed but heavily urban nonetheless, as the City of Uniontown housed over 1,300 (about 20 percent of the total) and no less than eight other minor civil divisions reported more than 300 each. Finally on this point, Huntingdon's black population was almost all found in three civil divisions.

TABLE 4

Sums of Absolute Deviations, Location Quotients, 1970 and 1980

	1970	1980	Difference
Counties	57.89	57.88	-0.01
SMSAs	9.21	9.03	-0.18
Within Central Cities	7.94	7.93	-0.01
Outside Central Cities	9.23	9.01	-0.22

Source: Computed by author from Census data.

A summary of distributional trends of Pennsylvania's black population is provided on Table 4, a list of sums of absolute deviations (9) of the location quotients for each type of civil division studied. It is significant that, although small in all cases, the sums diminished from 1970 to 1980 for counties, SMSAs, central cities, and non-central city sections of SMSAs, indicating modest deconcentrations of black inhabitants. In fact, the losses in the cities of Philadelphia and Pittsburgh most likely account for this important trend, however slight (10).

Among the few counties in which black numbers are somewhat greater than might be expected considering location and nonmetropolitan status, a check of age, sex, marital status, population resident in households as well as population living in group quarters (11) reveals a simple explanation in most cases. For example, in Centre and Union counties, the young, highly male, overwhelmingly single black populations are mostly resident in group quarters rather than households. In Centre, the Pennsylvania State University and a state correctional facility account for the presence of most blacks, whereas Union's black residents are largely there as inmates of a correctional facility—Lewisburg Federal Penitentiary—although a college accounts for a small number as well. By contrast, age, sex, marital status, and household-group quarters comparisons are unexceptional in counties such as Crawford, Fayette, Franklin, and Lawrence. Indeed, the black populations living in these counties are highly urban, often centering on industrial cities despite their nonmetropolitan label.

Comparing black trends to white, Table 5 indicates that, although quite varied and not very strong, the geographic associations for counties, SMSAs, and nonmetropolitan areas were positive. This is quite a departure from the earlier study of the 1960s insofar as counties and central cities are concerned—1960-1970 trends for black and white inhabitants were inverse, as the coefficient of correlation for counties was over -0.7 and for cities of 25,000 or more within SMSAs the coefficient exceeded -0.9. Figure 2, a diagram illustrative of the geographic association between

TABLE 5

Geographic Associations between Black and White Population Trends 1970-1980

	Coefficients of Correlation
Counties	0.46
SMSAs[1]	0.62
Within Central Cities	0.32
Outside Central Cities	0.59
Non-SMSA[2]	0.65

Source: Computed by author from Census data.

[1] The SMSAs included are those defined in the note on Table 3.

[2] Non-SMSA counties number eleven and include those with 500 or more black inhabitants in 1970.

black and white population change in counties with 500 or more blacks in 1970, presents a rather simple pattern. Only Philadelphia, Cambria, and Beaver counties recorded black as well as white declines, the great majority of counties registering growth of both racial groups. Of these, Lehigh and Monroe stand apart, Monroe because of large relative gains in both racial groups and Lehigh because of relatively great black gains. Bucks is identified because it is a suburban county in the Philadelphia SMSA and represents a trend of importance, one worth repeating—the growth of blacks in previously white preserves. Cumberland County, located in the Harrisburg SMSA, and other Philadelphia suburbs of Montgomery and Chester counties fall within this group too, although they are not identified on Figure 2. Allegheny County is shown because of its demographic importance and Armstrong County simply represents the lower limit of white population change.

CONCLUDING REMARKS

As was the case in the 1960s, Pennsylvania's black population distribution changed little during the decade of the seventies. Although the absence of very much change indicates that the Commonwealth's blacks remained primarily a metropolitan pop-
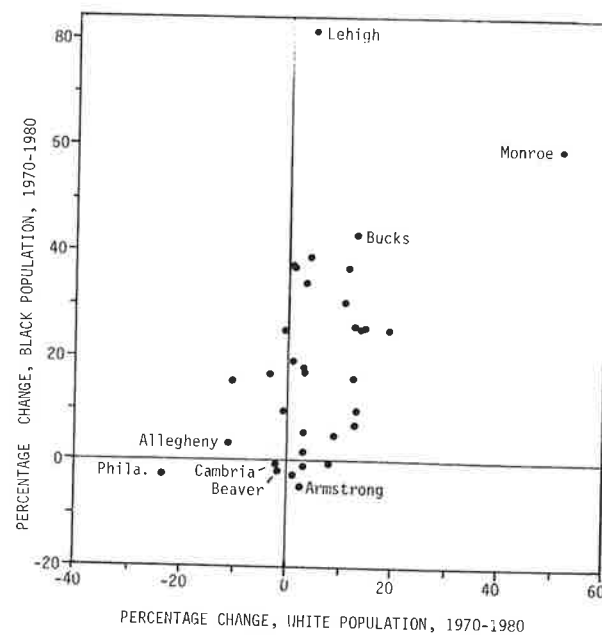
FIGURE 2. Geographic association between black and white population trends, 1970-1980, in counties with 500 or more blacks in 1970.

ulation, there was sufficient evidence to suggest that deconcentration at county as well as SMSA level is underway. Perhaps the decline, although slight, of black numbers in both the City of Philadelphia and Pittsburgh combined with the growth in counties suburban to such important black residential centers (Philadelphia, Pittsburgh, as well as Harrisburg) represents an incipient trend, one that might herald significant changes in Pennsylvania's population distribution by race.

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5. In complex, heavily urban SMSAs such as Philadelphia and Pittsburgh, distinctions between the central city and the remainder of the metropolitan area are unclear given the importance as black population centers of some ''non-central'' cities. Chester City, for example, located in Delaware County, has maintained the greatest black concentration in Pennsylvania—over 45 percent of its more than 56 thousand residents were recorded as black in 1970 and, despite an overall decline to less than 46 thousand in 1980, the number of blacks increased and their percentage of the total rose dramatically to 57.

6. The location quotients were calculated as follows:

$$\text{Location Quotient} = \frac{\dfrac{\text{Black Population in County A}}{\text{Total Population in County A}}}{\dfrac{\text{Black Population in Pennsylvania}}{\text{Total Population in Pennsylvania}}}$$

Or, in even simpler terms:

$$\text{Location Quotient} = \frac{\text{Black Population as a \% of Total Population in Co. A}}{\text{Black Population as a \% of Total Population in Pa.}}$$

Although counties are used in the example above, the same equation was used to calculate location quotients for SMSAs and their component parts, substituting SMSAs or the com-

ponent parts for counties and using total black population in all of Pennsylvania's SMSAs or component parts therein as the base in the denominator.

7. The coefficients of correlation for location quotients, 1970 and 1980, were calculated for SMSAs, central cities, and the metropolitan areas outside central cities and were found to be virtually the same as the county coefficient, indicating little change in distribution of blacks in SMSAs or their component parts.

8. Between 1970 and 1980, the total number of SMSAs in the nation was increased to 323 from 287. This change was brought about in part by a change in definition. ''Under 1980 standards, an area qualifies for recognition as an SMSA in one of two ways: if there is a city of 50,000 population, or an urbanized area of 50,000 with a total metropolitan population of at least 100,000.'' Sharon (Mercer County) and State College (Centre County) were classified as SMSAs by the Office of Management and Budget and, it is clear, State College was added on the basis of the new rule. In addition, Williamsport (Lycoming County) became a new SMSA some time between 1970 and 1980, and this was announced before the qualifications were changed for such status. State College is hardly an exemplar of our SMSAs, its new title notwithstanding—the Borough of State College and the County of Centre owe this ''distinction'' to the presence of the Pennsylvania State University, a presence which accounts for most of the 36 thousand inhabitants of State College and, therefore, a significant part of the county's 112 thousand as well. For this reason and for the sake of comparability, the Commonwealth's SMSAs were returned to their 1970 status in this study. Susquehanna County is the only exception—despite its inclusion as part of the Binghamton (N.Y.) SMSA in 1970 and 1980, it was treated as nonmetropolitan here because of its rural nature. For a brief review of the change in SMSA definition and a complete list of new areas, see Executive Office of the President, Office of Management and Budget, *Information Office Press Release* OMB-81-5, June 19, 1981.

9. Sums of absolute deviations were calculated as follows:

$$\sum_{i=1}^{n} |1 - LQ_i|,$$

where LQ is the location quotient for the ith place and n the total number of places. If the sum decreases, as it did for all units shown on Table 4, it indicates a deconcentration, whereas an increased sum of absolute deviations is taken to mean greater concentration.

10. The 1973 study cited earlier revealed similar trends between 1960 and 1970 for SMSAs and their component parts but, among counties, an increased concentration of black residents was reported.

11. At the time of this writing, characteristics such as these were not yet available. Therefore, 1970 data have been used.

A CHEMICAL STUDY OF PRECIPITATION IN SOUTHEASTERN MONROE COUNTY, PENNSYLVANIA[1]

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ABSTRACT

A chemical study was conducted on precipitation water samples collected in Southeastern Monroe County from February 1, 1981 to February 28, 1982. A total of 301 samples were analyzed for sepcific conductance, pH, phenolphthalein acidity, sulfates, and nitrate-nitrogen by the EPA approved methods.

The annual mean pH was determined to be 4.30, indicating the acidic nature of precipitation prevailing in the study area. The test values show that the acidity of water samples was highest in the late spring to summer seasons. The high correlation coefficients obtained for nitrate-nitrogen and sulfates tend to indicate that these chemical species were emitted into the atmosphere from the combustion of fossil fuels.

INTRODUCTION

The Pocono Mountains of Monroe County have many lakes and streams which are considered among the finest of sporting and recreational facilities in Pennsylvania. Several of these lakes and streams are stocked each year by the Pennsylvania Game Commission. The quality of water is extremely important not only for the use and enjoyment of the public, but also for the survival of biota in the surrounding environment. A decrease in water quality, specifically by acid precipitation and its effects on chemical runoff, could conceivably reduce the quantity of game fish and other organisms. Because tourism is one of the largest businesses for the area, such a decrease in water quality can adversely affect the economy of the area.

Next to increased carbon dioxide emissions, acid precipitation is considered a world-wide environmental problem (1). It has become an increasingly important issue in the United States only in the past two or three decades mainly due to the information received from eastern European countries and Canada. Precipitation with a pH of less than 4.00 was reported in 1966 for the Netherlands and in 1967 the average at DeBuilt, Netherlands was reported at pH 3.78 (2). Many stations analyzing precipitation in Canada reported pH values between 3.95 and 4.42 (3) and in the United States the pH averaged 4.70 (4).

During the mid-1960's precipitation in Pennsylvania averaged a pH of 4.44 and in 1972-73 the pH mean for Pennsylvania dropped to 4.21 (4). There have also been documented reports on adverse effects on the environment in Norway and the New York Adirondack region (4).

There is an evergrowing awareness of the potential adverse effects of acid precipitation in the Monroe County area, especially the effects on the water quality of its lakes and streams. As little information on the nature of precipitation in the area is available and there is an urgent need for obtaining such information, this study was undertaken with the following objectives:

1. To obtain specific data by chemical analyses of collected samples of precipitation,

2. To find seasonal and/or yearly trends from the analyzed data,

3. To examine correlations among the chemical tests chosen.
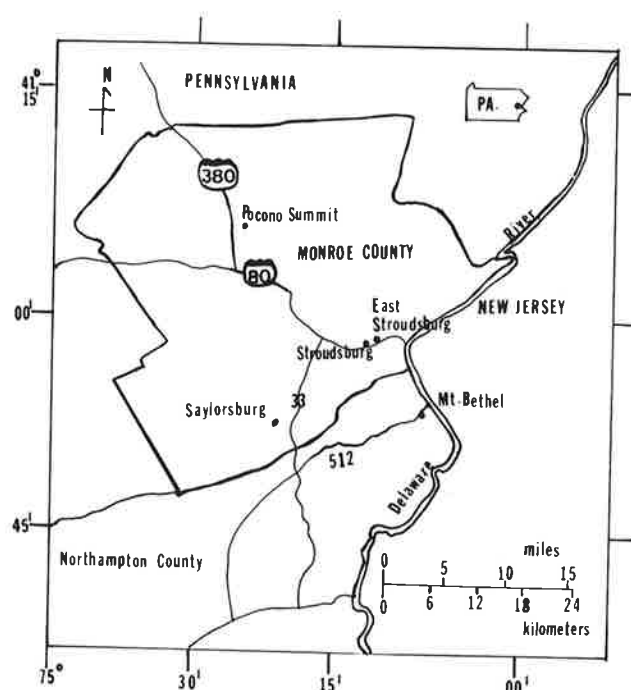
FIGURE 1. Study Locations.

MATERIALS AND METHODS

Study Locations:

Five sampling locations were chosen for their accessibility and convenience. Two of the locations, namely Stroudsburg and East Stroudsburg were continued throughout the whole year for consistency. One or more sampling sites were established at the five study locations chosen. As some locations were discontinued, others were chosen to replace them to attain enough data for the study. The sampling locations (5) shown in Figure 1 are:

1. Stroudsburg, two collectors on a residential building roof which is centralized in a business district with light indutry,

2. East Stroudsburg, three collectors located on Gessner Science building roof, East Stroudsburg State College,

3. Pocono Summit, two collectors placed on the ground, very little industry, heavily traveled highways (Interstate Route 80 and Route 940) surrounded by dense forest.

4. Mount Bethel, two collectors close to the Delaware River amidst a coal- and oil-fired plant,

5. Saylorsburg, farmland with scattered population.

Sample Collection:

Illustrated in Figure 2 is the home-made device with which precipitation was collected. The coffee can was centered on a piece of sturdy wood and nailed in place. A plastic polyethylene bottle (32 oz. capacity) with its top cut off was placed inside the can. Each site was equipped with one rain gauge to monitor the amount of precipitation for each event of precipitation. Before each rain the polyethylene bottles were washed with detergent and rinsed with tap water and then thoroughly rinsed again with distilled water; thus, the collectors were not exposed to dry deposition between precipitation events.
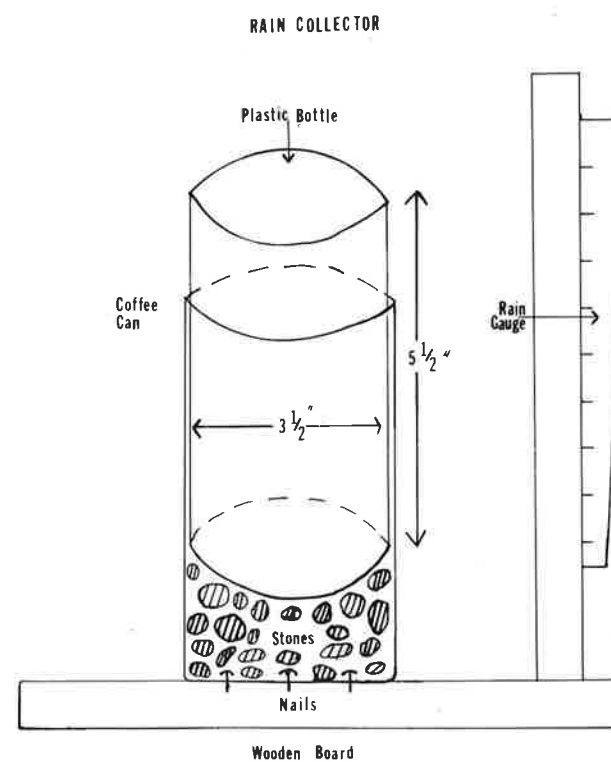
FIGURE 2. Rain collector.

TABLE 1

Annual Ranges, Means, and Standard Deviations.

	Range	Means	Standard Deviation
Specific Conductance (micromhos cm⁻¹)	9.06 - 197.46	45.53	8.89
pH	3.37 - 6.85	4.30	0.18
Phenolphthalein Acidity (ppm $CaCO_3$)	1.04 - 19.60	7.72	1.91
Sulfate (ppm SO_4^{-2})	0.03 - 28.00	2.88	1.20
Nitrate-Nitrogen (ppm N)	0.03 - 6.15	0.54	0.23

Experimental Methods:

After each rain or snowfall the samples were collected and transferred to clean polyethylene bottles with caps. The samples were brought to the laboratory and chemically analyzed within 8-14 hours after precipitation. In the case of snow or ice, the samples were melted in the laboratory and brought to room temperature (25 °C) before tests were performed.

The five tests performed on each sample are based on the approved methods by the United States Environmental Protection Agency (6). The chemical analyses were performed in the following sequence:

1. Specific conductance was measured by using a Beckman Conductivity Bridge and a cell with platinized, platinum electrodes,

2. pH was measured on a Beckman Century SS pH meter with a Beckman combination glass electrode,

3. Sulfates were determined on a Hach Ratio Turbidimeter by adding a conditioning reagent and barium chloride crystals to the sample (7),

4. Nitrates were tested by using a cadmium reduction pillow (NitraVer VI) followed by diazotizing with sulfanilamide coupling with N-(1-naphthyl)-ethylene-diamine dihydrochloride (NitraVer III) to form a highly colored azo dye. The transmittance was read at 500 nanometers on a Bausch and Lomb Spectronic 20 Spectrophotometer (8),

5. Phenolphthalein acidity was determined by titration using a standard NaOH solution and phenolphthalein as the indicator.

RESULTS AND DISCUSSION

From February 1, 1981 to February 28, 1982 the tests for the five parameters chosen were performed on 301 precipitation water samples. Table 1 shows the annual ranges, means, and standard deviations for specific conductance expressed in micromhos cm⁻¹, phenolphthalein acidity in parts per million (ppm) $CaCO_3$, sulfates in ppm SO_4^{-2}, and nitrate-nitrogen in ppm nitrogen. The mean pH values were calculated from the respective mean hydrogen ion concentrations.

According to the definition of acid rain (9), rain water having a pH value below 5.6 is considered acidic. Based on this definition, 94% of the precipitation events in Southeastern Monroe County, Pennsylvania during this study period were of acidic nature; although the pH ranged from 3.37 to 6.85, the annual mean pH, as given in Table 1, was 4.30.

The annual mean phenolphthalein acidity of 7.72 ppm $CaCO_3$ as given in Table 1 is equal to 154 microequivalents per liter of acidity. This value is substantially lower than the total

TABLE 2

Daily Means for Consecutive Days of Precipitation.

Date	Specific Conductance (micromhos cm⁻¹)	pH	Phenolphthalein Acidity (ppm CaCO₃)	Sulfates (ppm SO₄²⁻)	Nitrate-Nitrogen (ppm N)
2-11/81	60.85	4.37	11.52	3.64	0.40
2-12/81	12.73	4.85	6.30	0.41	0.25
2-23/81	49.56	4.36	7.40	1.54	0.37
2-24/81	17.85	4.68	5.24	0.74	0.19
3-5/81	32.09	5.14	1.77	4.84	0.49
3-6/81	22.40	4.71	4.81	0.87	0.54
6-4/81	78.62	3.90	11.98	2.81	0.79
6-5/81	32.69	4.58	5.36	2.31	0.32
7-20/81	100.57	3.80	15.66	5.14	0.61
7-21/81	78.16	3.89	16.32	3.17	0.52
7-22/81	55.36	4.21	7.97	2.70	0.34
9-15/81	74.48	4.12	14.11	2.15	0.61
9-16/81	27.00	4.44	7.47	0.41	0.25
9-17/81	88.51	3.82	15.57	2.35	1.10
10-26/81	16.42	4.72	4.85	0.58	0.17
10-27/81	51.08	3.98	8.31	1.98	0.19
10-28/81	75.26	4.48	4.48	0.73	0.10
12-15/81	13.17	5.04	3.45	2.08	0.19
12-16/81	20.77	4.49	5.04	1.06	0.20
2-3/81	70.68	5.03	5.23	2.80	0.07
2-4/82	48.10	4.19	4.57	2.60	1.16

TABLE 3

Seasonal Means and Standard Deviation for the Five Parameters.

		Winter '80-'81	Spring '81	Summer '81	Fall '81	Winter '81-'82
Specific	X	33.80	46.33	58.28	47.76	41.10
Conductance	σ	18.65	35.02	25.59	22.27	23.88
pH	X	4.71	4.44	3.98	4.24	4.55
	σ	0.21	0.09	0.04	0.17	0.12
Phenolphthalein	X	6.77	8.27	9.92	8.84	6.44
Acidity	σ	2.28	3.71	3.82	3.50	2.98
Sulfates	X	3.11	4.79	2.77	1.71	2.03
	σ	2.39	4.70	1.49	0.93	1.11
Nitrate-Nitrogen	X	0.39	0.95	0.46	0.47	0.45
	σ	0.24	0.91	0.22	0.32	0.33

TABLE 4

Correlation Coefficients

	Specific Conductance	[H⁺]	Phenolphthalein Acidity	Sulfates	Nitrate-Nitrogen
Specific Conductance	1	0.577	0.627	0.616	0.637
[H⁺]	0.577	1	0.565	0.133	0.236
Phenolphthalein Acidity	0.627	0.565	1	0.249	0.305
Sulfates	0.616	0.133	0.249	1	0.812
Nitrate-Nitrogen	0.637	0.236	0.305	0.812	1

FIGURE 3. Seasonal means for specific conductance.

acidity of 179 microequivalents per liter as reported by Likens (10). The lower value obtained in this study would indicate lower atmospheric concentrations of acidic pollutants in Southeastern Monroe County. The annual mean nitrate-nitrogen of 0.54 ppm is equivalent to 38.6 microequivalents of nitric acid and its salts, whereas the annual mean sulfate value of 2.88 ppm is equivalent to 60.0 microequivalents of sulfuric acid and its salts. Likens (10) reported 39 microequivalents per liter for HNO_3 and 54 microequivalents per liter for H_2SO_4. Although these two values are for acids only, they are relatively close to the corresponding values of acids and their salts obtained in this study.

Daily means for all sampling sites for each precipitation event lasting for two or three days are given in Table 2. For the events of 2/11-12/81, 2/23-24/81, and 6/4-5/81, it was observed that on the second day of each of these events the pH increased, meaning the hydrogen ion concentration decreased and all other test values decreased substantially. These decreases, including that of hydrogen ion concentration, occurred because large fractions of atmospheric chemical substances responsible for high test values had been brought down during the first day of precipitation, thus leaving small fractions in the atmosphere to be brought down during the second and third day of precipitation. This "normal" trend was also observed for the events of 7/20-21-22/81 with a slight deviation in which the phenolphthalein acidity showed a small increase rather than a decrease on the second day of rain. For the events of 9/15/-16-17/81, this "normal" trend of decreased test values was observed for the second day, but on the third day the trend was reversed in which all the test values increased. This "reverse" trend was probably due to the increased atmospheric pollutants brought to the study area on the third day by the wind. For the event of 12/15-16/81, the "reverse" trend was observed with a slight deviation of the sulfate value. Other deviations from the "normal" or "reverse" trend could also be pointed out; these deviations were attributed to the concentration changes in the air pollutants generated by local power plants, industries, and automobile traffic or brought in from other areas by the wind.

The seasonal means for each test parameter were computed from the daily means of that parameter according to the following seasonal periods:

Winter '80-'81: February 1981 (no data were obtained for December '80 and January '81)

Spring '81: March-April-May

Summer '81: June-July-August

Fall '81: September-October-November

Winter '81-'82: December-January-February

In Table 3 these seasonal means are shown and these values are plotted in Figures 3 to 7 for the five parameters, respectively. In Figures 3 and 5, both specific conductance and phenolphthalein acidity values show progressive increases from Winter '80-'81 to Spring '81 and to Summer '81. These increases were then followed by two seasons of successive decreases. The peak values for these two parameters during Summer '81 corresponded to the seasons of high industrial activities and highway traffic. The seasonal changes in pH as shown in Figure 4 coincide very well with the changes in specific conductance and phenolphthalein acidity; as expected, the high pH corresponds to the low values of the other two parameters and the minimum pH corresponds to the highest specific conductance and phenolphthalein acidity. As shown in Figure 6 and 7 the sulfate and nitrate-nitrogen concentrations show a similar pattern of seasonal changes. Both rose sharply from Winter '80-'81 to a peak in Spring '81, followed by a sharp drop in Summer '81. For the sulfate, a further decrease from Summer '81 to Fall '81 was observed; this decrease was followed by a slight increase in the Winter. For the nitrate-nitrogen, the value stayed little changed from Summer '81 to Fall '81 and to Winter '81-'82.

A correlation analysis was performed on all the data obtained in this study, using the computer facilities at East Stroudsburg State College. For the purpose of this analysis all pH values were converted into [H⁺]. A perfect linear correlation is given a coefficient of +1, a perfect inverse linear correlation −1, and zero for no correlation. As shown in Table 4, all the correlation coefficients obtained are positive. Based on these values the following observations can be made:

1. Specific conductance correlates highly with other test parameters: 0.577 with [H⁺], 0.627 with phenolphthalein acidity, 0.616 with sulfates and 0.637 with nitrate-nitrogen.

FIGURE 4. Seasonal means for pH.

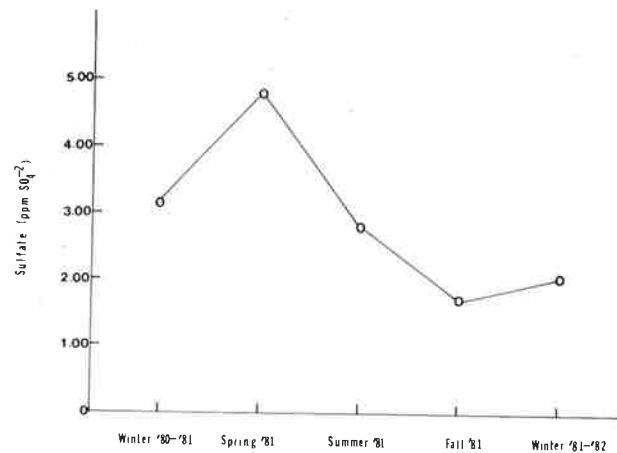FIGURE 5. Seasonal means for phenolphthalein acidity.

FIGURE 6. Seasonal means for sulfate concentration.
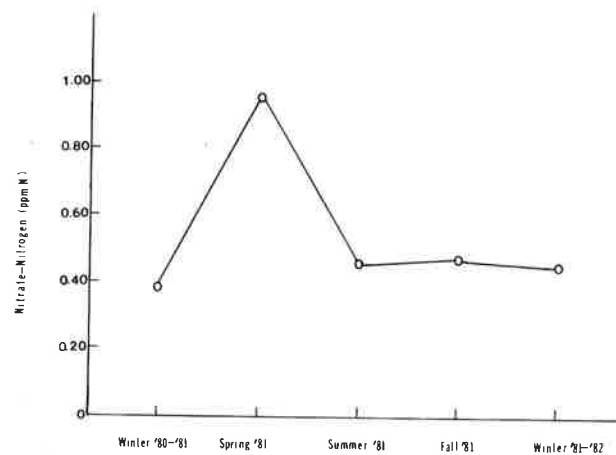

FIGURE 7. Seasonal means for nitrate-nitrogen concentration.

2. Although the correlation between phenolphthalein acidity and [H⁺] is relatively high with a coefficient of 0.565, the values for sulfates and nitrate-nitrogen respectively with [H⁺] are quite low, namely 0.133 and 0.236. These low values could mean that the contributions to [H⁺] by the sulfates and nitrates in the form of H_2SO_4 and HNO_3 are not high.

3. When the two sets of coefficients for sulfate and nitrate-nitrogen respectively with phenolphthalein acidity (0.249 and 0.305) and respectively with [H⁺] (0.133 and 0.236) are compared, the set with phenolphthalein acidity is higher than the set with [H⁺]. This could mean that both sulfates and nitrates contribute more to the phenolphthalein acidity than to [H⁺]; perhaps some of the sulfates and nitrates are present as $(NH_4)_2SO_4$ and NH_4NO_3 and these salts being weak acids contribute to the phenolphthalein acidity. Furthermore it could mean that weak acids other than those derived from sulfates and nitrates are also contributing to the phenolphthalein acidity.

4. When the two sets of coefficients for nitrate-nitrogen and sulfate with [H⁺] and phenolphthalein acidity (namely, 0.236 for NO_3^--N and 0.133 for SO_4^{2-}, respectively with [H⁺], and 0.305 for NO_3^--N and 0.249 for SO_4^{2-}, respectively with phenolphthalein acidity) are compared, the nitrate-nitrogen values are higher than the sulfate values. Although both sulfates and nitrates could be emitted into the atmosphere by the combustion of fossil fuels in power plants and automobiles, such combustion in automobiles yields less sulfate than in coal- or oil-fired power plants. As the study area bears heavy traffic of Interstates 80 and 380, the auto emission probably plays a significant role in increasing the NO_3^--N.

5. The relatively high coefficient of 0.812 between the sulfates and nitrate-nitrogen suggests that these two chemical species occur simultaneously in the atmosphere; it may further suggest that these two pollutants originate from the combustion of fossil fuels.

Fluctuations in experimental data for each of the test parameters among sampling locations do exist, but for this study data from all sites and locations were analyzed collectively. Also, this study did not cover a sufficient time period for establishing the year-to-year trend in the chemical nature of precipitation. Thus, in the study to follow such trends will be investigated as well as site and locational fluctuations.

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GROWTH AND REPRODUCTION OF THE SATINFIN SHINER, NOTROPIS ANALOSTANUS, CODORUS CREEK, PENNSYLVANIA[1]

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ABSTRACT

Over 1014 satinfin shiner, *Notropis analostanus,* were used to study sex-ratio, condition factor, ovary and ova development, fecundity, tuberculation, coloration and age and growth of this species in Codorus Creek, Pennsylvania.

Satinfin shiner appeared to have a normal life span of three years (II⁺) with a few reaching III⁺. Annulus formation for most occurred in June. Mean fork length for the I⁺ age group was 58.6 mm, II⁺ 67.0, and III⁺ 84.0. Length frequency distributions by sex were not significantly different for I⁺ and II⁺ age groups, indicating similar growth rates within each sex. Tuberculation in females and yellow coloration in males were recorded for the first time.

Significantly fewer males occurred in the 51-70 mm size group in spring (ratio 1:2) and in all specimens combined for 1976 (ratio 1:1.4). Condition factors for females were generally higher and decreased after spawning. The II⁺ age group (both sexes) had higher condition factors in May and June, the 51-70 mm size group higher than other size groups.

Ovary development, based on mean gonosomatic indices, and the mean ova diameter were maximum in June. Maximum tuberculation in males and females recorded in June, and "running-ripe" females colleted 26 June and 3 July, indicated peak spawning in the last week of June and first week of July. Coloration on males and females and length frequency distributions suggested a spawning season that begins prior to this and may extend through July. Ova counts from right and left ovaries were not significantly different and mean potential fecundity for 1976 was 1506 eggs (residual 629, actual 877).

INTRODUCTION

Notropis analostanus, the satinfin shiner, is found in southern tributaries of Lake Ontario, and Atlantic drainages from the Hudson River system southward to Cape Fear River in North Carolina (Blair et al. 1968). In Pennsylvania it occurs in the Delaware, Susquehanna and Potomac drainages, being locally common but often misidentified as the spotfin shiner, *Notropis spilopterus.* A member of the family Cyprinidae, *N. analostanus* is distinguishable from *N. spilopterus* by the following combination of characters: usually 9 anal rays versus 8 in *N. spilopterus,* 34-36 lateral line scales versus 36-38, more pigment in anterior dorsal membranes and on the lower half of the body, a deeper caudal peduncle, and frequently melanophores on the basal half of the anal rays versus none in *N. spilopterus.*

Aspects of the life history of *N. analostanus* have been studied by Conover (1972), Gale and Buynak (1978), and Stone (1940). However, available information is scant and no published studies on the general life history exist.

The purpose of this paper is to provide life history data on *N. analostanus;* specifically sex-ratio, condition factor, ovary and ova development, fecundity, tuberculation, coloration, and age and growth.

METHODS

Satinfin shiner were collected from the West Branch Codorus Creek at Spring Grove, York County, Pennsylvania using a 1.3 m by 3.3 m x 6.3 mm mesh seine. Collection occurred once in May and August 1975, weekly from May through August 1976, and then monthly through December 1976. Breeding coloration from live specimens, ripeness, associated species and water temperatures were noted in the field.

Laboratory processing began by measuring fork and standard lengths to the nearest mm, weighing to the nearest 0.1 gm, and sexing by internal examination of gonads. Sex-ratios were determined and chi-square used to test significant difference (p ≥ 0.05). Condition factor was calculated using $K = W \times 10^5/(SL)^3$ from Hoyt (1971), where K is the condition value, W the weight of each specimen in gm, and SL the standard length in mm. Length frequencies and scale examination were used to determine age and growth. Scales were removed from the caudal peduncle region, mounted between glass slides, examined with the aid of a bioscope, and aged by both authors.

Ovaries were removed from 89 females (41 to 80 mm FL) and weighted. Two gonadosomal indices were calculated: (1) as in Mathur and Ramsey (1974), GSI ± ovary weight/(body weight -ovary weight) x 100; and similar to Hoyt (1971), ovary weight/body weight x 100. Ova were individually counted for each of 10 females collected in May and August 1975 and 20 females collected in May and early September 1976. After noting the number of size groups, a mean ova diameter was determined for May and August 1975; and May, June, late July, and early September 1976. Random groups of ova were aligned and the number included in one millimeter counted. This was done twice for each ovary in 5 fish from each time period noted above.

A tuberculation index was determined for 270 males and 36 females by ranking each in one of the following stages: 1-a few
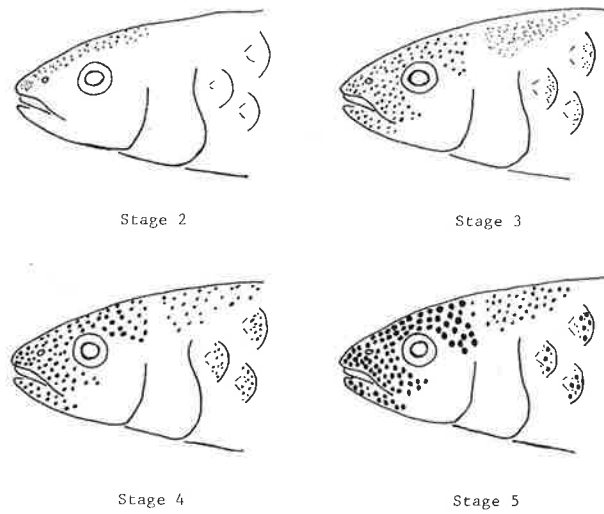
FIGURE 1. Illustrations of tubercle distribution on the head of the satinfin shiner from Codorus Creek, 1976. Stages (description in text) were used for tuberculation index; stage 1 applied to individuals having a few small tubercles on the head and is not diagrammed.
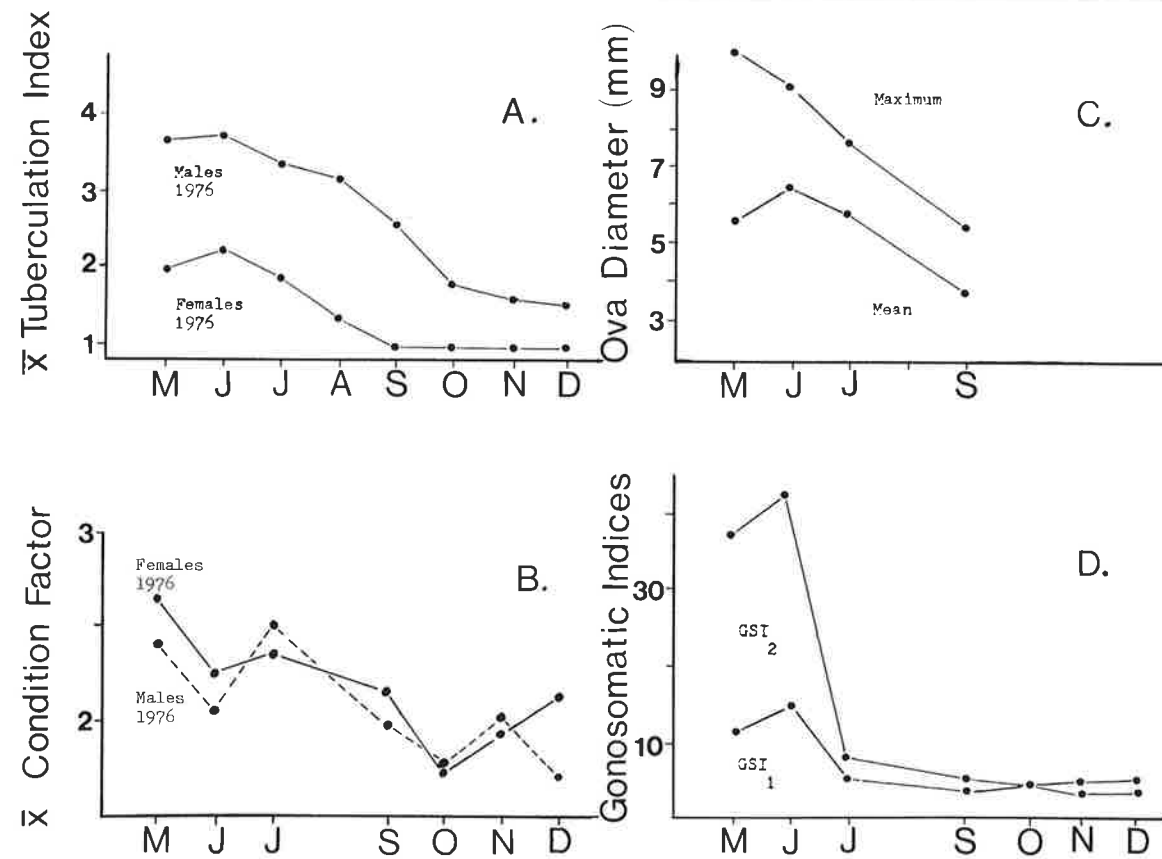
TABLE 1

Chi-square tests on sex ratio by size group of satinfin shiner collected in Spring (18 May - 21 June) and summer (26 June - 3 September) 1976 from Codorus Creek. (* means significant at p ≥ .05).

Size Group		Number	Percent of of Total	Mean Fork Fork Length	Chi-Square
0-30	Summer	4 males	50	29.0	
		4 females	50	28.0	—
31-50	Spring	8 males	38	43.9	
		13 females	62	47.0	1.19
	Summer	79 males	51	40.9	
		76 females	50	41.1	0.06
51-70	Spring	61 males	33	62.0	
		122 females	67	63.6	20.33*
	Summer	45 males	45	56.3	
		56 females	55	62.4	1.20
71-90	Spring	12 males	46	82.7	
		14 females	54	72.9	0.15
	Summer	0 males	—	—	
		5 females	100	72.4	—
Total All Groups		209 males	42	—	—
		290 females	58	—	13.69*

FIGURE 2. Seasonal variation in mean tuberculation index (A), condition factor (B), ova diameter (C), and gonosomatic index 1 and 2 (D) for the satinfin shiner from Codorus Creek, 1976.

small tubercles present on head; 2-small tubercles present on occiput, dorsal-lateral aspect of head and on snout; 3-small tubercles as in 2, plus presence on mandible, above eye, on cheek, and on scales of upper half of body; 4-tubercles enlarged on snout, occiput, above eye, and on mandible with smaller and increased number on scales of the upper half of the body; 5-maximum tuberculation in size and extent over head region, and in extent on body and fins (Figure 1). Mean values were then determined for each sex and time period.

RESULTS AND DISCUSSION

Sex Ratio

Most specimens were easily sexed (internally or externally) from 18 May to 21 August. However, from 3 September the II[+] age group was not collected and the I[+] age group was difficult to sex with certainty. Females predominated in collections taken in May through August. The 51-70 mm size group (122 females out of 183) in the spring and all size groups combined (290 females out of 499) varied significantly (chi-square, p ≥ 0.05) from a 50:50 ratio (Table 1).

Condition Factor

Mean condition factors by month (based on 624 specimens) ranged from 1.73 in December to 2.62 in July for males and 1.86 in October to 2.65 in May for females (Figure 2B). They were also examined by size group (31-50, 51-70, and 71-90 mm FL) and age group (I[+], II[+]). Generally, the average values for females were greater than males, being highest from May to July (2.12 to 2.66) and lowest from September to December (2.00 to 2.22). Male values were 1.59 to 2.66 and 1.72 to 2.31, respectively. The increase for both male and female values in June to July may hve been related to increased food and/or development of gonads for repeat spawning. This sexual difference was true for both the I[+] and II[+] age groups in May and June. The II[+] males and females had slightly higher conditon factors in May and June, while the I[+] males and females were higher than the II[+] in July. The 51-70 mm FL size group tended to have higher values than either the 31-50 or the 71-90 mm size groups in spring and in summer. Condition factors generally decreased after July.

Ovary and Ova Development

Ovary development was estimated by calculation of two slightly different gonosomatic indices on 123 adult females, 51-70 mm FL. The second index appeared to more sharply depict change (Figure 2D). Ovary weights were highest in June and decreased to one-fourth this weight by 31 July, stongly suggesting a cessation of spawning. Ovaries contained four distinct sizes of ova which were measured monthly to obtain an estimated mean size (Table 2). The largest "grand" mean diameter, .065 mm, was measured 26 June, while the individual size group means were .091, .053, .036, and .027 mm in diameter. Ova from "running ripe" females in late June and early July were light orange with a tinge of pink. In subsequent collections ova "forced" from females were yellowish-orange and eventually pale yellow. By September no ova could be "forced" from females and ovary examination of three females revealed a mean ova diameter of .038 mm, approximately one-half the highest mean of .065. The four sizes of ova had decreased to three on 31 July and the diameter of the largest ova from 0.1 to .077 mm (Figure 2C). These decreases and the gonosomatic indices which were low from late July through December also indicated most spawning had ended by August or shortly thereafter.

Fecundity

The mean potential fecundity (total number of eggs within the ovaries) of the satinfin shiner based on 20 females taken 28 May 1976 was 1506, and based on 10 females from May 1975 was 1781. This gave a weighted mean of 1598 for the two years (Table 2).

TABLE 2

Number of ova, ova diameter (10⁻³mm), and ova size groups for the satinfin shiner (≥ 51 mm FL) collected 1975 and 1976 from Codorus Creek.

1976:	N	Number of Size Groups	Maximum Diameter	Mean Diameter
28 May	5	4	10.00	5.56
26 June	5	4	9.09	6.51
31 July	5	3	7.69	5.75
3 Sept	3	3	5.56	3.82
Oct-Dec	undeveloped			

		Number of Ova				
		Right Ovary		Left Ovary		Combined
	N	Range	x	Range	x	Range	x
May 1975	10	290-1624	917	320-1720	863	610-3344	1781
May 1976	20	180-1260	748	365-1328	758	545-2588	1506

The difference between the right and left ovary counts in May for 1975 and for 1976 was not significant (chi-square, p ≥ .05). "Running-ripe" females were collected 26 June and 3 July. As stated above, the four sizes of ova observed in May and June decreased to three in late July; and maximum ova size, recorded in late May to late June, had decreased considerably in late July. Spawning was assumed to have occurred, and we estimated a mean residual fecundity (number of ova remaining for subsequent spawning) of 629 for 12 females taken 31 July. Thus the actual fecundity prior to this date was estimated at 877. Gale and Buynak (1978) described repeated spawning of 6 to 634 eggs per session from June through August and Stone (1940) also suggested a lower fecundity (409-864). Our higher estimates of fecundity, based upon actual egg counts in the ovaries might well have been realized over an extended season of repeat spawnings. The "potential" suggested by our study would represent a recuitment buffer for the species and would only be realized by successful repeated spawning.

Although spawning was not observed, gonosomatic indices, tuberculation, and ripeness placed peak spawning from late June to early July. However, ova diameter and length frequencies (Figure 3) suggested it may extend over several weeks from June through at least July as concluded in Conover (1972) and observed by Gale and Buynak (1978). Our estimated actual fecundity for 1976 was therefore 877 with a potential fecundity of 1506.

Tuberculation

Examination of specimens revealed that both male and female adult satinfin shiner possessed tubercles. Tuberculation was more extensive and color (discussed below) more intense on males with considerably higher levels maintained May through August. Tuberculation has been reported for males (Gibbs 1963), but not for females. We found tubercles on the largest females in each collection from May through December. They were commonly located on the occiput and dorsal aspect of the snout. Maximum tuberculation on females was observed in late June and early July when small tubercles were also found on the mandible, above the eye, on the cheeks, and on some scales of the upper half of the body. Maximum tuberculation on males was observed also in late June, but extended through early August. Males had large tubercles over the head regions (Figure 1) and small tubercles on scales of the upper half of the body and ventral fins, much as
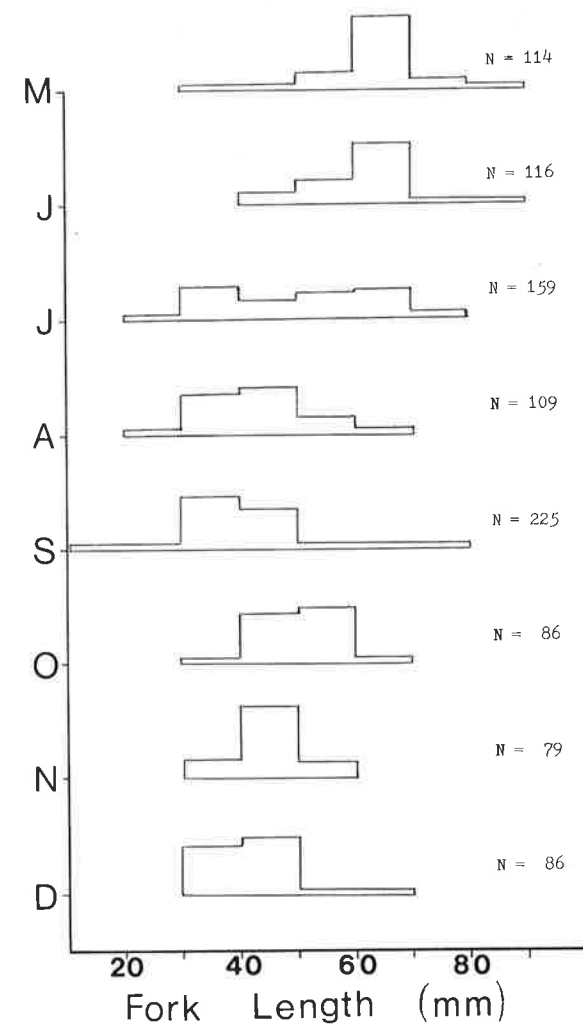
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MICROFOSSILS IN SEDIMENTS FROM THE WYMPS GAP LIMESTONE (UPPER MISSISSIPPIAN) IN SOUTHWESTERN PENNSYLVANIA[1]

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ABSTRACT

Sediments were collected from the Wymps Gap Limestone in
southwestern Pennsylvania, which is correlated with the Green-
brier Series of West Virginia. The massive limestone with calcar-
eous shale interbeds is part of the Mauch Chunk Formation. The
sediments were wet sieved using three standard-sized sieves (425,
850, 2000 microns). Taxonomic study relied on microscopic anal-
ysis of the external morphology. The diverse microfauna included
foraminifera (*Endothyra*), bryozoans (*Fenestella, Polypora,
Protoretepora, Penniretepora, Septopora, Rhombopora,
Tabulipora, Diplostenopora*), pelecypods, ostracods, brachio-
pods, crinoids and a blastoid (*Pentremites*). Inferred paleoen-
vironments indicate normal marine environments with proximity
to an ancient shoreline. The environments may reflect the
changes the site underwent during the transgression and regres-
sion of the Mississippian sea on to the platform.

INTRODUCTION

This study involved the collection and examination of micro-
fossils from the Wymps Gap Limestone in southwestern Pennsyl-
vania. The limestone is in the lower Mauch Chunk Formation
(Upper Mississippian) and was formerly called the Greenbrier
Limestone of Pennsylvania (Flint, 1965). It was assigned a late
Meramecian - early Chesterian age and correlated with the upper
part of the Union Limestone (Greenbrier Series) of West Virginia,
the Maxwell Formation of Ohio, and the lower part of the Mauch
Chunk shale of northwestern Pennsylvania (Haney, 1963).
Busanus (1974) suggests that the Wymps Gap and the Union
Limestone in northern West Virginia are equivalent. The Wymps
Gap Limestone is a thin tongue extending from the larger Green-
brier Group (Formation) in West Virginia (Arkle, *et al*, 1979). It is
a dark, blue-gray, massive bedded limestone with several thinner
layers of limestone and interbedded calcareous shales above and
below it.

Studies of the macrofauna in the Wymps Gap Limestone have
revealed a dominant brachiopod and crinoid fauna (Benson,
1934, Haney, 1963). A very diverse assemblage was identified in
the Mauch Chunk in northwestern West Virginia by Busanus
(1974) which included foraminifera, bryozoans, brachiopods,
scaphopods, gastropods, pelecypods, cephalopods, ostracods,
trilobites, crinoids, echinoids, chondrichthyans, osteichthyans,
and amphibians. Horowitz and Rexroad (1972) in their study of
conodonts in Mississippian biostratigraphy identified a rich
conodont fauna in the Wymps Gap Limestone.

Faunal studies of upper Mississippian strata (Chester) in states
other than Pennsylvania, such as the Glen Dean in Indiana (Ut-
gaard and Perry, 1960, Perry and Horowitz, 1963), revealed
bryozoans similar to those identified in this study of the Wymps
Gap Limestone. The Glen Dean Limestone contains a rich brach-
iopod, blastoid, and crinoid fauna with corals, conulariids, trilo-
bites, gastropods, and pelecypods. The microfauna of the Glen
Dean contained ostracods and foraminifera (Coryell and Rozan-
ski, 1942).

METHODS

The outcrop from which the specimens were collected is lo-
cated at the J.V. Thompson Quarry which is about seven miles
east of Uniontown, Pennsylvania and one mile west of Chalk
Hill, Pennsylvania on U.S. Route 40. The site is north of the
highway and can be seen from the road as highway crews have
cleared the entrance to the quarry in order to store road materials
and equipment (Figure 1).

Sediments were collected from the float at the base of the out-
crop at two sites. The site in the northeastern corner is where the
Wymps Gap Limestone is about 25 feet thick, and the site in the
southwestern corner the rock outcrop is about 10 feet thick. The
sediments were wet sieved to reduce the bulk mass into a number
of particle sizes, and to free the shale and limestone fragments of
encrusting detritus. Three standard-sized sieves were utilized (#40
- 425 microns, #20 - 850 microns, #10 - 2000 microns). Specimens
were extracted from small samples of the bulk collection using
microscopic analysis. Many technical difficulties were encoun-
tered because of the small sizes and delicate character of the
forms. Measurements of external morphological features were
made to assist in the taxonomic treatment of the fossils. Most
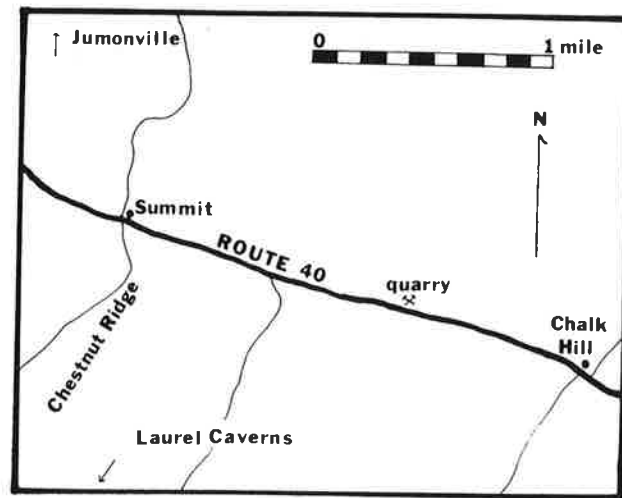specimens were weathered and fragmented. Many of the fossils

FIGURE 1. Location Map of the Thompson Quarry Outcrop of the Wymps Gap Limestone on U.S. Route 40 near Chalk Hill, Pennsylvania.

were identified to genus level and a few have been tentatively identified to species level. In several cases only one specimen of the genus was found. Photomicrographs were made for all forms identified (Figure 2). Where possible, bryozoans were photographed in frontal (obverse) and in back (reverse) views.

RESULTS

One specimen from the Protist Kingdom was identified. Systematic and morphologic descriptions follow.

PHYLUM PROTOZOA von Siebold, 1845
CLASS RETICULARIA Lankester, 1885
Order Foraminiferida Eichwald, 1830
Family Endothyridae Brady, 1884
Genus Endothyra Phillips, 1846

The morphology of the test was the basis for the identification of *Endothyra*. It has distinctive planispiral, evolute coiling to its multilocular test. Septa were evident. Because the specimen was embedded in a fragment of limestone, measurements were difficult to make. The diameter of the test is about 0.6 mm. The length of the last globular chamber is about 0.1 mm (Figure 2K).

Two fusiform fragments were collected. Several faint furrows are evident on one of the specimens. Axis - equator measurements were 1.3 mm - 0.6 mm and 2.4 mm - 1.2 mm. The origin of these fragments was not determined, but they may be weathered parts of echinoderms (Figure 2N).

PHYLUM ARTHROPODA Siebolt and Stanius, 1845
CLASS OSTRACODA Latreille, 1806

The weathered specimens were found with variations such as sulci, nodes and overlapping right valves. Vertical - horizontal axes measurements were 0.7 mm - 1.0 mm, 0.45 mm - 0.8 mm, 0.5 mm - 0.9 mm, and 0.45 mm - 0.75 m m. One of the ostracods may be *Geffenina* sp. Coryell and Sohn (Figure 2J), and another *Sargentina* sp. Coryell and Johnson because of the overlapping right valve and a sulcus in the dorsal half.

The systematics for the bryozoans employ Cuffey's (1973) revised classification.

PHYLUM BRYOZOA Ehrenberg, 1831
CLASS STENOLAEMATA Borg, 1926
Order Cryptostomida Vine, 1883

Family Fenestellidae King, 1850
Genus Fenestella Lonsdale, 1839

The zoarium of the specimen is fenestrate and delicate. Zooecia are in two rows on a branch, with 23-25 circular apertures in 5 mm longitudinally, and two apertures per fenestrule. There are no apertures on the dissepiments (crossbars). Along each branch is a row of straight nodes with 25-28 nodes in 5 mm. There are 30-38 branches in 10 mm with a mean branch width of 0.18 mm. Fenestrules are square to rectangular, from 0.2 mm to 0.35 mm in length and 0.2 mm to 0.25 mm in width. The reverse side is striated (Figure 2A).

Family Polyporidae Vine, 1893
Genus Polypora McCoy, 1844

The zoaria are fenestrate and robust. Zooecia are in four rows on a branch with 21-27 circular apertures in 5 mm longitudinally. Peristomes were evident on the apertures. The dissepiments are thinner than the branches and have no apertures. The branches have carinas between the rows of zooecia. Branches have a mean width of 0.55 mm and there are 13-15 branches in 10 mm. The ovate fenestrules are 0.25 mm - 0.3 mm wide and 0.6 mm - 0.65 mm long with 12-13 fenestrules in 10 mm longitudinally. A striated reverse side was observed (Figure 2G).

Tentatively, these specimens could be assigned to *Polypora cf. nodolinearis* McFarlan, 1942 (McFarlan, 1942). Due to weathering, only one of the four specimens had more than one fenestrule.

Genus Protoretepora DeKoninck, 1876

A slightly undulating, robust, fenestrate zoarium was observed on a single specimen found. Zooecia are in three rows per branch with 21-23 apertures in 5 mm longitudinally. Peristomes were observed around the circular apertures. Wavy carinas separate the rows of apertures. Apertures occur on the short dissepiments. Branches are about 0.3 mm in width with 20-24 branches in 10 mm. Fenestrule shape is elliptical, 0.3 mm wide by 0.65 mm long. There are 10-12 fenestrules in 10 mm. The reverse side is strongly striated. The specimen contained only one complete fenestrule and parts of two adjacent fenestrules. Because of the small fragment of the zoarium and the undulating nature of the form it may only appear that there are apertures on the dissepiments. It may be that this specimen is *Polypora. Protoretepora* is distinguished from *Polypora* by having apertures on the dissepiments (Figure 2D).

Family Septoporidae Morozova, 1962
Genus Septopora Prout, 1859

Zoarium is fenestrate with two rows of zooecia on the branches and on the dissepiments. Dissepiments are pinna-like branches that connect the primary branches, and are not the same as the fenestellid dissepiments. The rows of zooecia are separated by a low carina. There are 16-19 apertures in 5 mm longitudinally. Branches are 0.3 mm - 0.4 mm in width with 18-20 branches in 10 mm. One small specimen was collected, (Figure 2F).

Family Acanthocladiidae Zittel, 1880
Genus Penniretepora d'Orbigny, 1849

The single zoarium collected is pinnate, delicate, unbranched and 1.5 mm in length. The stem is 0.5 mm and the pinnae are 0.3 mm in width. The pinnae are opposite and extend from the stem about 0.3 mm in length at angles between 45° and 60° with stem edge (Figure 2H). Zooecia are in two rows separated by a carina on the stem and the pinnae. There are 19-21 zooecial apertures on the stem in 5 mm longitudinally. The stem is granular in texture on the reverse side (Figure 2I).

Family Rhabdomesidae Vine, 1883
Genus Rhombopora Meek, 1872

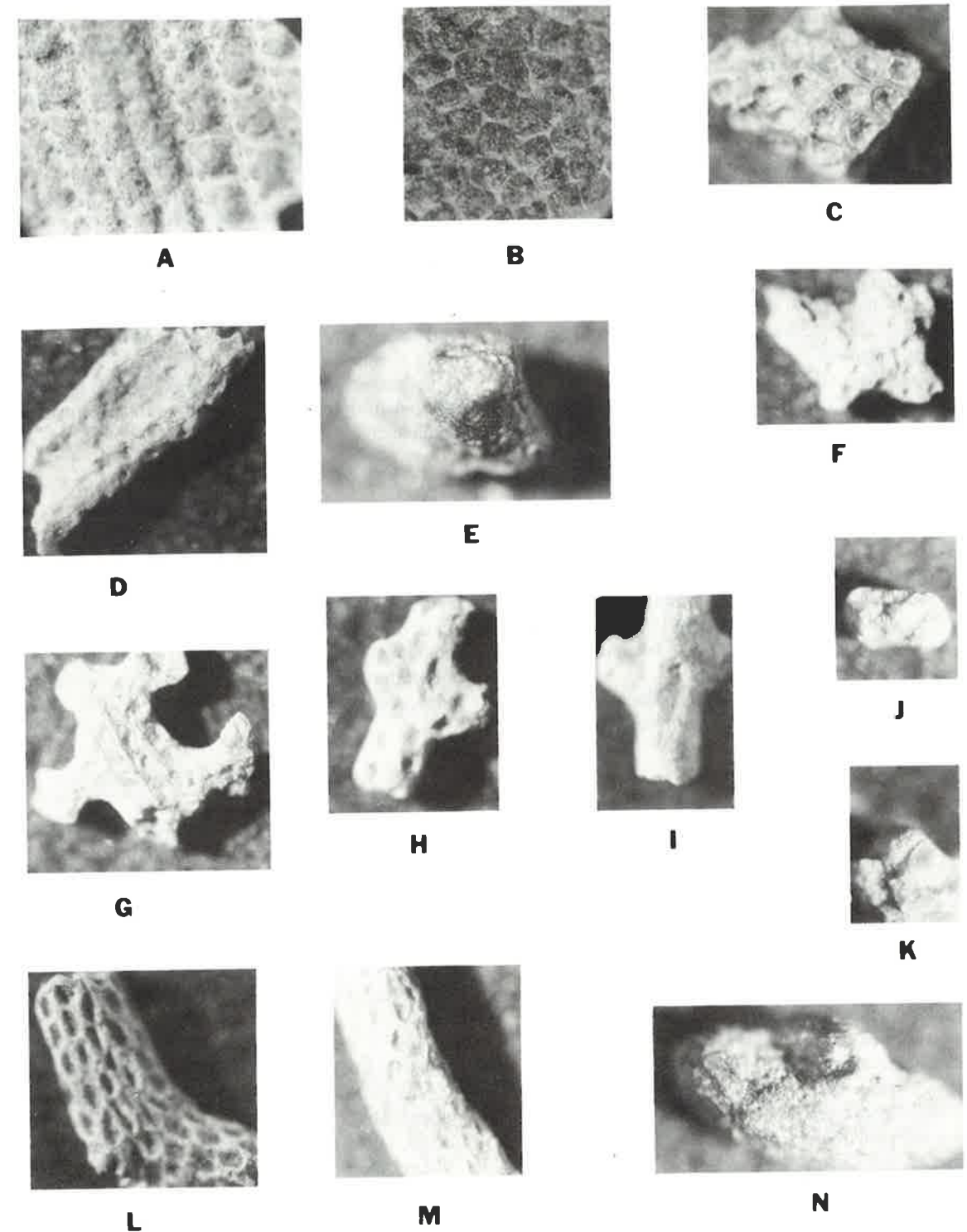Zooecia extend from the axis on all sides of these ramose, cylin-

FIGURE 2. (A) *Fenestella* sp., (B) *Tabulipora* cf. *ramosa* Ulrich, (C) *Diplostenopora*? sp., (D) *Protoretepora* sp., (E) bivalve, (F) *Septopora* sp., (G) *Polypora* cf. *nodolinearis* McFarlan, (H) *Penniretepora* sp. frontal, (I) *Penniretepora* sp. reverse, (J) *Geffenina*? sp. (K) *Endothyra* sp., (L) *Rhombopora* sp. (M) *Rhombopora* sp., (N) fusiform fragment. All specimens X 22.

drical bryozoans. Apertures were oval and located in a vestibule with 12-22 in 5 mm longitudinally. The rows of apertures are arranged obliquely in intersecting patterns that produce a rhombic shape. Small acanthopores were evident. Branches ranged from 0.4 mm to 0.6 mm in diameter. Many fragments of *Rhombopora* were collected (Figure 2L). Two specimens were flatter than the typically cylindrical forms. One weathered specimen had the ap-

pearance of *Rhombopora* on one side but did not have apertures on the other side much like *Rhombocladia*. Most likely more than one species of *Rhombopora* is present in the collection (Figure 2M).

Order Trepostomata Ulrich, 1882
Family Stenoporidae Waagen and Wentzel, 1886
Genus Tabulipora Young, 1883

The only specimen collected measured 2 mm by 3.5 mm and had a laminar zoarium. Weathering of the surface provided a tangential view of the zooecial apertures. Interzooecial walls were thin. The subpolygonal apertures were about 0.2 mm across and acanthopores were evident at many of the zooecial corners. In longitudinal view the long zooecial tubes were visible with diaphragms extending transversely. Tentatively, this specimen could be assigned to *Tabulipora cf. ramosa* Ulrich (Figure 2B).

Genus Diplostenopora Ulrich and Bassler, 1912

The specimen collected measured 1.1 mm by 1.7 mm and is a bifoliate zoarium. The zooecial apertures are polygonal to subpolygonal and about 0.2 mm across. The interzooecial walls are moderately thick with a central divisional line between adjacent zooecia. Tentatively, this specimen has been assigned to *Diplostenopora cf. sp.* (Figure 2C).

PHYLUM MOLLUSCA Linnaeus, 1758
CLASS BIVALVIA Linnaeus, 1758

Four pelecypod specimens with closely spaced, concentric growth lines about the umbo were collected. These specimens had strong beaks on the valves which were equivalve and inequilateral. The shells were 1.1 mm - 1.9 mm in height, 1.7 mm - 2.6 mm in length, and 0.5 mm - 0.7 mm in thickness (Figure 2E).

PHYLUM ECHINODERMATA Klein, 1734
CLASS CRINOIDEA Miller, 1821

Specimens were limited to circular and pentagonal columnals and pleuricolumnals. They were abundant. In 45.5 grams of hash there was 0.59 grams of crinoid fragments. A few nodal columnals with cirri sockets were observed.

Macrofossils which were collected from the sediments included brachiopods (*Composita* sp.), blastoid (*Pentremites* sp.) and a bryozoan (*Batostomella* sp.).

DISCUSSION

Because these fossils were collected from sediments in the float it would be inappropriate to discuss the paleoenvironment in a narrow sense. It is obvious that the assemblage collected indicates that a marine body covered southwestern Pennsylvania during a part of the Mississippian Period. Busanus (1974) feels that any interpretation of the organic remains must be taphonomic rather than paleoecological in nature.

Bryozoans, crinoids, and brachiopods appear to dominate the fauna collected at the outcrop. McKinney and Gault (1980) found that *Fenestella, Septopora,* and *Polypora* existed in a variety of environments with moderate to low energy conditions. *Penniretepora* appears to have lived predominantly in quieter marine waters. Simonsen and Cuffey (1980) found considerable variations in paleoenvironmental conditions that fenestrate and pinnate bryozoans could tolerate. These bryozoans appear to have preferred mixed clay and carbonate bottoms that were under deeper, though still shallow, quieter and normal marine conditions offshore. Some bryozoans appear to have trapped sediments on chalky mounds. *Fenestella, Protoretepora, Septopora, Penniretepora, Rhombopora,* and rarely *Tabulipora* were found to have grown out across muddy bottoms and helped to stabilize them. Crinoids and brachiopods have been found in close association with bryozoans on the sea floor. Paleozoic brachiopods lived in shallow waters and up to depths of 200 meters. They appear to have thrived in warm, clear to intermittently turbid marine settings with some water movement to provide a food supply. Williams (1957) felt that a prolific fauna is indicative of optimum conditions, a warm, shallow, normal marine environment. Ostracods are found in Paleozoic rocks of freshwater, brackish, and marine conditions. Their extremely small size and low specific gravity allowed them to be transported by water movements to different sites including those unsuitable for growth. Busanus (1974) believes that the variety of forms of *Endothyra* found in his study was indicative of proximity to a shoreline that was influenced by the influx of silt and clay particles. McKinney and Gault (1980) describe the area of this study as being a narrow embayment which was part of the extensive shallow carbonate platform along the western side of the Appalachians.

The fauna collected may not have inhabited the Mississippian sea concurrently. There were varied environments during the time of the Wymps Gap Limestone's formation due to closeness to the shoreline and the transgression and regression of the sea. Shallow, relatively clear, warm, normal marine environments predominated.

ACKNOWLEDGEMENTS

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IMPLEMENTATION OF THE E.P.A. AIR QUALITY INDEX IN THE WILKES-BARRE/SCRANTON AIR BASIN PART II — FORECASTING[1]

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ABSTRACT

One year of daily air quality index values (predicted and observed) of the Wilkes-Barre/Scranton air basin were investigated. The skill of the forecasts, was found to be low (28% accuracy). Index data and local weather data were statistically analyzed and a new forecasting scheme developed. This scheme is based upon routine observations at a single N.W.S. observing station (which does not have radiosonde capabilities) and utilizes data which is of the type which is readily available to the public. Forecast skill was again evaluated and an improvement noted (65% accuracy).

INTRODUCTION

During the spring of 1977 the Northeastern Pennsylvania Environmental Council in cooperation with the Pennsylvania Department of Environmental Resources began issuing a daily index and forecast of local air pollution conditions to the citizens of northeastern Pennsylvania. This index was computed according to the E.P.A. Pollution Standards Index guidelines (except for the addition of an extra descriptive category)* (1).

Berryman (2) evaluated the air quality index (A.Q.I.) portion of the first year of data from that program. He found an average A.Q.I of 63 (highest value: 161, lowest value: 25) and a two-season air pollution year (cool season: November through February, warm season: March through October). The cool season had an average A.Q.I. of 59, a standard deviation of ± 14, and T.S.P. as the major pollutant. The warm season had an average A.Q.I. of 66, a standard deviation of ± 25, and ozone as the major pollutant.

The present paper studies the forecast portion of the same data set. The operational forecasting scheme in use employed an empirical technique. The (local) predicted A.Q.I. was equal to a factor times the (local) observed A.Q.I. This factor is developed each morning at D.E.R. from their ventilation index** and constrained to vary only between 0.5 and 1.5. The same factor is applied statewide. The forecast was calculated and issued at mid-morning based upon the previous 24-hour (ending at 8:00 a.m.) air pollution data and was valid for the subsequent 24-hour period (ending at 8:00 a.m. the next morning).

RESULTS

The accuracy of the A.Q.I. forecast was tested by several criteria (Table 1) and found to be low. About one-quarter of the forecasts were within 5 A.Q.I. units of the observed value. The tendency of the daily change was forecast correctly in about one-third of the cases, the pollution category was forecast correctly in slightly less than half of the cases.

In addition, it was found that there was a range of error (predicted minus observed A.Q.I.) of − 84 to + 75, a tendency to underforecast (approximately two-thirds of the forecasts were for levels below those observed, producing an average error of − 10), a tendency to forecast persistence (approximately two-thirds of the forecasted A.Q.I.'s were within ± 10% of the "present" A.Q.I. whereas only about 25% of successive A.Q.I.'s were within ± 10% of each other), and a tendency for cool season forecasts to be better than warm season forecasts (for example, the "category forecast" accuracy in Table 1 (44%) represents the average of a 55% cool season accuracy and a 23% warm season accuracy).

In view of the above results, N.E.P.E.C. asked the author to investigate the possibility of developing a new forecasting scheme. The following constraints were placed upon the author by the agency: the scheme was to be based upon data available to the public through the N.O.A.A. weather radio system, able to be implemented with a few minutes work by clerical staff

TABLE 1

Evaluation of Operational Air Quality Index Forecasting Scheme

Criteria	percent correct forecasts (N = 175)
A.Q.I.$_{forecast}$ minus A.Q.I.$_{observed}$ ≤ |5|	24%
sign of A.Q.I. change forecast correctly	31%
category of A.Q.I. forecast correctly	44%

*Basically, this index expresses the observed concentration of each major air pollutant as a percentage of its national primary standard and then classifies the air according to the highest value (good: 0-50, moderate: 51-75, unsatisfactory: 76-100, unhealthful: 101 and above).
**The ventilation index is based on the Philadelphia N.W.S. air stagnation index which is derived from the New York City and Washington, D.C. morning soundings.

TABLE 2

Contingency Table Forecasting Scheme

A. Warm Season

temp (°F)	wind speed (mph)		
	≤ 5.9	6 - 8	≥8.1
≤ 49	B		A
50 - 65	B		A
≥ 66	C	C	C

B. Cool Season

temp (°F)	wind speed (mph)		
	≤7.9	8 - 12	≥12.1
≤ 19	C		A
20 - 30	C		A
≥ 31	C		B

C. Forecast Statements

A	If A.Q.I. low, it will remain low; if A.Q.I. moderate or high, it will decrease (a change of > − 10%)
B	A.Q.I. value will not change significantly (≤ ± 10%)
C	If A.Q.I. high, it will remain high; if A.Q.I. moderate or low, it will increase (a change of > + 10%)

lacking meteorological and statistical training, and available by 11:00 a.m.

The final forecasting scheme developed consisted of 3 x 3 contingency tables of daily temperature and wind speed data (Table 2). For each of the two local air pollution seasons the observed daily average temperatures and wind speeds were broken into three classes of approximate equal frequency of occurrence. Using the available one year of daily A.Q.I. data, average A.Q.I.'s were computed for each of the nine temperature and wind speed classes. These were ranked (1 = lowest) and then grouped into forecast categories based upon the rankings. For example, air quality index forecast category A in summer corresponds to meteorological forecasts of low temperatures and high wind speeds. This forecast category (for low levels of air pollution) corresponds to the grouping of temperature and wind speed boxes ranked low (1, 2, and 3) according to their average observed A.Q.I.'s.

In other words, a forecast of that day's air quality index can be calculated from yesterday's A.Q.I., an estimate of that day's average temperature (the average of the previous night's observed low temperature and that afternoon's forecasted high temperature), that day's predicted average wind speed, and the tables.

Applying this method to one year's worth of observed daily A.Q.I., temperature, and wind speed data yielded average "forecast" accuracies of 62% and 71% (Table 3). In both seasons, days of high air quality (i.e., low air pollution levels and low A.Q.I. values) were forecast somewhat more accurately. Forecasts were less accurate during the warm season due to

TABLE 3

Evaluation of Contingency Table Air Quality Index Forecasting Scheme

A. Warm Season

category	percent correct (N = 128)
A	65%
B	58%
C	63%
average	62%

B. Cool Season

category	percent correct (N = 77)
A	83%
B	67%
C	64%
average	71%

total correct forecasts = 65%

TABLE 4

Evaluation of Operational Forecasting Scheme by Season and Category

A. Warm Season

category	percent correct (N = 118)
A	31%
B	10%
C	18%
average	21%

B. Cool Season

category	percent correct (N = 57)
A	67%
B	57%
C	17%
average	42%

total correct forecasts = 28%

the greater variability in air quality during this season.

When compared to the operational scheme (Table 4), the new method indicates improved forecasting ability in all categories and both seasons. During the important warm season (which covers 75% of the year and has the greatest variability and the highest pollution levels), the percentage of forecasts correct was approximately three times greater. In total, there were over twice as many correct forecasts using the contingency table method.

DISCUSSION

The new forecast method developed in this study must now be tested on an independent data set and in other geographic areas to confirm its potential. Due to the high reliability of the parameters used in developing the scheme (i.e., 6-12 hour temperature and wind speed forecasts), it is not expected that the independent test accuracy would be markedly different from that obtained in this study.

This scheme assumes a correlation between temperature, air mass, and air quality. (For example, in northeastern Pennsylvania in winter, low temperatures are often associated with northerly winds which lower A.Q.I. values by advecting air masses from relatively unpolluted areas into the study ara.) Thus, this method will be most applicable to locations whose similar associations exist. It may not be as applicable elsewhere (for example, in Los Angeles which is relatively unaffected by large and frequent temperature and air mass changes and where air pollutants tend to be locally derived). However, since this new scheme is based on parameters which have high forecast reliability in most locations, on parameters which have an effect on air pollution levels in most locations, and on local observed air pollution levels (which include any effects of local meteorology and terrain conditions), this technique may work well in many areas other than northeastern Pennsylvania.

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SELF-INHIBITION IN SYNTHETIC GAS COMBUSTION[1]

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ABSTRACT

By comparing the burning velocities (and thus the global reaction rates) of various mixtures of oxygen, nitrogen, and three fuels, it was discovered that methane inhibits its own combustion in fuel-rich flames, while hydrogen and carbon monoxide do not. This self-inhibition by methane is due to chemical effects rather than physical effects. Oxygen is not a self-inhibitor in any of the flames.

INTRODUCTION

As the U.S. strives to become energy independent, the use of coal-derived low- and medium-Btu gases (syngases) will play an increasingly important role; the use of these gases in place of natural gas, however, presents problems from the point of view of both the combustion engineer and the environmentalist. The former is concerned with retrofitting, flame temperatures, burning velocities, and fuel/air ratios, while the latter is concerned with NO_x, CO_x, and soot production.

Syngases are typically comprised of three fuels (methane, hydrogen, and carbon monoxide) and three diluents (carbon dioxide, water vapor, and nitrogen). Immediately some of the difficulties with the use of syngas become evident:

A. The fuel contains a slow-burning (CO), a fast-burning (H_2), and an intermediate-burning (CH_4) combustible, yet the burning velocity of a mixture of these three combustibles is not a linear function of the concentrations of the individual components [1].

B. The burning velocity of one of the components (CO) is increased by trace amounts of three other components (H_2, H_2O, CH_4) [2-5].

C. Two of the components (CO_2, H_2O) are traditional flame extinguishants.

D. One of the components (CH_4) is a self-inhibitor; that is, in rich mixtures, it inhibits its own combustion [7].

In order to be able to use these syngases, their combustion properties must be better characterized. It would be convenient if one were able to predict their combustion properties based on the contents of the syngases, but no method is totally reliable. Thus, more information is needed on the effects, upon combustion, of various combinations of fuels and diluents.

Probably the most interesting discovery in flames to date is the existence of self-inhibition [7]. Self-inhibition is the process by which an agent, which normally contributes to or plays a role in combustion, acts to hinder or otherwise retard the combustion process. Self-inhibition, for the purposes of this paper, is considered to be a chemical process, and not the result of thermal and/or species dilution.

The general concept of self-inhibition is not new; it has been extensively studied in enzyme systems in solution by biochemists [8]. Recently, fuel self-inhibition has been shown to occur in low pressure, non-adiabatic hydrocarbon flames [7]. Furthermore, it has been theorized to exist, along with oxidant self-inhibition, in atmospheric pressure, adiabatic hydrocarbon flames [9]. This paper will deal with the reasoning behind the argument used to support the adiabatic, atmospheric-pressure self-inhibition theory, and use literature data to show that: 1) although hydrocarbon fuels exhibit self-inhibition at atmospheric pressure, other fuels (namely hydrogen and carbon monoxide) do not; and 2) oxidant self-inhibition does *not* occur.

METHODS

The burning velocity data of Jahn is plotted by Lewis and von Elbe [10] in the form of burning velocity versus percent fuel in the mixture, keeping the $O_2/(O_2 + N_2)$ ratio constant. Unfortunately, this is not quite the plot needed, since one would like to compare burning velocity as a function of fuel percent while the oxygen percent is kept constant. Therefore, the data used in this paper was taken from the smooth-line plots of Jahn's data for $CH_4/O_2/N_2$, $H_2/O_2/N_2$, and $CO/O_2/N_2$ flames in Lewis and von Elbe [10] and the oxygen and nitrogen percents calculated at each fuel percent for each curve in the following manner:

If $X = O_2/(O_2 + N_2)$,

then $\%O_2 = X(1 - \%Fuel)$

and $\%N_2 = (1 - X)(1 - \%Fuel)$.

The results are plotted in Figures 1-6, in the form of burning velocity versus either fuel percent or oxygen percent. The flammability limits are compared with *downward* propagation limits, since Jahn used a Bunsen type flame in which the flame would have to propagate downward against an upward gas flow. It is assumed here that nitrogen is inert in the combustion reactions.
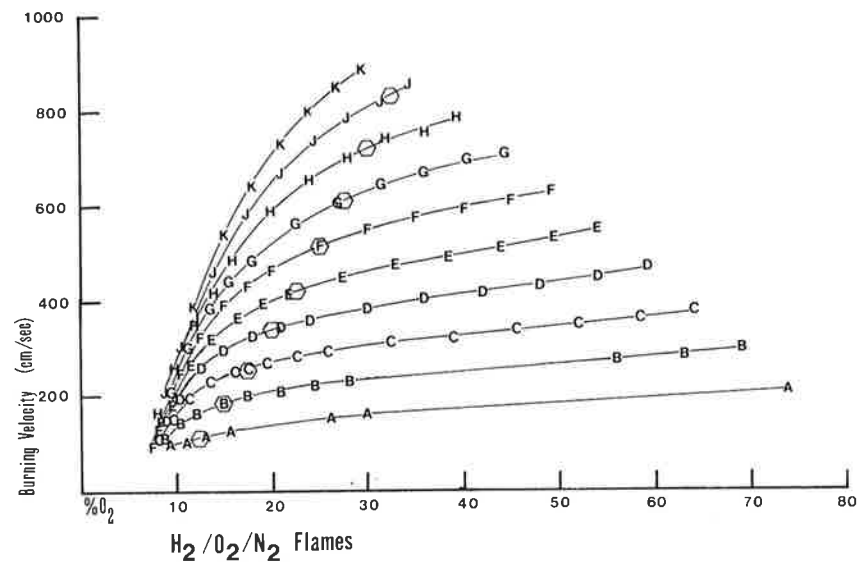
FIGURE 1. Burning velocity as a function of oxygen concentration ($H_2/O_2/N_2$ flames). A = 25% H_2; B = 30% H_2; C = 35% H_2; D = 40% H_2; E = 45% H_2; F = 50% H_2; G = 55% H_2; H = 60% H_2; J = 65% H_2; K = 70% H_2. Hexagons = stoichiometric.

FIGURE 2. Burning velocity as a function of hydrogen concentration ($H_2/O_2/N_2$ flames). N = 10% O_2; P = 15% O_2; Q = 20% O_2; R = 40% O_2; S = 60% O_2. Hexagons = stoichiometric mixture.

RESULTS AND DISCUSSION

In his survey paper on gas phase flame inhibition, Reuther [9] states that, "Addition of excess air above the stoichiometric ratio causes a reduction in burning velocity. . . . Since no other change is made to the flame except for addition of more oxidant, this phenomenon is called oxidant self-inhibition. . . . Continued increase in the percentage oxygen richness leads to total inhibition, or extinction (the oxygen-rich flammability limit)." The flaw in this reasoning lies in the second sentence, that the only change in the flame system is oxidant addition. This cannot be true. If the oxidant concentration of any flame system is increased, the fuel concentration is decreased in the same manner, assuming the pressure remains constant. For example, in a stoichiometric atmospheric pressure methane/oxygen flame, the fuel/oxidant mixture contains 33.3% methane and 66.7% oxygen. If the oxygen concentration is increased so that the mixture now contains 80% oxygen, the methane concentration is necessarily reduced to 20%. Thus, whether the corresponding drop in burning velocity is due to oxygen inhibition or fuel dilution cannot be determined from the variance of burning velocity with mixture stoichiometry.

The same line of reasoning is used to suggest that fuel self-inhibition occurs in adiabatic atmospheric pressure flames, and thus it also falls prey to the same flaw in the reasoning. (Note that using Reuther's criteria, *all* flame systems would show both fuel and oxidant self-inhibition, since all flames show a peak in the plot of burning velocity versus mixture stoichiometry.) Thus, fuel and oxidant self-inhibition in atmospheric pressure adiabatic flames has not been proven, although in this case it does not mean that it does not occur.

What is desired then is a way to change the fuel concentration while keeping the oxidant concentration constant, and vice-versa. One method of doing this is to use an inert gas to dilute the system, and measure the burning velocity of various fuel/oxidant/inert systems. That approach was used here.

Figure 1 shows the effect of increasing the oxygen concentration of a hydrogen flame when the hydrogen concentration is kept constant. Extrapolation of the lines to a burning velocity of zero should give an approximation of the low-oxygen flammability limit. Two observations should be pointed out concerning this graph: the first is that regardless of nitrogen and hydrogen content, the oxygen-lean limit of flammability seems to be the same, approximately 7-8% oxygen. This agrees rather well with the literature value of 6.0-8.0% oxygen for downward H_2/O_2 flame propagation and 26-32% air (equivalent to 5.5-6.7% oxygen) for H_2/air [11]. The second observation is that addition of oxygen in excess of the stoichiometric amount shows no reduction in burning velocity. Instead, it has a tendency to level-off after reaching stoichiometic concentration. This suggests that excess oxygen does not get involved chemically in the hydrogen flame, but instead acts as a simple inert diluent in the same manner as nitrogen. Thus, oxygen self-inhibition does *not* occur in $H_2/O_2/N_2$ flames.

Figure 2 is the reverse of Figure 1, and shows the effect of increasing the hydrogen concentration while keeping the oxygen concentration constant. The lower limit of flammability appears to be between 10% and 15% hydrogen; the literature values for the downward propagation limits are 8.4-9.5% hydrogen for H_2/air and 9-10% hydrogen of H_2/O_2 [11]. In addition, this plot shows that addition of hydrogen in excess of the stoichiometric amount shows no reduction in burning velocity. Thus, hydrogen self-inhibition does not occur, and one can conclude from Figures 1 and 2 that self-inhibition does not occur *at all* in $H_2/O_2/N_2$ flames.

The effect of increased oxygen concentration on carbon monoxide combustion is shown in Figure 3. Extrapolation to a burning velocity of zero gives a low-oxygen limit of around 6% oxygen. This compares favorably to the literature values of 6.5% oxygen and 30% air (equivalent to 6.3% oxygen) for downward propagating carbon monoxide flames [11]. As with hydrogen flames, no oxidant self-inhibition is seen, as addition of oxygen in excess of the stoichiometric amount does not decrease the burning velocity. Again, the burning velocity seems to level-off after reaching the stoichiometric concentration. Thus, excess oxygen is an inert diluent in the $CO/O_2/N_2$ flame.

Figure 4 shows the effect of increasing the carbon monoxide concentration. Extrapolation shows the lower limit of flammability should be around 16% carbon monoxide. The literature gives 16.3% and 16.7% carbon monoxide for CO/air and
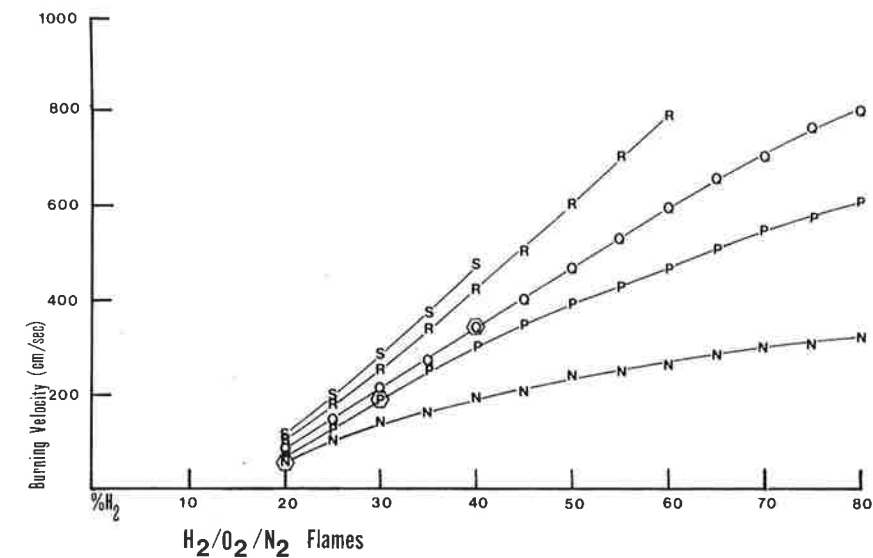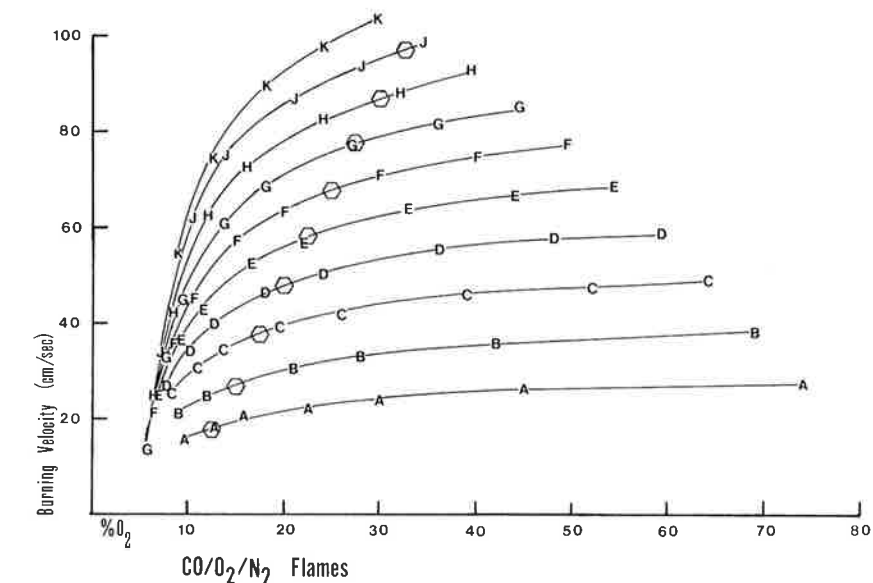

FIGURE 3. Burning velocity as a function of oxygen concentration ($CO/O_2/N_2$ flames). A = 25% CO; B = 30% CO; C = 35% CO; D = 40% CO; E = 45% CO; F = 50% CO; G = 55% CO; H = 60% CO; J = 65% CO; K = 70% CO. Hexagons = stoichiometric.

CO/O_2, respectively [11]. Again, no reduction of burning velocity is observed. Thus, as with the hydrogen flame, self-inhibition does not occur at all in the $CO/O_2/N_2$ system.

The effect of increased oxygen concentration on methane flames is shown in Figure 5. As with the hydrogen and carbon monoxide systems (Figures 1 and 3), the burning velocity levels off after reaching stoichiometric concentration, but never decreases. Thus oxygen self-inhibition does not occur in methane flames. There is a large difference between this plot and Figures 1 and 3. Whereas extrapolation to zero burning velocity in Figures 1 and 3 result in the same flammability limits regardless of hydrogen or carbon monoxide concentration, the flammability limits in Figure 5 are highly dependent on methane concentration. For example, the limits for 15%, 20%, and 25% methane are about 20%, 23%, and 28% oxygen, respectively. The literature values for the flammability limits are 45% oxygen at 55%

methane for CH_4/O_2 flames and 86.4% air (equivalent to 18% oxygen) at 13.6% methane for CH_4/air flames [11].

Figure 6 shows the effect of increasing methane concentration while the oxygen concentration is held constant. Extrapolation to zero gives a lean flammability limit of around 8% methane, regardless of methane concentration. The literature values are 5.75% and 6.4% methane for CH_4/air and CH_4/O_2, respectively [11].

The startling difference between this curve and the previous five is the reduction of the burning velocity if methane is added above the stoichiometric point. The burning velocities all go through a maximum on the slightly fuel-rich side of stoichiometric concentration, and then rapidly decrease. Thus, in fuel-rich methane flames, when the inert nitrogen is replaced by methane, the burning velocity decreases dramatically. This is very significant, because it means that the excess methane is somehow
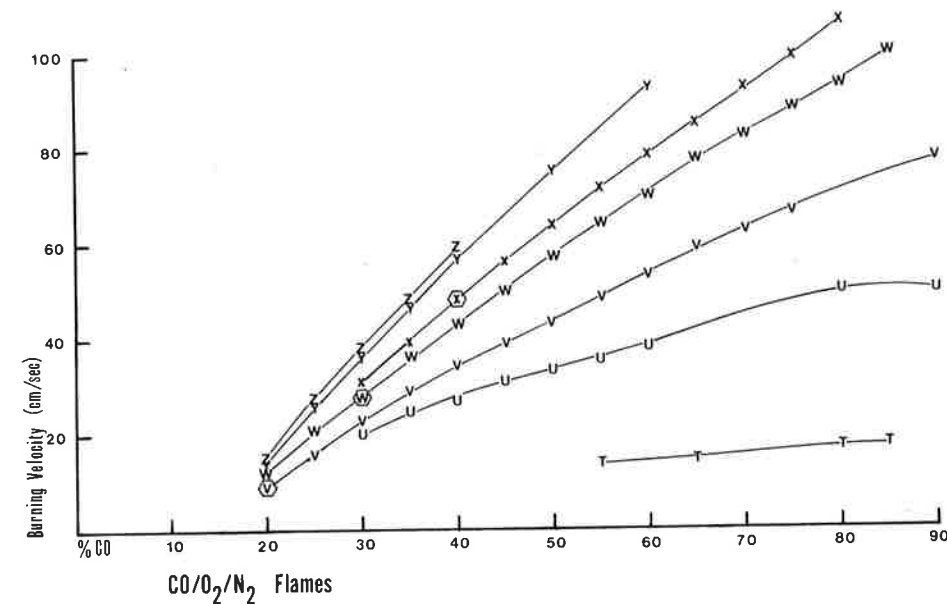
FIGURE 4. Burning velocity as a function of carbon monoxide concentration (CO/O$_2$/N$_2$ flames). T = 6% O$_2$; U = 8% O$_2$; V = 10% O$_2$; W = 15% O$_2$; X = 20% O$_2$; Y = 40% O$_2$; Z = 60% O$_2$. Hexagons = stoichiometric mixture.
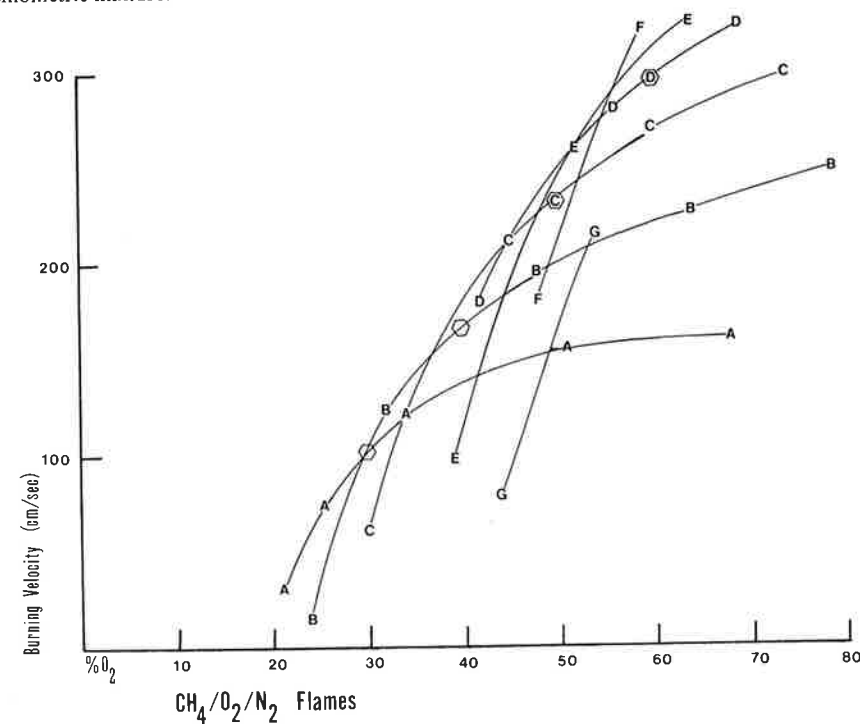

FIGURE 5. Burning velocity as a function of oxygen concentration (CH$_4$/O$_2$/N$_2$ flames). A = 15% CH$_4$; B = 20% CH$_4$; C = 25% CH$_4$; D = 30% CH$_4$; E = 35% CH$_4$; F = 40% CH$_4$; G = 45% CH$_4$. Hexagons = stoichiometric mixture.

inhibiting the combustion reactions. The question that must now be addressed is whether or not this inhibition is a result of chemical inhibition (*i.e.,* the methane molecules becoming involved in the chemistry of the combustion reaction) or simple thermal dilution, because of methane's lower thermal diffusivity relative to nitrogen. Admittedly, some thermal dilution and thus a reduction in burning velocity must occur when the thermal diffusivity is lowered; however, the proof that methane is chemically inhibiting the flames lies in the comparison of Figures 1 through 6. Recall that, except for Figure 5, the flammability limits seem to be independent of nitrogen concentration. Figure 5, however,

shows that in methane flames, the low-oxygen concentration limit is highly dependent on the methane concentration, *i.e.,* the greater the methane concentration the higher the minimum oxygen concentration needed for flame propagation. Thus, the methane is raising the low-oxygen flammability limit. Since one of the properties of traditional chemical inhibitors (*e.g.* halons) is a narrowing of the flammability limits [12], and since the other plots of burning velocity versus oxygen or fuel concentration show that the flammability limits remain constant when a purely physical inhibitor (nitrogen) is present, one can conclude that methane *chemically* inhibits its own combustion, and can thus be
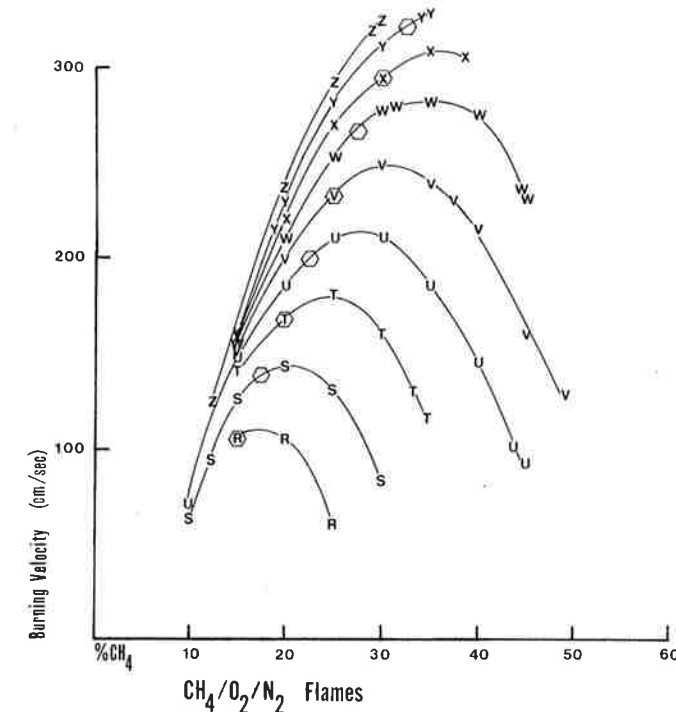
FIGURE 6. Burning velocity as a function of methane concentration (CH$_4$/O$_2$/N$_2$ flames). R = 30% O$_2$; S = 35% O$_2$; T = 40% O$_2$; U = 45% O$_2$; V = 50% O$_2$; W = 55% O$_2$; X = 60% O$_2$; Y = 65% O$_2$; Z = 70% O$_2$. Hexagons = stoichiometric mixture.

considered a self-inhibitor.

A second look at Figures 2 and 4 show that, contrary to the burning velocity versus percent oxygen curves, when hydrogen or carbon monoxide is added to the system, the burning velocity does not level-off after stoichiometric concentration is reached, but rather, keeps increasing. This behavior is the opposite of self-inhibition and will be referred to as "self-activation", *i.e.,* excess fuel gets involved chemically in the combustion reactions and speeds them up rather than slowing them down. Whether or not hydrogen or carbon monoxide self-activation occurs is not clear from these curves. The carbon monoxide used in Jahn's experiments contained 1.5% H$_2$ and 1.35% H$_2$O. The burning velocity of carbon monoxide is greatly increased by small amounts of hydrogen or water [2-5]. Since the concentration of carbon monoxide is increasing, the hydrogen and water concentrations must be increasing, as well. This may be responsible for the steady burning velocity increase, rather than a leveling-off, in the carbon monoxide system of Figure 4.

The steady rise in the hydrogen system of Figure 2 may be the result of replacement of the nitrogen in the system with excess hydrogen, which has a higher thermal diffusivity. This would result in a higher flame temperature and thus a higher burning velocity. Therefore, no conclusion can be drawn on the possibility of self-activation in hydrogen/oxygen/nitrogen or carbon monoxide/oxygen/nitrogen flames.

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RESEARCH NOTE:

DO CEBUS MONKEYS USE ADAPTATION LEVEL AS A FUNCTIONAL FRAME OF REFERENCE FOR PERCEPTUAL JUDGMENTS?[1]

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ABSTRACT

The use of a single variable oddity problem for discriminating cylinder heights by *Cebus* apella failed to show changes in their frames of reference as reflected by shifts in their Adaptation Levels (AL). It was suggested that the monkeys were not paying attention to the background stimulus. Therefore the *Cebus* are being trained on a two variable Weigl oddity problem which requires them to pay attention to specific background stimuli. After they learn to solve the Weigl oddity problem the *Cebus* will be retested on single variable oddity problems where changes in their frames of reference should be reflected by shifts in their Adaptation Levels.

In 1981 Masters (1) reported that the *Cebus* in his laboratory were having difficulty learning a cylinder height matching to sample task. Performance on this task was to reflect a shift in the monkey's judgmental frame of reference as measured by shifts in the monkey's Adaptation Level (AL). Since the *Cebus* were having difficulty learning this matching problem, they were asked to learn a single variable oddity problem (1). Davis and McDonald (2) have successfully used the oddity task in assessing *Rhesus* monkeys' perceptual judgments of cylinder height differences. The *Rhesus* learned to select either a tall cylinder when it was matched with two equally short cylinders or a short cylinder when it was matched with two equally tall cylinders. The three cylinders were always presented in a straight row in the vertical plane directly in front of the monkey. The left-right position of the odd cylinder was randomly determined; and the *Rhesus* were never allowed to choose the middle cylinder. After the *Rhesus* had learned this oddity task, Davis and McDonald (2) systematically changed the height of the middle cylinder from short to tall. When the *Rhesus* no longer saw the middle cylinder as short, they switched from choosing the tall cylinder as odd to choosing the short cylinder as odd. Davis and McDonald (2) referred to this change area as the *Rhesus'* perceptual threshold for tall cylinders in this particular viewing situation. The Davis and McDonald (2) procedure was used in the present study as the fundamental perceptual task.

Once the *Cebus* had learned this oddity task, five specific cylinder heights (55 mm., 65 mm., 75 mm., 85 mm., 95 mm.) were pre-

sented in the middle cylinder position in order to establish a specific Adaptation Level as a specific frame of reference for these heights. A very tall (200 mm.) or a very short (25 mm.) anchor cylinder was used to manipulate any frame of reference which the *Cebus* may have developed while learning the oddity problem. The tall anchor was first presented alone in front of a white screen which shielded the oddity problem. After the monkey pushed over the tall anchor cylinder the screen was removed. The monkey then saw the center cylinder alone with the two outside cylinders still shielded from view. The second shield was removed and the monkey selected one of the two outside cylinders in the oddity problem. This procedure followed Helson's (3) anchor procedure for Adaptation Level formation with human subjects.

An analysis of the *Cebus'* choices using Masters' (1) extension of Helson and Himelstein's (4) short method for calculating Adaptation Levels showed no significant shift in the *Cebus'* Adaptation Level due to the presence of the tall anchor stimulus. The mean calculated AL's for the no anchor and the tall anchor conditions were 70.8 mm. and 70.5 mm. respectively. Since it appeared that the tall anchor had no effect when it was presented in succession with the oddity problem, the testing with the short anchor cylinder was slightly modified. The short anchor was presented for 5 seconds next to the middle cylinder of the oddity problem before the shield blocking the two outside cylinders was removed. After this second shield was removed the *Cebus* chose one of the two outside cylinders. The mean calculated AL's for both the no anchor and short anchor conditions were 70.8 mm. AL's. Again, there was no significant difference between these AL's.

Similar data were reported for albino rats in a brightness discrimination matching to sample task (1). Neither *Cebus* nor albino rat, seemed to change their frames of reference as reflected by Adaptation Level shifts in the presence of an anchor stimulus. Masters (1) has suggested that the albino rat may need more time in the presence of the anchor stimulus in order for the anchor to be effective. Further studies looking into this possibility are currently under way in this laboratory. The same could be said for the *Cebus* monkeys. Perhaps the *Cebus* are not spending enough time paying attention to the anchor stimulus in order for it to have an effect on the *Cebus'* Adaptation Level. A start in this direction appeared as the 5 second pairing of the short anchor cylinder with the middle cylinder of the oddity problem. This 5 seconds, which was comparable to that used with albino rats, did not seem to effect the *Cebus'* performance on the oddity problem. Therefore, the monkeys are now being specifically trained to pay attention to

a background stimulus. Helson (3) refers to an anchor stimulus as a background stimulus, so specific training for the *Cebus* should enhance the effects of the tall and short anchor cylinders in changing the *Cebus'* frame of reference as reflected by Adaptation Level shifts. The *Cebus* are currently engaged in such special training in the form of a two variable Weigl (5, 6) oddity problem. In this problem the *Cebus* learn to select an object that is odd either to form or to color. Designation of the cue to be judged odd depends on a specific background stimulus such as the color of the tray upon which the oddity problem is presented to the *Cebus*. After the *Cebus* learn to pay attention to the background stimulus which indicates the solution to the oddity problem, they will be retested on single variable oddity problems with anchors to see if shifts in their frames of reference are reflected by shifts in their Adaptation Levels.

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ABSTRACTS*

FARRELL, WALTER C., Jr., ASTRID K. MACK, WALTER R. ALLEN and PETER A. DUAL. Department of Community Education, University of Wisconsin-Milwaukee, Milwaukee, WI 53201, University of Miami, University of Michigan, and University of Eastern Michigan, respectively. SPATIAL AND RACIAL PATTERNS OF PERCEPTION OF THE MIAMI DISTURBANCE, 1980.— The purpose of this study was to determine the perceptions of black and white Miamians of the causes of and the solutions to the 1980 Miami disturbance. A purposive sample of black (N = 108) and white (N = 93) Miami leaders was drawn from leadership lists and a survey instrument was mailed to each. The returns reflected a 56% and 25% black and white response rate, respectively. The analysis revealed that there were significant differences between black and white perceptions (p < .05) and that the intensity of blame and responsibility for the solution of the black community for the disturbance was associated with distance from the disturbance site.

MONMONIER, MARK S. Department of Geography, Syracuse University, Syracuse, NY 13210. TOPOGRAPHIC MAP COVERAGE OF PENNSYLVANIA: A STUDY IN CARTO-GRAPHIC EVOLUTION. — The effective topographic mapping of the Commonwealth began in the late 1800s, shortly after the establishment of the U.S. Geological Survey. The spatial-temporal pattern of expansion for the state's topographic coverage reflects the replacement of plane table surveying by modern photogrammetric mapping as well as Pennsylvania's internal priorities and its support of base mapping through a fifty-fifty federal-state cost-sharing program. Major mineral and metropolitan regions were generally mapped before less inhabited, more remote and more agricultural regions. The present pattern of publication dates reflects a shift from a 15-minute to a 7.5-minute quadrangle, improved accuracy standards, the need to revise more frequently where landscape change has been more pronounced, the development of new products such as the orthophotoquadrangle map, and the efficiency of procuring aerial photography for large areas.

SCHNELL, GEORGE A. Department of Geography., State University of New York, College at New Paltz, New Paltz, NY 12561. RECENT TRENDS IN THE DISTRIBUTION OF PENNSYLVANIA'S BLACK POPULATION. — A recent demographic phenomenon has occurred throughout the United States but is especially evident in the nine northeastern states. This "population turnaround" is described as the re-distribution of population generally from metropolitan areas to nonmetropolitan areas. This paper, concerned with the racial aspects of "turnaround," examines black population trends in Pennsylvania from 1970 to 1980, compares them to national trends, to earlier changes, and to variations in distribution in the white population. Counties are the primary areal units studies although metropolitan areas and their constituent parts are examined as well. Except for black inhabitants, other racial minorities are omitted from the discussion because of their numerical insignificance at the county level of aggregation.

MILLER, E. WILLARD. Department of Geography, Pennsylvania State University, University Park, PA 16802. SPATIAL IMPACT OF FEDERAL LEGISLATION ON THE PENNSYLVANIA BITUMINOUS COAL INDUSTRY. — Beginning in the late 1960's a number of federal laws have been passed that have influenced the spatial pattern of the bituminous coal industry at both the national and state levels. Most important of these are the Clean Air Act and the Federal Coal Mine Health and Safety Act. This paper investigates the effect of these legislative acts on the spatial patterns of bituminous coal production in Pennsylvania, one of the oldest coal producing states in the nation.

STACHOWIAK, EDWARD and CHARLES B. REIF. Department of Geography, Wilkes College, Wilkes-Barre, PA 18766. ESTIMATING AREAS OF LAKES. — Areas of one hundred lakes have been estimated by projecting the outline of each lake as shown on the appropriate U.S. Geodetic Survey map to enlarge the outline twenty diameters and then treating each enlarged outline by three methods: planimetric, gravimetric, and least squares. Three values thus determined for each of the one hundred lakes have been subjected to statistical analysis and the percent divergence calculated between planimetric and gravimetric values, the planimetric and least squares methods, and the gravimetric and least squares methods.

KERTIS, CARLA A. Geologist, U.S. Bureau of Mines, Pittsburgh, PA. RECOGNITION AND PREDICTION OF COAL-BED DISCONTINUITIES, INDIANA AND ARMSTRONG COUNTIES, PENNSYLVANIA. — Coalbeds in western Penn-

*The abstracts published herein have not been subjected to editorial scrutiny.

sylvania are not continuous, but typically are punctuated by discontinuities. These discontinuities may occur as a result of thinning of a coalbed over a paleotopographic high, but are more commonly the result of scouring by a channel-phase sandstone. Not only do coalbed discontinuities cause economic problems because of the thinning or absence of the coalbed and decrease in coal quality, but discontinuities also pose serious health and safety problems in underground mines. These problems include roof-rock instability, water seepage, roof rolls, and methane emissions in the proximity of a channel sandstone. In Indiana and Armstrong Counties, several channel sandstones have been delineated. These channels are part ofta large deltaic complex that dominated much of western Pennsylvania during the time of peat accumulation. Through the interpretation of core hole and gas well data, trends of the channel sands and areas likely to be plagued by coalbed discontinuities are easily determined. Once areas of discontinuity have been outlined, mine plans may be modified to eliminate or avoid the problems associated with coalbed discontinuities.

REIF, CHARLES B. Department of Biology, Wilkes College, Wilkes-Barre, PA 18766. THERMAL VALUES FOR TWO SETS OF LIMNETIC SEDIMENTS. — Mean monthly temperatures for the sediments of Nuangola Bog (1967 through 1977) and for the mean temperatures of the sediments and water of Cummings Pond (Februaries of 1967, 1969, 1973, 1978 and 1981) are presented and a periodicity of temperature is shown for the bog and suggested for the lake sediments.

ULERY, JAMES P. Geologist, U.S. Bureau of Mines, Pittsburgh, PA. INFLUENCE OF SURROUNDING STRATA ON METHANE EMISSIONS IN COAL MINES: A GEOLOGIC CASE STUDY. — The Federal No. 2 mine operating in the Pittsburgh coal seam in northern West Virginia has been the site of numerous Bureau of Mines investigations relating to methane emission and degasification. Abnormally high methane emissions have been observed in the eastern section of the mine since 1970. The volume of these emissions indicated a possible source other than the coalbed. A geologic investigation was undertaken to attempt to delineate a probable methane source. The resulting study showed that a sandstone unit directly above the coalbed is probably the source of these emissions. The sandstone body appears to be an abandoned ancient stream channel in-filled with fine grained sand and organic matter. Coalification of the organic matter produced methane as a byproduct. This methane generated in situ and possibly migrating methane originally generated in the coal seam or other source rocks was stratigraphically trapped in the clastic unit by surrounding impermeable strata.

SIMONSEN, AUGUST H. and JOHN RITTER. Department of Environmental Sciences, The Pennsylvania State University, McKeesport, PA 15132. MICROFOSSILS IN SEDIMENTS FROM THE WYMPS GAP LIMESTONE (UPPER MISSISSIPPIAN) IN SOUTHWESTERN PENNSYLVANIA. — Sediments collected at the Thompson Quarry were from a marine limestone containing a diversity of invertebrates. The Wymps Gap Limestone in Pennsylvania is an extension of the Greenbrier Series of West Virginia. It is a dark colored, massive-

bedded limestone with calcareous shale interbedded that is part of the Mauch Chunck Formation, the uppermost Mississippian unit in Fayette County. Haney (1963) assigned an early Chesterian age to it. The sediments were wet sieved using 3 standard-sized sieves (425, 850, & 2000 microns). Taxonomic study relied on microscopic analysis of the external morphology. The diverse fauna included foraminifera (*Endothyra*, fusulinids), bryozoans (*Pennireteppora, Polypora Fenestella, Septopora, Protoretepora, Rhombopora, Streblotrypa, Tabulipora*), pelecypods, ostracods, brachiopods, crinoids and blastoids (*Pentremites*). Inferred paleoenvironments obtained from the study indicate normal marine conditions with proximity to an ancient shoreline. The water most likely did not reach depths greater than 50 meters. The microfauna shows evidence for more than one environment within the confines of the above mentioned environmental conditions. The environments may reflect the changes the site underwent during the transgressive and regressive cycles of the Mississippian sea.

BREZINSKI, DAVID K. Department of Geology, University of Pittsburgh, Pittsburgh, PA. LITHOFACIES VARIATION AND COMMUNITY RESPONSE IN THE AMES (PENNSYLVANIA) MARINE INTERVAL. — Reconstruction of the lithofacies and biofacies of the Ames marine-interval (Pennsylvanian) in western Pennsylvania, northern West Virginia, and eastern Ohio has led to recognition of four varying lithofacies and four biofacies. A nearshore carbonaceous shale lithofacies with plant fragments and quartz detritus grades seaward into a calcareous shale lithofacies, which in turn grades into a nodular limestone lithofacies. Normal-marine limestone is the most distally developed lithofacies and represents deposition farthest from clastic input. Biofacies consist of a proximally-developed molluscan-dominated community; a transgressive ''opportunistic'' *Neochonetes* community; a stillstand high diversity, *Composita-Neospirifer* community; and the regressive *Crurithyris* community.

MESSNER, CHARLENE E. and JACK M. GILES. Lycoming College, R.D. #2, Box 201, Linden, PA 17744 and Wildlife Biologist, Pa. Game Commission, R.D. #1, Box 189-A, Allenwood, PA 17810. THE STUDY OF THE HISTOMORPHOLOGY AND REPRODUCTIVE POTENTIAL OF A LIMITED NUMBER OF FEMALE BLACK BEAR (*URSUS AMERICANUS*) REPRODUCTIVE TRACTS. — Twenty reproductive tracts collected from Pennsylvania black bears (*Ursus americanus*) by Game Commission personnel during the November 1979 and 1980 bear harvests were analyzed. The reproductive cycle of the female black bear is outlined emphasizing delayed implantation. Changes in the morphology of the female reproductive tract during the two year reproductive cycle are highlighted. Results of tract examination parallel those presented by Kordek and Lindsey (1976) relating to age-specific reproduction. Potential recruitment is assessed by the counting of corpora lutea, the presence of blastocysts, or implanted embryos. Actual recruitment analysis is taken from 1980 field observations of females with cubs up to 1½ years old. Particular attention is given to the pictoral examination of the gross morphology of female reproductive organs in this study. Additional reproductive tracts will be collected during the 23 November 1981 Pennsylvania bear hunting season.

OGREN, ROBERT E. Department of Biology, Wilkes College, Wilkes-Barre, PA 18766. THE IDENTIFICATION AND REPRODUCTIVE APPARATUS OF THE LAND PLANARIAN, *MICROPLANA ATROCYANEUS* (WALTON) FROM PENNSYLVANIA (PLATYHELMINTHES: TURBELLARIA). — This triclad terricola has an elongate, black, cylindrical body, 20-25 mm long. It is found in moist soil in various localities of Eastern United States including Pennsylvania. A mature specimen found in a garden site at Carlisle, Pa. is described. It is compared with two other specimens known to represent the species. The identification of this species depends on having sexually mature specimens. Characters found in these specimens, considered typical of the mature condition as we know it, included the presence of only prepharyngeal testes, and well-developed penis bulb and papilla; the female system, with one pair of ovaries, has paired ovovitelline ducts leading posteriorly toward the reproductive apparatus; the narrow vagina gives rise to a short, simple genito-intestinal connection. The species is currently separated from other species of the genus by its external characters and the above simple features of its reproductive system.

KACZOROWSKI, SUSAN L. and MARC A. SYLVESTER. Department of Biology, California State College, California, PA 15419. THE EFFECTS OF VARIOUS CULTURAL CONDITIONS ON THE GROWTH AND SPORULATION OF *BACILLUS CEREUS*. —Bacterial endospores are used for testing the sterility of media and hardware subjected to standard sterilization methods. However, the preparation of spore suspensions may lower the resistance of the spores. A need, then, has arisen whereby the preparation of spore suspensions must be standardized. In this study, *Bacillus cereus* was grown in liquid culture: nutrient broth, G-medium, and modified G-medium. Results showed that conditions of incubation, relative volume relationships and media greatly influence sporulation of *B. cereus*. The optimal conditions for sporulation required that cultures be grown for 48h at 35C, followed by 24h incubations in ''shake-culture'' at 35C, and a volume relationship of 20:1 (25ml broth/500ml Erlenmeyer flask) be maintained. Percent sporulation was determined through microscopic examination. When 90% sporulation was achieved, the vegetative cells were killed by subjecting them to 80C in a water bath for 10 minutes. These cultures were then centrifuged (10,000 x g; 4C, and 10 min.) to obtain a spore pellet. The pellet was washed three times with sterile distilled water to remove debris, and resuspended in 0.2M sucrose solution for further study. The previously described methodology provides a reliable method for obtaining a ''clean'' source of spores which could be used in sterility testing.

SIVER, PETER A. and STANLEY FREEDA. Department of Biology, Wilkes College, Wilkes-Barre, PA 18766. THE EFFECT OF GROWTH RATE ON THE STATIS OF FORM IN *SCENEDESMUS* STRAIN 170. — *Scenedesmus* strain 170 is capable of forming several different morphologies. The common morphology is a colony consisting of four cells aligned longitudinally to form a flat plate. *Scenedesmus* strain 170 is also capable of forming two and eight celled colonies. The terminal cells of a colony each bear two spines. Under certain conditions (high nitrogen concentrations, high light intensities, and high temperatures) *Scenedesmus* strain 170 produces a four

spined unicellular morphology. The factors controlling the formation of two, four, and eight celled colonies are not fully understood. This study investigated the effects of growth rate, temperature, and nutrient concentration on colony formation. In general, conditions yielding high growth rates produced populations of four and eight celled colonies; whereas conditions yielding lower growth rates produced populations of two celled colonies. However, at very low growth rates (less than 0.7 doublings per day) there was a reversion back to producing four celled colonies. This phenomenon was investigated further through observing the cell cycle.

LEMKE, L. A. and C. H. COLLISON. Department of Biology, The Pennsylvania State University, University Park, PA 16802. PRESENCE OF THE NORTHERN FOWL MITE, *ORNITHONYSSUS SYLVIARUM* (CANESTRINI AND FANZAGO, 1877), ON PULLETS. — In an attempt to identify potential sources of northern fowl mite infestations, 18 pullets were obtained from a commercial poultry farm at Rheems, PA and the university poultry farm. Birds were killed, frozen and later skinned. The skins were dissolved using the modified Cook's technique to determine if any arthropods were present on the skin or in the feathers. The results indicated that northern fowl mite populations do not become established on pullets. At Rheems, a total of six mites were obtained from eight birds, thus indicating that pullets may serve as vectors of mites from farm to farm. Two months after the pullets were caged, a severe mite infestation was present. No other poultry ectoparasites were present on the birds.

VARUGHESE, POTHEN. Department of Chemistry, Indiana University of Pennsylvania, Indiana, PA 15705. SYNTHESIS OF SOME N, N-DIALKYLPIPERIDINIUM AND N-DIALKYLMORPHOLINIUM BROMIDES AND A STUDY OF THEIR ANTIBACTERIAL ACTIVITY. — Several functionalized and nonfunctionalized N,N-dialkylpiperidinium and morpholinium bromides were prepared by the reaction of N-methylpiperidine or N-methylmorpholine with the corresponding alkyl bromide in acetonitrile under reflux conditions for a period of seven days. The quaternary ammonium salts were isolated and recrystallized from suitable solvents. They were characterized by elemental analysis and spectroscopy. Appropriate dilutions of these salts were prepared in pH 7 buffer solutions and sterifiltered. These were tested against 1) Staphylococcus Aureus 2) Pseudomonas Aeruginosa and 3) Salmonella Cholerasuis. A standard 4 mm innoculating loop of a 24 hr broth culture of the test organism was added to each 5-ml sample of the quaternary ammonium salt solution. After exposure of the organism to the solution for a certain length of time at room temperature, a 4 mm loopful of the mixture was innoculated into a subculture medium and incubated at 37 degrees Celsius. The subculture medium was observed for visible growth at the end of 24, 48, 72 hours and at the end of 7 days. The results will be presented and discussed.

BRAUE, ERNEST H. JR. and DENNIS HOOVER. Department of Chemistry, The Pennsylvania State University at Mont Alto, Mont Alto, PA 17237. SYNTHESIS AND THE SOLVOLYSIS OF ISOBUTYL p-HYDROXYBENZOATE BY ACETATE FUSED SALT. — Isobutyl p-Hydroxybenzoate was

synthesized by the Fischer Method of direct esterification of p-hydroxybenzoic acid with isobutyl alcohol using sulfuric acid as catalyst. The structure was confirmed by infrared and nuclear magnetic resonance spectroscopy. The solvolysis of this ester with acetate fused salt was then studied. The kinetics and reaction products of this nucleophilic displacement reaction were determined and a reaction mechanism proposed.

BRAUE, ERNEST H. Jr. and JAMES D. BAKER. Department of Chemistry, The Pennsylvania State University at Mont Alto, Mont Alto, PA 17237. STEREOCHEMISTRY IN THE COMPETITIVE NUCLEOPHILIC DISPLACEMENT OF 2-BUTYL p-HYDROXYBENZOATE WITH ACETATE FUSED SALT AND ADDED POTASSIUM THIOCYANATE. — The competitive nucleophilic displacement of 2-Butyl p-Hydroxybenzoate by fused Lithium-sodium-potassium acetate and thiocyanate have been investigated and reported in the literature (JACS, 101, 5303 (1979)). The kinetic and reaction product data support an S_N2 mechanism. This present study investigates the stereochemistry with respect to both the acetate and thiocyanate nucleophile. The results will be interpreted and a reaction mechanism proposed.

KRISTINE, FRANK J. and STEVEN M. GRUBE. Department of Chemistry, The Pennsylvania State University at Mont Alto, Mont Alto, PA 17237. A PHYSIOCHEMICAL STUDY OF IRON (III) CHELATES OF TRIETHYLENETETRAMINEHEXAACETIC ACID. — Prior studies have shown that iron (III) ion will combine with triethylenetetraminehexaacetic acid (H_6ttha) in aqueous solution to form a binuclear complex formulated as $[Fe_2(ttha)(OH)_2]^{2-}$ (K. H. Schroder, Acta Chem. Scand., 19, 1797 (1965)). Physiochemical data will be presented for solutions of ferric ion and H_6ttha and for the solids isolated from these solutions. The results suggest the existence of μ-oxo bridging between iron centers. Either an intramolecular interaction as would occur in monomeric $[Fe_2O(ttha)]^{2-}$ or an intermolecular interaction as would occur in dimeric $[FE_2(ttha)(OH)]_2O^{4-}$ can explain the experimental observations. Comparisons will be made to well characterized μ-oxo bridged dimers of iron (III) ion to elucidate the correct formulation.

VARUGHESE, POTHEN. Department of Chemistry, Indiana University of Pennsylvania, Indiana, PA 15705. STRUCTURAL AND SOLVENT EFFECTS ON THE OXIDATION OF SUBSTITUTED N,N-DIMETHYLBENZYLAMINES BY CERIUM(IV) SULFATE. — N,N-Dimethylbenzylamine, N,N-dimethyl-4-methoxybenzylamine, N,N-dimethyl-4-nitrobenzylamine and N,N,δ-trimethylbenzylamine were synthesized by literature methods and characterized by UV, IR and-NMR spectroscopy. The oxidation reactions were carried out under heterogeneous conditions with cerium(IV) sulfate suspended in anhydrous organic solvents. Hydrolysis of the reaction mixtures yielded aldehydes, ketones and dialkylamines as products. Solvent effects on the reactions were studied by comparing the amounts of adlehyde or ketone formed in acetonitrile, tert-butyl alcohol, ethyl acetate and cyclohexane as solvents during a reaction time of 8 hrs at reflux temperatures. The substituent effects and steric effects on the reaction were investigated by competition reaction between pairs of amines and a given amount of cerium(IV) sulfate in ethyl acetate. The relative amounts of aldehyde or ketone formed were considered to be indicative of the relative reactivities of the amine used. The results and conclusions of these experiments will be presented.

BREITLAUCH, KARIN-SUSAN and C. Y. CHENG. Department of Chemistry, East Stroudsburg State College, East Stroudsburg, PA 18301. TURBIDIMETRIC DETERMINATION OF SULFATE IN AQUEOUS SAMPLES. — The sulfates in aqueous samples were analyzed by precipitation as $BaSO_4$. Excess $BaCl_2$ was added to the sample, and the precipitate suspended by the use of a conditioning reagent. The resulting turbidity was then measured using a ratio turbidimeter. The method yielded a linear relationship between turbidity and the sulfate concentration ranging between 0.5 ppm to 10 ppm. An exponential relationship was observed for the sulfate concentration in the range of 10 to 90 ppm. This method is particularly suitable for the determination of sulfate in rain water often containing less than 1 ppm sulfate.

MURPHY, CLARENCE J. and JOHN A. MANSON. Department of Chemistry, East Stroudsburg State College, East Stroudsburg, PA 18301. THE EXTRACTION, CHARACTERIZATION AND ABSORPTION SPECTRA OF LIMNANTHES ALBA SEED OIL. — Considerable effort has been devoted in recent years to the search for renewable resource-based materials which can be used as replacements for petroleum-based materials. Castor oil, linseed oil and a number of new botanical oil supplied by the USDA have been investigated at Lehigh University's Materials Research Center for possible use in reinforced elastomers or tough plastics. Among the most agronomically attractive of the potential oil seed crops identified by the USDA is Limnanthes alba, whose seeds during screening tests have been found to yield a triglyceride oil whose fatty acid components are cis-5-eicosenoic acid and mono- and diunsaturated C_{22} acids. Using seeds supplied by the USDA, finely ground Limnanthes alba seeds were extracted with petroleum ether, the extract was washed with sodium bicarbonate solution, treated with fuller's earth and dried over 4A molecular sieves. Removal of the solvent yielded a cloudy yellow oil which was cooled to 4°C to precipitate solids. Filtration of the chilled oil removed a waxy solid and yielded a clear light yellow oil. Based on the dry weight of seeds, the oil recovery was 13%. The physical properties, infrared and nuclear magnetic resonance spectra of Limnanthes alba seed oil have been determined and are consistent with the assigned composition.

WITHUM, JEFFREY A. and JAMES J. REUTHER. Fuels and Combustion Laboratory, The Pennsylvania State University, University Park, PA 16802. SELF-INHIBITION IN SYNTHETIC GAS COMBUSTION. — As the United States strives to better utilize its vast and abundant coal resources, the use of coal-derived synthetic gases will become increasingly important. The problems associated with its use, specifically combustion, must be anticipated for the transition from natural to synthetic gas to occur without technological difficulties. Syngases generally contain three fuels: a fast-burning one (hydrogen), and a slow-burning one (carbon monoxide) compared to the intermediate one (methane), along with inert diluents. The overall combustion characteristics of the syngas cannot be predicted a

priori because the flame behavior of the individual fuel constituents are not additive. Moreover, there is experimental evidence that some of the named fuels may inhibit their own combustion [Kaskan, W.E. and Reuther, J. J.: "Limiting Equivalence Ration, Dissociation, and Self-Inhibiton in Premixed, Quenched, Fuel-Rich Hydrocarbon/Air Flames," Sixteenth Symposium (International) on Combustion, pp. 1083-1095, The Combustion Institute, 1977]. This paper will discuss the results of a comprehensive literature and experimental study to determine and understand the synergism in multi-fuel syngas combustion chemistry.

FANNING, ROBERT J., Jr. and ADAM ANTHONY. Department of Biology, 208 Mueller Lab., The Pennsylvania State University, University Park, PA 16802. PLASMA AND LIVER ACETYLCHOLINESTERASE LEVELS IN RATS EXPOSED TO ACUTE AND CHRONIC HYPOXIA. — Correlative data were obtained on the relationship between circulating plasma acetylcholinesterase (AChE) levels and liver AChE levels in rats subjected to acute (1 hour) and chronic (14 day) hypoxia (380 torr). Plasma AChE was assayed using an automated thiocholine technique; liver tissue AChE activity was quantified using Karnovsky-Roots direct coloring staining and scanning cytophotometry. Plasma AChE was elevated with both acute (70%) and chronic (173%) hypoxia. Liver AChE was elevated in both acute and chronic exposure groups (25%). The coincident moderate and protracted increase in both liver and plasma AChE levels supports the belief that liver tissue is a major site of AChE synthesis. The data also indicate that both acute and prolonged exposure to hypoxia appears to be associated with an augmentation in AChE synthesis and it's release into the circulation.

BOCAN, THOMAS and ADAM ANTHONY. Department of Biology. The Pennsylvania State University, University Park, PA 16802. QUANTITATIVE CYTOCHEMICAL ANALYSES OF ACUTE AND CHRONIC HYPOXIA INDUCED ALTERATIONS IN RNA CONTENT AND CHOLINESTERASE AND DEHYDROGENASE ACTIVITY IN RAT BRAIN AND LIVER SECTIONS. — Quantitative cytophotometric analyses of ribonucleic acid (RNA), cholinesterase (ChE) glucose-6-phosphate dehydrogenase (G-6-PDH), lactate dehydrogenase (LDH), succinic dehydrogenase (SDH), $NADH_2$ and NADPH diaphorase following brief and protracted exposure to decompression hypoxia was undertaken to investigate metabolic alterations in brain and liver functioning associated with reduced oxygen availability. Twenty-one male Sprague-Dawley rats were exposed to an atmospheric P_{O2} of 76 mmHg via decompression hypoxia for 1 hr (acute) and 14 day periods. Cytochemical procedures employed included: tetrazolium staining for dehydrogenase and diaphorase enzymes, direct thiocholine staining for cholinesterase and azure B for cellular RNA. Similar patterns of brain cytochemical were observed with both acute and chronic exposure to hypoxia with more marked changes during the acute phase, i.e. increased neuronal RNA levels, elevated G-6-PDH, LDH activity and lowered extents of SDH and ChE activity. Hepatocytes exhibited elevated RNA levels and ChE activity but no marked changes in dehydrogenase activity. The overall data are consistent with the hypothesis that acute as well as protracted phases of hypoxic

stress entail adaptive metabolic homeostatic alterations in both central and peripheral tissue compartments.

MADONNA, FRANK A. and ADAM ANTHONY. Department of Biology, 208 Mueller Bldg., The Pennsylvania State University, University Park, PA 16802. FEULGEN-DNA ACID HYDROLYSIS PATTERNS IN CAUDATE NEURONS AND HEPATOCYTES IN RATS WITH NORMAL AND LOW PLASMA ACETYLCHOLINESTERASE LEVELS. — Comparative analyses were made of differential Feulgen-DNA (F-DNA) acid hydrolysis patterns of caudate neurons and liver hepatocytes in rats with normal levels ($0.7 \pm 0.1 \mu mol/ml/min$) of plasma acetylcholinesterase (AChE) and low circulating AChE ($0.1 \pm 0.02 \mu mol/ml/min$) to ascertain whether the lability of nuclear chromatin to acid hydrolysis is affected by the availability of endogenous AChE in central and peripheral tissue compartments. F-DNA measurements were made using scanning-integrating cytophotometry and AChE using automated colorimetry. In normal rats, diploid hepatocyte nuclei exhibited higher F-DNA levels than diploid brain nuclei. An increase in acid hydrolyzability of hepatocyte nuclei whereas a decreased susceptibility of brain neurons was evidenced in the presence of low plasma AChE levels. The overall data indicate that in addition to tissue specific differences in Feulgen hydrolysis, the susceptibility of chromatin to acid can be influenced by alterations in AChE levels. The data further attest to the utility of acid lability as an indication of subtle alterations in regulatory aspects of DNA transcriptional metabolic functioning.

BAIRD, RONALD E., SHARON FELDMAN and THOMAS P. BUCKELEW. Department of Biology. California State College, California, PA 15419. THE EFFECTS OF GOLD THIOGLUCOSE ON MICE: HYPERPHAGIA, OBESITY, AND HYPOTHALAMIC LESIONS…A PRELIMINARY REPORT. — Ten Swiss laboratory mice were injected with a single dose of gold thio-D-glucose, resulting in the death of five mice within three days, presumably due to hyperphagia. The majority of the survivors showed varying degrees of excess weight gain relative to the Ringer's solution-injected control group. All mice were sacrificed twelve weeks post-injection and their brains removed for microscopic study. The brains of the experimental and control mice as well as the brains of the dead hyperphagic mice were fixed in gluteraldehyde and osmium tetrozide, dehydrated in a series of acetones, and embedded in Spurr's resin. Semi-thin sections were obtained from the vicinity of the hunger and satiety center of the hypothalamus using glass knives with the Porter-Blum MT-2 ultramicrotome. These glass slide-mounted sections were stained with 0.1% toluidine blue. Histological changes in the experimental group were noted and recorded using the Zeiss Photomicroscope II.

FELDMAN, SHARON L., RONALD E. BAIRD and THOMAS P. BUCKELEW. Department of Biology. California State College, California, PA 15419. THE EFFECTS OF THIO-GLUCOSE ON BODY WEIGHT AND HYPOTHALAMIC HISTOLOGY…A PRELIMINARY REPORT. — Five mice were injected daily with measured doses of thio-D-glucose for six weeks. Daily weights were recorded and no significant in-

crease could be ascertained in the experimental group relative to the control group. After six weeks, all the mice were sacrificed and the brains removed. The brains were fixed in glutaraldehyde and osmium tetroxide, dehydrated in a graded series of acetones and embedded in Spurr's resin. Semi-thin sections of the hunger and satiety center in the hypothalamus were obtained using glass knives with the Porter-Blum MT-2 ultramicrotome and were subsequently stained with 0.1% toluidine blue. Histological features of members of the experimental and control group were recorded using the Zeiss Photomicroscope II.

HAAS, JOSEPH F., JOHN B. SCHUMAN and Rev. JOSEPH C. GREGOREK. Gannon University, Erie, PA 16541. STUDIES ON THE DEVELOPMENT OF EARLY CHICK EMBRYOS I.—The morphology of unincubated and early stage chick blastoderms was investigated by light and transmission electron microscopy. The blastoderm consisted of two layers of cells, the epiblast, and hypoblast. Epiblast cells were distinguishable from hypoblast cells in that the former were larger, contained fewer intracellular yolk spheres, and displayed smaller intercellular spaces. The epiblast of the unincubated blastoderm formed a continuous sheet, but there was some variation in the progress of development of the hypoblast. Cells comprising the epiblast were more coherent than the underlying hypoblast cells, and assumed characteristics of a simple epithelium. Junctional complexes between adjacent epiblast cells were represented by focal tight junctions immediately beneath the cell apex and intermediate junctions (zonula adherens) in the basal region. The hypoblast was a loosely coherent layer of irregularly shaped cells which displayed regional differences in development along a caudo-cephalic axis. The cytoplams of hypoblast cells was rich in yolk which appeared to displace cellular organelles to a peripheral position. During the early hours of incubation, the adhesion of some epiblast cells appeared to be lost or reduced. Eventually, these cells were released into the subgerminal cavity and contributed by delamination to the forming hypoblast.

SCHUMANN, JOHN B. Department of Biology, Gannon University, Erie, PA 16541. STUDIES ON THE DEVELOPMENT OF EARLY CHICK EMBRYOS II.—The morphology of the unincubated chick blastoderm was investigated by scanning electron microscopy. Apical surfaces of epiblast cells tended to bulge outward and were relatively smooth with occasional surface projections. Localized areas of apparent membrane continuity suggested sites of focal tight junctions between adjacent epiblast cells. Mid-sagittal sections demonstrated regional morphological variation along a caudo-cephalic axis. Epiblast cells tended to be more cuboidal shaped in the embryonic shield region grading into a single layer of tall columnar epithelium cephalically. The hypoblast development varied along the same axis corroborating the light and transmission electron microscopic study. In general, three groups of hypoblast cells could be recognized as follows: (1) stratified layers of cells in the caudal region corresponding to the embryonic shield, (2) clusters of cells in the central region of the zona pellucida, and (3) scattered cells located more cephallically.

NIXON, CRAIG E. Department of Biology, Lafayette College, Easton, PA 18042. DEVELOPMENT OF THE BACULUM (OS PENIS) IN THE LABORATORY MOUSE.—A penile bone has been found in a large number of mammals in anatomical studies. A few workers have examined the development of the bone, but no study has been done on the early stages. This study reports on the early development of the baculum in the laboratory mouse. The pelvic region was removed and fixed in Schmidt's fluid, serially sectioned at ten microns and stained in haematoxylin and eosin. The baculum develops by intracartilaginous bone formation. In newborn mice, mesenchymal cells appear in the location where the bone will form. During day two, cartilage begins to form. The breakdown of cartilage and formation of the bone matrix are present by day eight. From the eighth day to the fifteenth, growth and development progress from the proximal end to the distal until the bone reaches its full histological differentiation.

SKINNER, W. F., R. B. DOMERMUTH. Pennsylvania Power & Light Co., Allentown, PA 18101 and J. M. BURKE, NUS Corp., Pittsburgh, PA. USE OF FLOY-TAGGED FISHES IN BIOMONITORING FOR CHRONIC IMPACTS OF AN INDUSTRIAL EFFLUENT.—Largemouth bass (Micropterus salmoides) and several other game/pan species have been individually Floy-tagged and released at a number of stream locations inside and outside the impact area of an industrial waste treatment basin effluent. Study objectives are to evaluate survival and movement of tagged fishes through periodic recapture during seasonal ichthyofaunal surveys and angler returns, and to establish the feasibility of utilizing recaptured fish to document possible bioaccumulation of discharged wastewater components. Data from recaptures one month after release indicated some fish remain relatively close to the release point, while others travel considerable distances, even traversing the effluent mixing zone.

VAVRECK, SUSAN M. and WILLIAM G. KIMMEL. Department of Biology, California State College, California, PA 15419. THE ACUTE TOXICITY OF AN ICE-MELTING COMPOUND (ANHYDROUS CALCIUM CHLORIDE) TO TWO SPECIES OF CYPRINIDS.—The acute toxicity of an ice-melting compound (anhydrous calcium chloride) was determined for the emerald shiner, Notropis atherinoides and the blacknose dace, Rhinichthys atratulus. A series of static tests were performed using the 96-hour LC50 as the toxicity criterion. At each test concentration, ten fish of approximately the same size were exposed and a similar control group maintained. Dead fish were removed at 24, 48, 72, and 96 hour intervals, and all tests were terminated after 96 hours. The 96-hour LC50 values were determined by graphical interpolation. Both species exhibited a 96-hour LC50 of 5750 mg/l for this compound.

DENONCOURT, ROBERT F. and DARRYL L. EBERLY. Department of Biology, York College of Pennsylvania, York, PA 17405. DISTRIBUTION OF FISHES IN THE SUSQUEHANNA RIVER DRAINAGE OF YORK COUNTY.—Over 280 collections at 114 stations from 1969 through 1981 form the basis for the distribution of fishes in the Susquehanna River and ten subdrainages of 4 or more square miles within York County. Additionally, records of the Pennsylvania Fish Commission and the Pennsylvania Department of Environmental Resources bring the known number of species to 55 plus 6 expected for a total of 61 fish species representative of 13 families. The distributions of Clinostomus funduloides, Ericymba buccata and Notropic volucellus are extended.

WERT, JEFFREY R. and MELVIN C. ZIMMERMAN. Department of Biology, Lycoming College, Williamsport, PA 17701. A MACROINVERTEBRATE SURVEY AND BIOTIC INDEX WATER QUALITY ESTIMATE FOR THREE PENNSYLVANIA STREAMS (POCONO CREEK AND McMICHAELS CREEK, MONROE CO.: MILL CREEK, LYCOMING CO.).—Six benthic samples from each of six sites, along the Pocono and McMichaels Creeks were collected during June and August (1981) for determination of density, species diversity and water quality, as estimated by the biotic index (BI) described in Hilsenhoff (1977). The BI classification of both streams is good, with possibly some disturbance or organic enrichment. Seasonal variations (June, October, April) in BI water quality estimates were checked from samples collected at two sites, above and below an agricultural-enriched area, along Mill Creek. Base line data on velocity, dissolved oxygen, pH, alkalinity, nitrogen and phosphorus are presented for all streams.

WOLFE, ALLAN F. Department of Biology, Lebanon Valley College, Annville, PA 17003. DISTRIBUTION OF CYZICUS MEXICANUS IN LEBANON COUNTY, PENNSYLVANIA (CONCHOSTRACA: CRUSTACEA).—One hundred and twenty sites in Lebanon County, with at least one sample from each of the twenty-six municipalities, were examined to determine the distribution of Conchostraca. Cyzicus mexicanus was found in small temporary pools at one site in Union and East Hanover and at two sites in Bethel and South Londonderry. Various physical, chemical, and biological data were obtained from sixty-four of these sites. In the six sites where Cyzicus was found, the water could be characterized as neutral (pH 6.7 to 7.5), low in oxygen (2 to 5 mg/L), high in carbon dioxide (16 to 22 mg/L), and very turbid (430 to 2400 FTU). The distribution of this conchostracan appears to be limited primarily by the presence of predators, especially fish; since several bodies of water had physical and chemical characteristics similar to those in which Cyzicus occurred.

ZIMMERMAN, MELVIN C. Department of Biology, Lycoming College, Williamsport, PA 17701. LIMNOLOGICAL CHARACTERISTICS OF THE TWO MUNICIPAL WATER AUTHORITY RESERVOIRS FOR WILLIAMSPORT, PA (LYCOMING COUNTY).—In cooperation with the Williamsport Municipal Water Authority, a comprehensive limnological study was initiated in April (1981) on their two 530 million gallon capacity reservoirs. Both the Heller Impoundment, which is fed by Hagerman's Run and discharge from springs, and the Mosquito Valley Reservoir, which is the headwaters of Mosquito Creek and is filled from spring discharges, have their watershed bordered by the North White Deer Ridge. Monthly (April, May, September, October, November) and weekly (during June, July, August) variations in productivity (light-dark bottle and chlorophyll-a), dissolved oxygen, pH, alkalinity, transparency, concentration of nutrients (nitrogen and phosphorus) and heavy metals (Al, Cd, Cr, Cu, Fe, Pb, Hg, Ni, Ag, Su, and Zn) were monitored. Collections of phytoplankton and zooplankton were made for density and species diversity determinations. The Heller Impoundment is the more eutrophic of the two reservoirs. A discussion of the critical difference in the iron content of the two reservoirs will be made.

NOLLENBERGER, EARL L. Department of Biology, Shippensburg State College, Shippensburg, PA 17257. A COMPARISON OF TWO MINNOWS, Notropis amoenus AND Notropis rubellus, FROM THE SUSQUEHANNA AND POTOMAC DRAINAGES IN SOUTH CENTRAL PENNSYLVANIA.—Notropis amoenus (Abbott), the Comerly shiner, and Notropis rubellus (Agassiz), the Rosy-faced shiner, are similar and often confused species. Nine meristic and six morphometric characters, melanophore pigmentation and breeding characteristics were examined in five collections of live specimens and seventeen collections of preserved specimens to identify external characters useful in field and/or laboratory identification. Anal fin ray and total pectoral fin ray counts, body circumferential scale counts above the lateral line, and snout length/eye length ratios in specimens between 40 and 55 mm standard length proved useful in identification in the laboratory. Melanophore pigmentation of the gular region, anterior lateral line, anterior dorso-lateral scale pockets, mid-dorsal stripe and ventral surface of the caudal peduncle proved useful in field and laboratory identification. Only three characters are of consistent value: the red breeding color in live specimens of Notropis rubellus, the differences in tuberculation of the pectoral fin rays in breeding males, and the gular melanophore pigmentation in Notropis amoenus. The other characters may overlap or exhibit clinal variation and therefore should be used to support the identification of specimens and not be the sole criterion.

MERCANDO, NEIL A. Department of Biology, Pennsylvania State University, Ogontz Campus, Abington, PA 19001. POPULATION DYNAMICS OF BROWN TROUT AND WHITE SUCKERS FROM TWO PENNSYLVANIA STREAMS.—The net production of brown trout and white suckers from a hard-water and a soft-water stream was compared as a measure of the effect of water fertility upon the fish populations. Estimates of the standing crops, growth rates, relative condition, and net production of the populations were made and compared on an intra- and interspecific basis. The standing crops of brown trout from fertile Spring Creek (87 lbs/acre) and infertile Brodhead Creek (70 lbs/acre) were similar, although the fish from the former stream grew faster and on the average were larger. Thus, the net production of trout was greater in Spring Creek. The standing crop of white suckers in Spring Creek (326 lbs/acre) greatly exceeded that in Brodhead Creek (39 lbs/acre). The former population exhibited good reproductive success but high mortality after the first year of life. The Brodhead Creek sucker population appeared very unstable with variable recruitment. The larger standing crop, faster growth rate, better relative condition, and larger net production in the Spring Creek population reflects the greater abundance of

available food in the fertile stream. The difference in the net production between the sucker populations was much greater than that between the trout populations. The restricted benthic food supply found in the infertile stream appears to have a greater limiting effect on the sucker population than on the trout population in Brodhead Creek.

BRYNE, THOMAS, DIANE HLAVIN and JOHN J. DROPP. Department of Science and Mathematics, Mount Saint Mary's College, Emmitsburg, MD 21727. DISTRIBUTION, HISTOCHEMISTRY AND LIGHT AND ELECTRON MICROSCOPIC MORPHOLOGY OF MAST CELLS IN THE AMERICAN CHAMELEON (ANOLIS CAROLINENSIS). Mast cells (MC's), which were characterized at the light microscopic level by the possession of chromatic nuclei and cytoplasmic granules stained metachromatically by toluidine blue, thionin or safranin and orthochromatically by alcian blue, were studied in eleven adult chameleons. They were most numerous in the connective tissue associated with the anterior-most portions of the alimentary and respiratory tracts. Smaller numbers of MC's were seen in the skin, pancreas, lung, brain, ganglia, liver and skeletal muscle. They were never detected in the stomach, intestine, spleen, kidney, ovary or testes. The predominant feature of intact MC's at the electron microscopic level was the presence of intermediately (88%), dark (9%) or light (3%) stained ovoid (82%), round (16%) or irregularly (2%) shaped cytoplasmic granules. Degranulated MC's were characterized by the presence of large, irregularly shaped, almost empty lacunae which contained varying amounts of loosely-arranged granular material. Degranulated MC's also contained large numbers of pinocytotic vesicles. In addition to centrioles and a very poorly formed golgi apparatus both intact and degranulated MC's possessed small numbers of the following organelles: microvilli, mitochondria, free ribosomes and cisterna of either rough or smooth endoplasmic reticulum.

BLETZ, WENDY E. and W. JEFFERY BURROUGHS. Juniata College, Huntingdon, PA 16652. THE EFFECTS OF SELF-MONITORING ON PERSONAL SPACE.—Attempts at studying personal space have used a wide variety of measurements techniques to attack the concept. Often, different measures produce widely varying estimates of distances where one would expect convergent validity. Such measurement problems have lead several authors to call for a reevaluation of the entire concept (Hayduk, 1978). Alternatively, it is possible that individual differences in sensitivity to cultural distancing norms may have prevented clearer evidence of convergent validity. As a first step in testing this notion, it was hypothesized that persons high in the trait of self-monitoring would be more sensitive to these norms than those low in that trait. High self-monitors should therefore display lower variability across different measures of personal space than low self-monitors. In this study, thirty subjects completed a self-monitoring scale and four Comfortable Interpersonal Distance Scales (CIDS) under conditions which varied the sex and degree of relationship of the stimulus individual. It was predicted that those subjects who scored highly on the self-monitoring scale would have less variability in measures of their personal space than those low in self-monitoring. The results showed that for two of the situations on the CIDS, opposite sex friend and same sex friend, the prediction was supported. Results are discussed in terms of a

model of interpersonal distancing based on individual differences in sensitivity to culturally learned rules.

MEDEIROS, ROBERT W. Department of Chemistry, West Chester State College, West Chester, PA 19380. SOME OBSERVATIONS REGARDING THE PASSAGE OF TIME. The phenomenon of time has both its objective and its subjective aspects. Not only do we reckon its passage through conventional timepieces, we also have internal "clocks" that are linked to one's physiology and state of consciousness. The rate of passage of such internal time is not at all uniform. We tend for example to perceive it as moving by more rapidly as we grow older, something that is believed to be associated with a slowing of the basal metabolic rate. Neither is time's passage always uniform in an external sense. The evolution of life forms over the earth's history seems to have proceeded in accordance with a steadily contracting time scale. The closer we come to the present, the faster, apparently, has been the rate of change. The same may also be said regarding the rate of cultural change in human society. What significance, if any, is there to this?

DEPLOEY, JAMES J. Department of Biology, Pennsylvania State University, York Campus, York, PA 17403. GERMINATION OF MUCOR PUSILLUS SPORANGIOSPORES IN AIR AND IN REDUCED OXYGEN ATMOSPHERES.—The influence of nutrients and reduced oxygen atmospheres on the germination of sporangiospores of the thermophilic fungus Mucor pusillus Lindt was determined. Sporangiospores of M. pusillus were inoculated into 9 types of liquid media and incubated (45 C) for varying periods of time in air and reduced oxygen atmospheres. Germination of sporangiospores was detected at the third hour of incubation in air in 3 of the 9 types of liquid media used. Decreasing the amount of oxygen in the incubator atmosphere decreased the rate of sporangiospore germination. Sporangiospores germinated in 3 of the 9 solutions when incubated for 30 hours in pure nitrogen atmospheres. The rate of germination increased as the oxygen content of the incubator atmosphere increased to 0.3, 0.7, and 1.0 percent.

KROEHLER, PETER A. and WILLIS RATZLAFF. Department of Biology, Millersville State College, Millersville, PA. HERPETOFAUNA OF LANCASTER COUNTY, PENNSYLVANIA.—During the spring, summer, and fall of 1980, a survey of the herpetofauna of Lancaster County, Pennsylvania was made. Of the 56 species known to have existed in the county, only 40 were observed. The 16 not observed are known to have existed recently or occur in areas adjacent to Lancaster County. Some species are abundant and widespread while others appear to be scarce and limited to small areas. Some species probably have disappeared from the county and others probably are disappearing. Species observed include ten salamanders, seven frogs, two toads, seven turtles, two lizards, and twelve snakes.

ALDEN, HARRY, ALLISON DION and WILLIAM YURKIEWICZ. Department of Biology, Millersville State College, Millersville, PA. ARISTOLOCHIC ACID INHIBITION OF MOUSE RED BLOOD CELL MEMBRANE DISASSEMBLY BY RATTLESNAKE VENOM.—Aristolochic acid, a consti-

tuent of Virginia snakeroot (Aristolochia serpentaria), was incubated with rattlesnale venom (Crotalus horridus horridus) prior to injection of the venom into laboratory mice. Venous blood was collected from the mice at different time periods following injection and examined for red cell membrane disassembly. Incubation of venom with aristolochic acid resulted in less membrane damage to red cells and fewer deaths as compared to control mice.

DAVENPORT, SUSAN DIANE. Student, Juniata College, P.O. Box 297, Huntingdon, PA 16652. RELATION BETWEEN MEASURES OF MIRROR DISPLAY AND BEHAVIOR IN PAIRED ENCOUNTERS IN SIAMESE FIGHTING FISH (BETTA SPLENDENS).—Betta splendens have long been a popular research subject, primarily because of their propensity to engage in agonistic display. Most of this research has looked at various properties of the display itself; less attention has been directed at the relation between properties of the display and success in actual paired encounters. Cain, et. al. (1980) have found that fish housed together for several days continued to display and that dominant fish were no more likely to display than those lower in the hierarchy. The present study attempted to enhance our knowledge of the role of the display in paired encounters by taking several measures of willingness to display to a mirror (latency to display, duration of display, number of shocks required to surpress the display) and then pairing fish for actual fights. Fight winners did not differ from losers with respect to any of the measures of willingness to display (t-tests). A second analysis used differences in display measures to predict fight durations to test the hypothesis that fish equally willing to display to a mirror would have longer fights than those with large initial differences in propensity to display. Only differences in display duration correlated with fight.

BRENNER, FRED J., R. BRUCE KELLY and JEFF KELLY. Department of Biology, Grove City College, Grove City, PA 16127. MORPHOLOGICAL AND PHYSIOLOGICAL CHARACTERISTICS OF THREE SPECIES OF SMALL MAMMALS ON SURFACE MINED LANDS.—Populations of Microtus pennsylvanicus, Peromyscus leucopus and Blarina brevicauda were sampled by snap trapping on 12 surface mines in Mercer County, Pennsylvania. The age composition and morphological characteristics of the three species did not vary significantly among the different populations. The number of animals showing visible pregnancy, lactation, adrenal weight and body fat was significantly correlated with population size but differences occurred in these relationships among the three species.

PRATT, CARL R. Department of Biology, Penn State Wilkes-Barre, P.O. Box 1830, Wilkes-Barre, PA 18708. GERMINATION AND SEEDLING ESTABLISHMENT OF GRAY BIRCH (BETULA POPULIFOLIA) ON ABANDONED ANTHRACITE COAL MINE SPOILS IN NORTHEAST PENNSYLVANIA.—Gray birch is often the predominate species of the local flora on anthracite mine spoils in NE Pennsylvania. Observation that gray birch grows on spoil areas where little else does, suggests that birch trees have solved some of the environmental problems inherent on the spoil banks. These en-

vironmental factors have apparently excluded other species which are capable of colonizing other types of abandoned habitat in the region. In order to address the problem of colonization of mine spoil areas by gray birch, a series of laboratory and field germination studies were conducted during the spring and summer of 1981. The following observations were made: (1) Soils of spoil areas on which birch trees have recently established are nutritionally equivalent to adjacent sites without such incursion of trees. (2) Ambient conditions of temperature, pH and moisture may not be conducive to germination. (3) Preliminary transplant experiments suggest extremely high mortality during the first year of establishment. A cohort of seedlings monitored during the summer of 1981 suggest mortality may be as high as 85%. The possible ecological implications of the seed germination and seedling establishment phases of the birch tree life cycle will be discussed.

WEBSTER, HAROLD J. and THERESA TRUCKENBRODT MUNGEOLI. Pennsylvania State University, DuBois, PA 15801 and Newark, Delaware 19702. EFFECT OF pH ON SEED GERMINATION OF STRIPMINE RECLAMATION SPECIES.—Seed germination of five species commonly used in stripmine reclamation was compared with radish germination, used as a control species. Percent germination was determined afer 72 hours on a phosphate buffer/distilled water solution and on a phosphate buffer/Bristol's solution at four pH levels. Honey locust, bird's foot trefoil, korean lespedeza and red clover germinated well at pH levels of 3.0, 3.5, 4.0, and 4.5 while radish and red clover germination were reduced on pH 3.0 solutions. Preliminary tests with limed and unlimed soil from a stripmine and with water extracts of these soils show germination and substrate pH may be less important than post-germination factors in determining seedling establishment in reclamation efforts.

LANGE, JOHN H. and E. C. AHARRAH. Departments of Biology, University of Toledo, Toledo, Ohio 43606 and Clarion State College, Clarion, PA 16214. COMPARISON OF SEVERAL METHODS FOR DETERMINING THE POPULATION OF SOIL BACTERIA FROM RECLAIMED STRIP-MINES ON GAME LANDS 72, CLARION COUNTY, PENNSYLVANIA.—Soil was collected from Game Lands 72, Paint Township, Clarion County, Pennsylvania weekly during February 23 to April 2, 1981, using aseptic techniques. A survey of the bacterial population was made using the most probable number (MPN) method with albumin, diluted albumin, diluted nutrient broth and plate counts using nutrient agar. Data indicatd that albumin and diluted albumin estimates the total bacterial population better than other media tested for reclaimed strip-mines.

GOLDNER, WILLIAM R. and FRANK M. HOFFMAN. Department of Biology, Slippery Rock State College, Slippery Rock, PA 16057. ANTIBIOTIC EFFECTS OF TOLUENE-ACETONE EXTRACTS OF CLADONIA CRISTATELLA TUCK. ON A PATHOGENIC FUNGUS, TRICHOPHYTON MENTAGROPHYTES.—Significant inhibition of mycelial growth of the pathogenic fungus, Trichophyton mentagrophytes, was observed when the fungus was grown on modified Sabouraud's Agar impregnated with a toluene-acetone extract,

1:3, of the lichen *Cladonia cristatella,* at 25 C. *C. cristatella* is known to possess substances with antibiotic potential, including the dibenzofuran derivatives, didymic and usnic acids. Further studies of the antibiotic effects of *C. cristatella* extracts include other pathogenic fungi, mycorrhizal fungi, and seeds of graminaceous and leguminous species. The physiological ecology of *C. cristatella,* growing in predominance on certain strip mine spoils of Butler and Venango counties of Western Pennsylvania, is being examined with deference to possible allelopathic potential and its implications on succession. Determination of the extract's substituents by standardized thin-layer chromatography and UV spectroscopy is being determined. Microchemical crystallization of the extract's components is being performed. A secondary bioassay will be implemented to determine the active constituents of the *C. cristatella* extract.

MUZIKA, ROSE-MARIE, ERNEST C. AHARRAH and JOHN H. LANGE. Department of Biology, Clarion State College, Clarion, PA 16214. SURVIVABILITY OF *RHIZOBIUM JAPONICUM* IN STERILE AND UNSTERILE STRIP-MINE SPOIL.—Strip-mine spoil from Gamelands #72, Paint Township, Clarion County, Pennsylvania was collected in the spring, 1981. The spoil was originally tested for the presence of *Rhizobium* and placed in clay pots, half of which were sterilized by autoclaving, while the other pots remained untreated. A known amount of *Rhizobium japonicum* was added to each pot. The pots were sampled each week thereafter, for five weeks, to determine growth and survivability of the bacteria. No growth was apparent in the sterile spoil after the first week, but unsterile spoil yielded growth that remained similar throughout the sampling period. A difference was indicated between spoil treatments at the 99% level of significance using a three-level nested analysis of variance.

MOORE, RICHARD A., ADAM ANTHONY, WILLIAM H. NEFF and GERALD STORM. Department of Biology, 208 Mueller Laboratory, The Pennsylvania State University, University Park, PA 16802. CYTOPHOTOMETRIC CORRELATES OF ALTERED RABBIT HEPATOCYTE METABOLIC FUNCTIONING FOLLOWING DIETARY PROTEIN AND/OR CALORIC INTAKE DEPRESSION.-A total of 36 captive male cottontail rabbits were randomly divided into 4 groups and placed on the following diets for a six weeks period: (1) 2500 digestable energy (DE) with 16% protein; (2) 2500 DE with 6% protein; (3) 2100 DE with 16% protein; and (4) 2100 DE with 6% protein. Dietary induced alterations in hepatocyte DNA, RNA, and protein contents were monitored utilizing Vickers M85 Scanning Integrating Microdensitometry following Feulgen-DNA, Azure-B RNA, and Mercuric Bromophenol Blue protein staining. Dietary protein deficiency depressed hepatocyte RNA and DNA levels irrespective of caloric intake. Reduced caloric intake, however, augmented Feulgen-DNA and RNA staining in animals on 16% protein diets; DNA content, but not RNA content, was elevated by caloric restriction following diets of 6% protein. The overall data indicate protein deficiency markedly depresses hepatocyte metabolic functioning whereas an elevation in metabolic functioning occurs in response to caloric deprivation.

TUROCZI, LESTER, MARC CLIFFORD and GARY DUGAN. Department of Biology, Wilkes College, Wilkes-Barre, PA 18766. UTILIZATION OF THE AMES TEST TO DETERMINE DOSAGE EFFECTS OF L-ASCORBIC ACID AND D1 ALPHA TOCOPHEROL.—Recent trends in human vitamin usage indicate that, in some cases, certain vitamins may have beneficial effects especially when employed in high doses. Since controversy surrounds such self-dosing regimens, these experiments were designed to investigate the relative safety of L-Ascorbic Acid (vitamin C) and d1 alpha Tocopherol (vitamin E) at different dosage levels. Pilot results revealed that Ascorbic Acid provided an inhibitory effect on the rate of reverse mutation in the Salmonella tester strains of the Ames Test for mutagenicity. When tested with a known mutagen, sodium azide, this inhibitory effect manifested itself as an antimutagenic or "protective" effect. Thus Ames testing was pursued using these two vitamins at various doses, alone and in combinations. Experiments were performed according to Ames protocol both with and without S-9 microsomal activation. Furthermore these vitamin combinations (C + E) were tested against the mutagen sodium azide. As a means of determining the effect of human metabolism, these dosages were investigated by using urine samples from healthy human male subjects who were given the vitamins orally on a daily basis.

DAVIS, ROBERT H. and HOWARD S. PITKOW. Department of Physiology, Pa. College of Podiatric Med., Philadelphia, PA. A NATURAL INFLUENCE ON ADJUVANT INDUCED ARTHRITIS IN RATS.—Adjuvant induced arthritis in rats closely resembles rheumatoid arthritis in man. Heat killed *mycobacterium brutyricum* in oil was injected into the right paw of adult male Sprague-Dawley rats. Our study consisted of two phases: prevention of the disease state and regression of an already established arthritis. Oil injected and adjuvant treated rats, each, served as controls receiving no therapeutic treatment. Hind paw volumes measured by mercury displacement were used to monitor the disease state. The left paw edema was considered to be the result of an immunologic phenomena whereas the right injected paw swelling related to inflammation. Volume readings were recorded from day 0 through day 38. A daily 150 mg 1 Kg subcutaneous injection of either ascorbic acid, thymus extract, aloe plant extract, RNA or DNA was given over the first 13 days for prevention. The treatment plan for regression was similar to the prevention phase except for a 21 day delay (day 21 through day 33). These natural occuring non-steriodal substances showed varying degrees of effectiveness in reducing the disease. For example, aloe extract was anti-inflammatory whereas ascorbic acid was immunosuppressive. This work may help find a tool for treating rheumatoid arthritis.

LIZAK, MARK A. and WILLIAM H. NECHES. California State College, California, PA 15419, and Univ. of Pittsburgh, Pittsburgh, PA 15213. ABNORMALITIES OF THE PEDIATRIC CARDIAC ELECTRICAL SYSTEM FOLLOWING OPEN HEART SURGERY.—In recent years it has become apparent that late death may occur suddenly in patients who have had open heart surgery. This infrequent problem can occur sud-

denly in seemingly healthy patients and has prompted medical research into the underlying causes of this problem. Researchers have suggested that a possible cause for late death may be heart rhythm irregularities, consisting of either extra heart beats from the ventricles, or possible interference with the normal mechanism of electrical conduction within the heart. Numerous postoperative electrical studies of heart patients who have undergone open heart surgery have been conducted at Children's Hosptial of Pittsburgh. In some patients, we find electrical abnormalities, yet these patients are asymptomatic. The presence of these electrical abnormalities suggest that the electrical system of the heart has been damaged. Additional sophisticated intracardiac electrophysiological studies have been performed in approximately four hundred patients at Children's Hospital. These studies involved the use of a special pacemaker that provides detailed information as to the specific site of these electrical heart abnormalities. The sum of these electrical data should have prognostic significance regarding the future of patients who have undergone open heart surgery.

PETERMAN, KEITH E., C. L. PINKOWSKI and M. F. RAUB. Department of Chemistry, York College of Pennsylvania, York, PA. ENZYME ASSAY UTILIZING NUCLEAR MAGNETIC RESONANCE TECHNIQUES.—A Varian EM-360L NMR was used to assay single and multiple substrate hydrolysis reactions for a variety of N-acyl-L-amino acids with the enzyme aminoacylase (3.5.1.14). The change in the NMR spectrum was monitered for incubated systems followed by heat denaturization as well as for dynamic in vitro reactions. Michaelis constants and specific activity were determined.

CANCELLIERE, KEVIN E., *B. Ann SEDITA and T. E. O'CONNOR. Student, Allentown College of St. Francis De Sales, Center Valley, PA and Division of Biological and Medical Research, Argonne National Laboratory, Argonne, IL 60439. ELECTROPHORETIC ANALYSIS OF PROTEINS ASSOCIATED WITH TUMOR-SPECIFIC CHROMATIN ANTIGENS.—Chromatins contain tissue-specific or tumor specific antigens (F. Chytil and T. C. Spelsberg, Nature New Biol. 233, 217, 1971; K. Wakabayashi and L. S. Hnilica, ibid 242, 144, 1973). Previsou studies in this laboratory indicatd that Novikoff rat hapatoma chromatin (NC) dihistonized chromatin (DHC), and a chromatin fraction (HC) that contains 5% of the chromatin protein all contain equivalent amounts per unit DNA of the antigen as detected by quantitative complement-fixation with antisera raised to DHC in rabbits. This study investigates the proteins associated with these fractions. Proteins were removed from the fractions with 1% SDS in 50mM Tris-HCl, pH 8, and analyzed on disc or slab gels (D. M. Neville, J. Biol. Chem., 246, 6328, 1971) employing a 3% acrylamide stacking gel and a 10% acrylamide separation gel and on disc 11% acrylamide-phosphate gel (A. L. Shapiro, Biocehm. Biophys. Res. Comm. 28, 815, 1967). The profiles of the NC, DHC, and the HC protein fractions were indistinguishable. This finding renders improbable the explanation that specific antigenicity arises from a qualitatively distinct subset of proteins. The data are consistent with the interpretation that specific antigenicity arises from specific protein-DNA conformations and/or substituents on the proteins.

*Work performed in the Division of Biological and Medical

Research, Argonne National Laboratory, while a student of the Undergraduate Research Program, administered by the Argonne Division of Educational Programs; work supported by the U. S. Department of Energy under contract No. W-31-109-ENG-38.

ARMSTRONG, STUART H., II and GLEN G. WURST. Department of Biology, Allegheny College, Meadville, PA 16335. SUPPRESSION OF THE GROWTH OF A MOUSE MAMMARY TUMOR BY ANDROGEN TREATMENT.—The hormone responsiveness of a spontaneously arising transplantable mouse mammary tumor was investigated. The tumor, previously shown to be estrogen-independent, was transplanted into male C3HeB/FeJ mice after being maintained in female mice of the same strain for 58 generations. The male mice, left reproductively intact, were divided into three groups and injected subcutaneously with (1) testosterone propionate (5ng/g body weight), (2) β-estradiol (5ng/g body weight), and (3) slaine, respectively. Injections were made every three days over a period of 18 days. Mice were killed at various intervals during this experiment and the weight of each tumor recovered was determined. Testosterone was found to suppress tumor growth over the duration of the experiment. Estradiol did not significantly affect tumor growth. We believe that this is the first demonstration of a mammary tumor whose gowth is both unaffected by estrogens and inhibited by androgens.

STRICKBERGER, S. ADAM and THEODORE M. HOLLIS. Department of Biology, The Pennsylvania State University, University Park, PA 16802. RELATIONSHIP BETWEEN HISTAMINE SYNTHESIS AND AORTIC ALBUMIN ACCUMULATION IN EXPERIMENTAL DIABETES.—Atherosclerosis represents a major cardiovascular complication of diabetes, and diabetes constitutes one independent risk factor of atherosclerosis. In the present study, aortic albumin accumulation has been examined in relation to alterations in aortic histamine synthesis, since increased histamine synthesis, decreased histamine catabolism, and increased intraendothelial and smooth muscle histamine contents occur in experimental diabetes as well as in other atherogenic states. Diabetes was induced in rats by streptozotocin (60 mg/kg, i.v.), with animals held for 4 weeks following overt manifestation of diabetes, i.e. plasma glucose concentrations greater than 275 mg/dl. During the 4th week, some received alpha-hydrazinohistidine (alpha-HH, 25 mg/kg, i.p. @ 12 h). Animals were injected with fluorescein isothiocyanate conjugated to rat serum albumin (FITCRSA), and the intima-media mass transfer rate of FITCRSA was determined. Mean data (cm/sec X 10^{-6}) are as follows: control, 6.84 ± 2.39; nondiabetic-alphaHH, 2.89 ± 0.18; diabetic, 21.30 ± 4.72; diabetic-alphaHH, 4.01 ± 0.26. This alphaHH dose completely blocks alterations in histamine synthesis observed in diabetic aortic endothelial and smooth muscle cells. The overall data are consistent with the hypothesis that de novo histamine synthesis mediated via histidine decarboxylase plays a significant role in mediating increased arterial wall macromolecule permeability, a process constituting an initial event in the atherogenic process, and that this may likewise be a factor contributing to the atherogenicity of diabetes as well. (Supported by USPHS, NIH grant HL 20460).

KEIPER, RONALD R. Department of Biology, Pennsylvania State University, Mont Alto, Mont Alto, PA. NURSING BEHAVIOR IN FERAL PONY FOALS.-Nursing Behavior of 90 feral pony foals living on Assateague Island was studied over a period of 5 years. Data were collected from over 2000 individual nursings covering the time period from an hour after birth to 28 months of age. The frequency of nursing decreased with increasing age, but there was no significant decrease in nursing frequency after 12 weeks of age. The length of a nursing bout also decreased with increasing age, but again did not decrease significantly after about 10 weeks of age. In most foals nursing continued for almost 12 months, and weaning occurred when the mare produced the next foal. If the mare failed to foal, then the previous year foal continued to nurse for about 18 months. There was no significant differences in the side from which the foal nursed. Similarly, there were no differences in nursing behavior between male and female foals. Evidence will be presented to suggest that proper foal nursing behavior contains a large learned component as well as an innate component.

BRENNER, FRED J. and TERRI L. LENOX. Department of Biology, Grove City College, Grove City, PA 16127. EFFECT OF NEST BOXES ON POPULATION GROWTH IN CF-1 MICE.—Two populations with and without nesting boxes were established and the populations monitored over a 5-month period. The population with nesting boxes had a higher reproductive rate, lower infant mortality and obtained a greater density than the population without nest boxes. Females from both populations, when offered a choice of where to nest, had a significant preference for next boxes.

MILLER, C. ALLAN. Department of Biology, California State College, California, PA 15419. EFFECTS OF COMPETITION BY *MICROTUS PENNSYLVANICUS* AND *PEROMYSCUS LEUCOPUS* ON HABITAT UTILIZATION IN *PEROMYSCUS MANICULATUS BAIRDI*.—This study experimentally compared the effects of interspecific competition on habitat utilization in three species of rodents, *Peromyscus maniculatus, Peromyscus leucopus* and *Microtus pennsylvanicus* in a simulated microhabitat arena. *P. m. bairdi* from the Red River Valley of the North (northeastern Great Plains region) is reported to have a ubiquitous habitat distribution, whereas *P. m. bairdi* from southern Michigan is reported to occur almost exclusively in grassland or open field habitats. To explain this apparent geographical variation in habitat distribution of *P. m. bairdi* it was hypothesized that (a) competition by *M. pennsylvanicus* would cause *P. m. bairdi* from the Red River Valley to disperse into woods habitat but such competition would not effect the grass habitat utilization of *P. m. bairdi* from southern Michigan and/or (b) competition with *P. leucopus* would restrict the woods habitat utilization of *P. m. bairdi* from both localities. Competition by *M. pennsylvanicus* did not significantly effect the habitat utilization of *P. m. bairdi* from either locality. Competition by *P. leucopus* did not have an effect on woods habitat utilization of *P. m. bairdi* from the Red River Valley but did significantly restrict *P. m. bairdi* from southern Michigan more to grassland habitat.

McDONALD, STEVEN M. and MELVIN C. ZIMMERMAN. Department of Biology, Lycoming College, Williamsport, PA

17701. SCAT ANALYSIS SURVEY FOR HELMINTH PARASITES AND FOOD OF THE BLACK BEAR IN LYCOMING CO., PA.—Thirty fecal droppings were collected between April and October, 1981 in Lycoming County, PA and examined for helminths. Species of *Ascaris, Trichuris* and *Ancylostoma* were identified. Food analysis of scats indicated that the majority of the bear's diet consisted of herbs (40%). Of the remaining material, 7% was of animal origin (beetles, flies, ants, wasps, bees), 20% was grass, 5% woody stems, 2% tree leaves and 5% berries. A monthly Species list of these items is included. The remaining 19% of droppings consisted of debris (i.e. clay, silt, sand). These results, supplemented by examination of stomach samples, are compared with bear studies from other areas.

RIGLEY, LOUIS, VALERIE VANDYKE and PETER CRAM. Department of Biology, Wilkes College, Wilkes-Barre, PA 18766. SHALLOW WATER FEEDING BY ATLANTIC BOTTLENOSE DOLPHINS.—Atlantic Bottlenose dolphins, (*Tursiops truncatus*), were observed cooperatively herding fish and feeding in shallow estuarine back waters of the May River at Bluffton, S.C. during June, July and Aug., 1981. Five hundred seventy eight dolphins were observed comprising 161 pods. Over 100 dolphins we resighted as identified by dorsal fin markings. One hundred thirty six beachings were observed, involving 289 dolphins, while herding and capturing mullet and menhaden. Wading birds were involved in about 20% of the dolphin beachings. Also, baby dolphins were observed in the marsh on many occasions.

HOUSEKNECHT, CLYDE R. Department of Biology, Wilkes College, Wilkes-Barre, PA 18766. RADIO-TRACKING DATA AND THE DETERMINATION OF HOME RANGE SIZE.—Siniff (Minnisota Mus. Nat. Hist. Tech. Report 12:1-22, 1966) developed a method of calculating home range size and shape that is readily adaptable to computer analysis. Radio position data for three striped skunks (*Mephitis mephitis*) were used to compare Siniff's method with the minimum area method of Stickle (j. Mammal. 35: 1-15, 1954). Small square sizes and few squares searched for boundary placement gave area values that were consistently smaller than those obtained with the minimum area method. Large square sizes yielded home range areas which were much larger than minimum area estimates.

PRATER, DEBRA and LOUIS RIGLEY. Department of Biology, Wilkes College, Wilkes-Barre, PA 18766. CHEMICAL RECOGNITION BY VOLES (*MICROTUS OCHROGASTER*).—Chemical recognition and male preference were demonstrated by the pregnant female vole (*Microtus ochrogaster*) during a recognition experiment used to determine whether the chemical communication of the pregnant female vole with the non-stud male was at an individual or class level. Pregnancy block did not occur in the experimental group of females, indicating that class recognition was likely. In addition, the pregnant female vole showed a preference for her stud male over a strange male (a male that had not been recently mated), vasectomized male, castrated male, and recently-mated male.

MASTERS, HENRY G., DANA MASTERS and DONNA HENRY. Department of Psychology, Juniata College and Edinboro State College. DO CEBUS MONKEYS USE ADAPTATION LEVEL AS A FUNCTIONAL FRAME OF REFERENCE FOR PERCEPTUAL JUDGMENTS?—The present study used a standard oddity problem for discriminating different heights of wooden cylinders. Each monkey selected the one cylinder out of three that was different in height. The monkeys were tested in two anchor (extreme stimuli) and one control condition. Adaptation Levels were calculated for each monkey using the Helson and Himelstein short method. These Adaptation Levels were compared to those calculated for albino rats after they were tested in a brightness discrimination situation. All Adaptation Levels were discussed in terms of Helson's Adaptation Level Theory.

FARR, JOHN E. and WILLEM VAN DEN BERG. Department of Physics, The Pennsylvania State University, DuBois Campus, DuBois, PA 15801. MICROCOMPUTERS IN THE TEACHING LABORATORY-AN EXAMPLE FROM PHYSICS.—Traditionally the selection of physics experiments has been limited by the need to minimize students' confusionin learning about new apparatus, so as to allow adequate time for acquiring and analyzing data. Now the monitor screen of a microcomputer can be used as a bridge from the familiar to the novel. Direct interfacing accelerates data acquisition and increases flexibility in the choice of measurements to be made. The computer is used to manipulate and plot the data. We present the technical aspects of interfacing a simple physics experiment to an Apple, the use of the experiment in the laboratory, and the students' responses.

GALVIN, JAMES M. Student, Moravian College, 1028 Monocacy St., Bethlehem, PA 18018. EFFICIENT COMPUTER EVALUATION OF FLOWGRAPHS BY MASON-CEBULKA.—A flowgraph is a directed network which allows self loops. The evaluation of a flowgraph is defined to be the total source to sink transmittance for the entire flowgraph. The Mason-Cebulka technique is based on the evaluation of determinants. The usual computer representation of a complex flowgraph requires a lot of storage when the flowgraph has a large number of vertices. An efficient computer representation of flowgraph is possible with a language such as PASCAL. PASCAL supports a structure, called a record, which becausee of its variable length is an economical representation of each vertex including all of its branches and the value of each transmittance. A preliminary step to the evaluation of a flowgraph is the identification of all paths from source to sink. The path finding is simplified by the use of recursion, which is supported by PASCAL. In order to evaluate the flowgraph the proper information must be extracted from the records of each vertex in order to construct several matrices. The determinants of the matrices are calculated using a method which is similar to pivotal condensation. (S. H. Crandall, Engineering Analysis, New York: Mc Graw Hill, 1956, pp 29-35.) The evaluation is efficient because of the following reasons. 1.) The method of representation which requires only as much storage as necessary. 2.) The use of recursion in path finding and the fast method of determinant evaluation.

WU, DAVID S. and GARRY B. HUTCHINSON. 5518 Williamsburg Blvd., Arlington, VA 22207 and Princeton University, BSE class of 1979. THE ROLE OF SCIENTISTS AND ENGINEERS IN THE DEVELOPMENT OF A NATIONAL ENERGY POLICY.—American's role in global development will depend on how well she meets her energy needs. It is clear that increased reliance on imported oil increases America's political vulnerability. As a nation that consumes more per-capita energy than any other on earth, it is ironic that she lacks a well-defined energy policy. In a society saturated with different kinds of mass media, it is important that the people receive objective data before they are inundated with dogma, opinion, and fears of others. Poor communication leads to poor execution and inefficiency for the government. Scientists and engineers must play a significant role to ensure that the government understands the state-of-the-art of energy developments. Increased communication among the public, scientists, engineers, and government officials through educational programs such as the Wharton Public Policy Program and the MBA/MSE Program in the University of Pennsylvania is the crucial step in the development of a national energy policy. The initial efforts to increase understanding will be enormous and costly. However, the fruits of such commitments can make the efforts worthwhile.

WU, DAVID S. and GARRY B. HUTCHINSON. University of Pennsylvania and Princeton University. THE ROLE OF SCIENTISTS AND ENGINEERS IN THE DEVELOPMENT OF A NATIONAL ENERGY POLICY.—The reasons why scientists and engineers should, and methods how they could participate more actively in the development of a National Energy Policy are discussed in this paper.

DeHOFF, PAUL H. and JACK HARCLERODE. Department of Biology, University of North Carolina, Charlotte and Bucknell University, Lewisburg, PA. FAILURE TESTING OF UHMWPE ACETABULAR COMPONENTS.—There is increasing evidence that degradation of the properties of ultra-high molecular weight polyethylene (UHMWPE) occurs under prolonged contact with body fluids and high compressive stress. Changes in these properties may account for occurrences of brittle fracture in UHMWPE acetabular cups. In the present study, the ASTM C-shaped fracture toughness specimen was used to compare failure behavior of new and retrieved UHMWPE acetabular components. A total of forty-nine C-specimens were tested and compared. All samples were tested to failure in an Instron screw-type machine at a loading rate of .05 inches/minute. Load vs. cross-head displacement curves were obtained for each sample. A qualitative measure of work to failure was determined by dividing the area under the Instron load vs. cross-head displacement curves by the initial uncracked specimen area. A normalized failure work index was obtained by dividing all values by the maximum value found for any specimen. The anticipated brittle behavior for specimens obtained from retrieved cups did not materialize. Specimens cut from three of the retrieved cups showed very similar behavior with significantly lower values for the fourth cup. Because the condition of the retrieved cups varied, control of specimen geometry was difficult. Thus, specimen size effects could play a role in the variability of results.

ELCHAK, LEE and JOHN OREBOTSKY. Department of Engineering, Wilkes College, Wilkes-Barre, PA 18766. ENERGY CONVERSION IN P-N JUNCTION SOLAR CELLS.—The current voltage characteristics of a selected p-n junction silicon solar cells were investigated as a function of the intensity of the incident illumination and of the width and position of the space charge region. The results were compared with the predictions of a simple phenomenological model. The dependence of the short circuit (I_{sc}) on the width and position of the space charge region and the dependence of both I_{sc} and V_{oc} (open circuit voltage) on the illumination intensity were in reasonable agreement with the model. The functional relationship between the current and the voltage of the cell was found to be related to the intensity of the illumination and was not generally consistent with expected behavior predicted from the model.

MELKA, RICHARD F. Department of Mathematics, University of Pittsburgh at Bradford, Bradford, PA 16701. LONG TERM PROFITS: A DIFFERENCE EQUATION MODEL.— Let U, represent the total value of an enterprise at time t, P, the accumulated profit over that period and I the growth rate of the enterprise. K is a parameter $0 < K < 1$ representing the portion of growth taken for profit. Difference equation models of the form:

$$U_{t+1} - U_t = F(I,K,U_t) \quad U_o > 0$$
$$P_{t+1} - P_t = G(I,K,U_t) \quad P_o = 0$$

are analyzed over long term periods and K values are specified so as to maximize profits.

SIKORSKI, ROBERT S. and CARL R. PRATT. Department of Biology, Penn State University, Wilkes-Barre Campus, Wilkes-Barre, PA 18708. LEAD CONTENT OF WILDFLOWERS AND HONEYBEE (APIS MELLIFERA) ALONG A ROADWAY: POSSIBLE CONTAMINATION OF A SIMPLE FOOD-CHAIN.—A modified dithiazone technique was used to determine lead content of honeybees and two wildflower species (Daucus carota and Solidago graminifolia) they were observed to frequent. Two sites were selected for investigation. One site was located along a moderately busy highway and designated 850 meters from the highway and was called the "lead-free" site. Both sites had a similar floristic composition. Significant differences in lead content of plants were detected between the two sites (t = 6.8, df = s6, P < 0.005). Mean lead contents of flowers from highway site was 13.6 ppm, while flowers from the lead-free site contained 0.2 ppm lead. Significant differences in lead content of bees from the two sites were also detected (t = 4.9, df = 8, P < 0.005). Bees observed to forage along the roadside contained a mean of 28.1 ppm of lead and those bees captured on the lead-free site contained a mean of 1.4 ppm of lead.

WITKOWSKI, STEVEN A. and SCOTT R. AULT. Students, Millersville State College, Millersville, PA. LEAD LEVELS OF WHITE-TAILED DEER (ODOCOILEUS VIRGINIANUS (MANDIBLE AND TEETH FROM PENNSYLVANIA.—Determination of normal environmental levels of lead in bone requires a much broader data base than is available. This investigation is concerned with lead concentrations in bone tissue of white-tailed deer. Mandibles and teeth were collected from a five county region in south central Pennsylvania. Mean lead levels ranged from 33.36 μg/g a.w. to 39.25 μg/g a.w. in man-

dibles and 34.59 μg/g a.w. to 40.72 μg/g a.w. in teeth. No significant differences were found in age, county, and sex. This study provides a reliable method to monitor chronic lead contamination in the environment.

COMLY, MARCH, ROBERT MOONEY and JACK HARCLERODE. Department of Biology, Bucknell University, Lewisburg, PA 17837. A RECIPROCAL DOSE STUDY OF Δ^9-TETRAHYDROCANNABINOL AND PHENCYCLIDINE AND TESTICULAR CYTOCHROME P-450, SERUM BLOOD LEVELS OF TESTOSTERONE, AND SEXUAL ORGAN WEIGHT IN MALE RATS.—The effects of reciprocal dosages of Δ^9-tetrahydrocannabinol (THC) and phencyclidine (PCP) were examined on testicular cytochrome P-450, serum levels of testosterone, body weight and sexual organ weight in the male rat. Male Wistar rats received daily injections of either drug (2 mg/kg body weight) for a period of 9 days followed on the 10th day by a single dosage of the reciprocal drug. Twenty-four hours later the animals were decapitated and the sexual organs were removed and trunk blood collected for hormonal analysis. Testicular microsomal fractions were isolated and cytochrome P-450 quantified by spectrophotometry. Serum testosterone levels were determined by radioimmunassay. It was found that rats treated with either reciprocal dose combination had a significantly higher level of testicular microsomal cytochrome P-450 than control levels. However, there was no corresponding difference in serum testosterone levels with any treatment. The seminal vesicles of rats treated with PCP followed by THC were lighter than controls. Supported in part by USPHS-NIDA grant #1DA 02372.

SAWYER, HEATHER, ROBERT MOONEY and JACK HARCLERODE. Department of Biology, Bucknell University, Lewisburg, PA. BLOOD SEX HORMONE LEVELS IN ADULT MALE RATS PRODUCED BY INJECTIONS OF Δ^9-TETRAHYDROCANNABINOL (THC) AND PHENCY-CLIDINE HYDROCHLORIDE (PCP) DURING PUBESCENCE.—Serum testosterone and luteinizing hormone levels in adult male rats were determined after daily injections of Δ^9-tetrahydrocannabinol (THC), phencyclidine hydrochloride (PCP), and their combination were administered during sexual maturation. Thirty-five-day-old male Wistar rats received daily drug dosages of 2 mg/kg body weight for 9 days. Blood samples were taken by cardiac puncture at 17, 38, 52, and 80 days after the last injection and the rats were sacrificed by decapitation and trunk blood collected at 84 days. Radioimmunoassay analysis showed no significant differences in testosterone levels at 18 days, however at 38 days post injection, the THC/PCP combination produced a significant (p < .05) increase in testosterone levels. By 52 days post injection all drug treated animals had significantly elevated serum testosterone levels. All serum testosterone levels returned to vehicle levels by 80 days post injection. Only the THC/PCP combination produced an increase in serum LH levels at both 18 days and 52 days post injection while no drug treatment produced a significant LH rise at 38 days. By 80 days all LH levels were normal. Supported in part by USPHS-NIDA grant #1DA 02372.

BIRD, LYNNE, ROBERT MOONEY and JACK HARCLERODE. Department of Biology, Bucknell University, Lewis-

burg, PA 17837. THE EFFECTS OF Δ^9-TETRAHYDRO-CANNABINOL AND PHENCYCLIDINE HYDROCHLORIDE ON BODY WEIGHT, ORGAN WEIGHTS AND SERUM TESTOSTERONE LEVELS IN THE MALE RAT.— The effects of Δ^9-tetrahydrocannabinol (THC), phencyclidine hydrochloride (PCP), and their combination were examined on body weight, various reproductive organ weights, and serum testosterone levels. THC and PCP were administered separately or in combination to sexually mature male Wistar rats at dosages of 2 mg/kg body weight. Rats were injected for 9 days, followed by a 60-day recovery period, at which time they were sacrificed by decapitation. Serum testosterone levels in all drug treatment groups were not significantly different from vehicle control levels. Rats treated with a combination of THC and PCP showed reduced body weights when compared with THC-treated rats, whose body weights were not different from control or PCP treated animals. Rats treated with the THC/PCP combination exhibited significantly lighter testicular weights than control rats or THC-injected rats, and smaller prostate weights than either control or PCP-treated rats. The combined prostate and seminal vesicle weights were also depressed below control levels in the THC/PCP-treated rats. These data indicate that the drug combination may exert a direct effect on the sexual accessory organs that is not mediated through serum testosterone levels. Supported in part by USPHS-NIDA grant #1DA 02372 and the Robert P. Vidinghoff Memorial Fund.

CAMPBELL, CAROLYN, ROBERT MOONEY and JACK HARCLERODE. Department of Biology, Bucknell University, Lewisburg, PA 17837. THE EFFECT OF VARIOUS DOSAGES OF PHENCYCLIDINE HYDROCHLORIDE ON SERUM TESTOSTERONE LEVELS IN MALE RATS.—The effect of phencyclidine hydrochloride (PCP) was examined on the serum testosterone levels of mature male Wistar rats. PCP was administered intraperitoneally in dosages of 2, 5, and 10 mg/kg body weight. An injection of an equal volume of the drug solubilizing vehicle solution was used on control animals. Four hours following the injection, blood samples were taken by cardiac puncture, and serum testosterone levels were determined by radioimmunoassay. At dosages of 2, 5, and 10 mg/kg body weight, PCP produced a significant decrease in serum testosterone levels when compared with the levels in the control rats; however, the magnitude of the decrease did not appear to be dosage dependent. Supported in part by USPHS-NIDA grant #1DA 02372 and the Robert P. Vidinghoff Memorial Fund.

STEELE, MICHAEL A. and DAVID A. ZEGERS. Department of Biology, Millersville State College, Millersville, PA 17551. THE ECOLOGY OF THE EASTERN FOX SQUIRREL (SCIURUS NIGER VULPINUS).—The eastern fox squirrel (Sciurus niger vulpinus) formerly inhabited large portions of the northeast, as far north as Massachusetts. Its present range includes only portions of Maryland, Virginia, West Virginia and the southern one-third of Pennsylvania. This is a preliminary report of a study which involves live trapping, field observations, feeding studies and nestbox surveys of a population of S. n. vulpinus along the Condoquinet Creek in Cumberland County, Pennsylvania. Body weights, coloration, food habits, home ranges and dispersal are examined. In addi-

toin data on coexisting gray squirrels S. carolensis was also collected and the role of gray squirrels in the decline of S. n. vulpinus is discussed.

KIRKLAND, GORDON L., JR. and EDWIN C. GILLMAN. The Vertebrate Museum, Shippensburg State College, Shippensburg, PA 17257. NOTES ON FURBEARERS OF THE CODORUS DRAINAGE, YORK COUNTY, PENNSYLVANIA.—During the trapping seasons of November-December 1979-1981, 240 furbearers of five species were collected by the coauthor along the drainage of Codorus Creek, York County, Pennsylvania. Included in the sample were 112 muskrats (Ondatra zibethicus), 59 raccoons (Procyon lotor), 47 opossums (Didelphis virginiana), 21 red fox (Vulpes fulva), and one gray fox (Urocyon cinereoargenteus). Prior to pelting, specimens were weighed and measured. Notes on habitat and reproduction were recorded in the field and during postmortem examinations, respectively. This paper presents the results of analyses of data on the relative abundance, ecological distribution, external and cranial measurements, relative ages, sex ratios, and reproduction in the first four species.

FINK, MIKE and JAMES L. TRUCKENMILLER. Department of Psychology, Wilkes College, Wilkes-Barre, PA 18766. DEMOGRAPHIC PREDICTORS FOR JUVENILE DELINQUENCY.—Data from questionnaires concerning demographic variables were statistically analyzed to produce predictors for different levels of juvenile delinquency and to find the percentage of correct placements into these subgroups. The Youth Needs Survey questionnaire was distributed by the Youth Service Systems, Pennsylvania Project to 1,689 subjects (male and female), ranging from 10 to 19 years of age. Both a multiple regression analysis and a stepwise discriminant function analysis were run on the data obtained from these questionnaires. The multiple regression analysis produced the following significant demographic predictors: For the general delinquency level, age and sex yielded a multiple R of .2505 with delinquency. For the low delinquency subgroup, grade yielded a multiple R of .1240 with delinquency. For the medium delinquency subgroup, sex and residence type yielded a multiple R of .1389 with delinquency. For the high delinquency subgroup, welfare status and residence type yielded a multiple R of .1792 with delinquency. The stepwise discriminant function analysis produced the following percentage of correct placements into the three delinquency subgroups, using age and sex as predictors: 58.8% for the low, 19.3% for the medium, 54.7% for the high, and 41.0% for the total sample.

GUR, DAVID, GOVIND R. RAO, WALTER F. GOOD, JOHN M. HERRON. Department of Radiation Health, University of Pittsburgh, Pittsburgh, PA 15261 and GEORGE K. TOKUHATA and MARILYN K. GOLDHABER. Pennsylvania Department of Health. THE TMI POPULATION: A CLOSER LOOK.—In the aftermath of the accident at Three Mile Island (TMI), considerable effort was expended to assess the potential health impact on the surrounding population. As the management of the TMI accident progressed it became evident that the integrated dose to the population was very low. At the same time the major early uncertainties concerning the acci-

dent were important stresses which could well result in health changes. To provide baseline demographic and dosimetric information on the 36,000 individuals residing within approximately 5 miles of the nuclear station, a comprehensive computerized data-base which includes a special census documentation on each individual has been developed. The location of residence of each of 13,000 household is superimposed on a digitized map of the area. Each individual within a given household can thus be identified. This report provides a general description of the comprehensive data-base and sites some examples of its possible use. Selected data are extracted from the data-base including residential location in terms of distance and direction, and movement into and out of the five mile area during the ten days following the accident. For example, this allows for investigations of temporary evacuation patterns as a function of distance and direction from TMI to the location of residence. It also allows for assessment of maximum possible and likely dose to individual members in this population.

ZIEGENFUS, THEODORE T. and DIGAMBER S. BORGAONKER. Department of Biology, The Pennsylvania State University, New Kensington Campus and Director, Cytogenetics Laboratory, Wilmington Medical Center. THE CYTOGENETICS OF TERMINAL AND INTERSTITIAL DELETIONS IN MAN.—Abnormal phenotypes have consistently been observed in association with either genic or chromosomal abnormalities. One type of chromosomal abnormality, the deletion chromosome, is the result of the loss of either a terminal or interstitial chromosomal segment. These aberrations result in a multitude of abnormal phenotypes. When a phenotypically abnormal individual presents, questions arise during interpretative counseling sessions regarding the prognosis of the propositus, the origin of the anomaly and the recurrent risk of this anomaly in subsequent sibs. This investigation was conducted in order to develop data applicable for genetic counseling. Data from our laboratory and additional data from the literature has resulted in the evaluation of more than 450 case reports. Only reprots containing defined break points were retained for analysis. Data were obtained with respect to the mode of ascertainment; parent's karyotype and age; patient's karyotype and age; phenotypic features and the family history. Analysis of these data may be summarized as follows. 1. Although fewer cases of interstitial deletions have been reported, no other significant differences with terminal deletions exists. 2. Only 12% of the terminal deletions and 15% of the interstitial deletions are *de novo* in origin. 3. There was no demonstrable increase in the frequency of deletion chromosomes as parental age increased. 4. The frequency of deletions was about twice as frequent in females as in males. A comparative analysis of frequency of deletions in each chromosome, arm, region and band was also studied.

MUNRO, JAMES. Department of Philosophy, Edinboro State College, Edinboro, PA 16444. NEWTON'S PAIL EXPERIMENT AND SCIENTIFIC METHOD: A MODERN ANALYSIS.—Since the advances in our understanding of time and space forged by Einstein, theoreticians have attempted to uncover what misled Newton in his earlier analysis of these topics. Attention has focused on Newton's famous Pail Experiment described in the Scholium to the Definitions in his *Principia.*

New work on the methodology of science; esp. on the techniques of mathematicizing descriptive propositions, show Newton's procedure was unexceptional and conceptually well founded. On this basis the criticisms against Newton's procedure developed by Ernst Mach, Hans Reichenbach and others to the point that Newton's argument is a non sequitor and is colored by metaphysical assumptions are shown not to apply. Nevertheless, recent treatment of instantaneous acceleration vectors by A. Troutman and C.S. Misner, K.S. Thorne and J.A. Wheeler reveal that accelerations need not be defined in terms of the absolute space for which Newton argued. However, these contemporary criticisms do not impugn Newton's scientific method. Furthermore, early writings and correspondence of Newton recently brought to light verify this emerging interpretation of Newton's methodology. A methodology which has proven so productive in the Western scientific tradition.

TWARK, RICHARD D., ROGER H. DOWNING and RAYMOND W. EYERLY. 105 Lan and Water Research Building, Institute for Research on Land and Water Resources, The Pennsylvania State University, University Park, PA 16802. JOB ACCESSIBILITY AS A DETERMING FACTOR IN EXPLAINING RESIDENTIAL PROPERTY VALUES.—One of the most important aspects of property value is location. Location can be defined in terms of accessibility to a variety of public and private services as well as job opportunities. The purpose of this study is to develop a method for measuring the monetary value of job-accessibility to residential property. A Job Accessibility Measure was tested using multiple linear regrssion analysis. Job accessibility was determined to be an important component of residential property value. Results are compared with traditional measures of accessibility.

BALCH, WILLIAM R. Department of Psychology, The Pennsylvania State University, Altoona Campus, Altoona, PA 16603. SPATIAL VS. SYMBOLIC REPRESENTATION OF MELODY IN MEMORY.—In a series of two experiments, undergraduate college students havinghigh, or low, musical experience were required to encode fifteen aurally presented 6-note melodies into written form: either in the context of immediate memory (Experiment 1) or simultaneous encoding (Experiment 2). The melodies were random sequences of three possible pitches: C₅ (523 Herz), D₅ (587 Herz) and E₅ (695 Herz). The primary independent variable was the type of *task* employed: either (a) the Symbolic task, in which a number was written for each pitch in the melody (1,2 or 3 for C₅, D₅, or E₅, respectively); or (b) the Spatial task, in which X's were marked in a 3 x 6 matrix diagram to create a spatial representation of the melody. The tasks were found to be equivalent in performance time and general task difficulty. In Experiment 1, where subjects recalled each melody immediately after it was presented, the Spatial task group was significantly more accurate than the Symbolic group in terms of percent correctly coded pitches. However, this Symbolic task superiority was not found in Experiment 2, in which subjects encoded pitches as they were heard. The results show that *memory* of melody can be facilitated by spatial representation during recall.

MOGUS, MARY ANN and TERRY GIFFEL. Departments of

Physics and Education Technology, East Stroudsburg State College, East Stroudsburg, PA 18301. MICROCOMPUTERS AT THE COLLEGE LEVEL: AN EDUCATIONAL PERSPECTIVE.—A survey of microcomputer use in Pennsylvania's four-year colleges reveals that most use is largely experimental. Microcomputer adoption and application depends upon the individual faculty members and appears not to be associated with a larger trend or commitment on the part of colleges as a whole. This paper describes the numbers and types of microcomputers available at Pennsylvania's four-year colleges, the subject areas in which they are used, and the institutional support offered. In addition, it explores the training and interests of the faculty users. Future trends in microcomputer applications to education are considered.

SENFT, JOSEPH P. Nutrition Department, Rodale Research Center, R.D. #1, Box 323, Kutztown, PA 19530. AMARANTH —NUTRITIONAL CHEMISTRY OF A POTENTIALLY IMPORTANT NEW FOOD CROP.—Amaranth grain was identified as a new potential world food source, particularly for tropical regions, by an advisory panel of the National Academy of Sciences in 1975. The Rodale Research Center has developed this crop over the past six years. This work suggests that amaranth has potential as an economically significant crop in temperate regions as well. It is drought resistant. Grain yields were normal where corn yields were reduced by more than 50% which suggest spotential where farm lands are now marginal for the more common grains. The protein content of amaranth is high, 16% compared to 7 to 15% for the more common grains. Perhaps the most important characteristic of amaranth grain is the high quality of its protein for animal nutrition. Unlike the more common grains it contains nutritionally adequate amounts of the essential sulfur-containing amino acids and lysine. Animal feeding studies in which raw grain was used as the sole protein source gave growth rates equivalent to 80% of those obtained for the standard ''ideal'' casein control diet. Fiber and mineral content are high which may be of significant value in the enhancement of the nutritional quality of cereal products.

LUCOSTIC, CONSTANCE M., WILLIAM G. KIMMEL, C. ALLEN MILLER and THOMAS C. MOON. Departments of Biology and Environmental Science, California State College, California, PA 15419. A FLORISTIC COMMUNITY SURVEY OF PINE SWAMP NATURAL AREA, MERCER COUNTY, PENNSYLVANIA.—A floristic community study of Pine Swamp Natural Area, Mercer County, Pennsylvania was conducted in an attempt to determine species composition with relationship to the amount and chemistry of available water (July 1980-May 1981). Line transects were established to delineate study plots surrounding the central raised bog. Each sampling station was surveyed to determine % ground cover, dbh employing the point quarter method, and taxa enumeration. Floral samples along with pH readings were taken at the various sampling sites. Baseline data was analyzed to determine population density, species diversity, and frequency. A floral checklist was compiled denoting location and stratification. Three community types were demonstrated: 1. raised peatland (*Sphagnum, Vaccinium corymbosum, V. oxycoccus, Aronia, Gaultheria*); 2. Swamp-Forest (*Salix, Populus, Betula, Pinus strobus, Tsuga canadensis, Quercus, Acer*); 3. Marsh (*Carex,*

Sparganium, Scirpus, Elocharis, Woodwardia virginica, Onoclea sensibilis).

MEDVE, RICHARD J. Department of Biology, Slipperty Rock State College, Slippery Rock, PA 16057. MYCORRHIZAL ASSOCIATIONS OF THE CRUCIFERAE.—Examination of 25 crucifer taxa, representing 15 genera and 24 species, showed that 92% of the Cruciferae species were non-mycorrhizal. *Lobularia maritima* and *Lunaria annua* were the only crucifers to have vesicular-arbuscular mycorrhizae. The number of arbuscles in both species and vesicles in *L. maritima* were sparse. Combining the present study with other investigations reported in the literature shows that V-A mycorrhizae have been found in a number of Cruciferae. Although the number of V-A structures are limited and the percent infection low, the designation of the Cruciferae as a non-mycorrhizal family should be discontinued.

THOMPSON, GAIL W. and RICHARD J. MEDVE. Department of Biology, Slippery Rock State College, Slippery Rock, PA 16057. THE EFFECT OF VARIOUS ALUMINUM AND MANGANESE CONCENTRATIONS ON THE DIAMETER GROWTH OF SELECTED MYCORRHIZAL FUNGI.—A study was conducted to ascertain the effects of aluminum and manganese on the diameter growth of various known mycorrhizal fungi. Mycelial disks of *Suillus luteus, Cenococcum graniforme, Thelephora terrestris,* and three strains of *Pisolithus tinctorius* were placed on Modified Melin-Nockran's (MMN) agar plates adjusted to metal concentrations of zero to 500 ppm in increments of 50 ppm. *Pisolithus tinctorius* strain #250 was palced on MMN agar adjusted to the metal concentrations with Al₂(SO₄)₃, AlCl₃, Al(NO₃)₃, MnSO₄, MnCl₂, or Mn(NO₃)₂; to determine the effects of various aluminum and manganese compounds on diameter growth.

MINEO, LORRAINE, I. RABIN, B. SLECKMAN, E. PERLMAN, J. JONES, P. MORGAN and U. ADOURIAN. Department of Biology, Lafayette College, Easton, PA 18042. ALLELOPATHY IN THE HERBACEOUS PERENNIAL, *LAVENDULA VERA.*—Allelopathy has been reported for various aromatic herbaceous perennials such as Salvia and Artemisia species, but more significant allelopathic effects have been found for *L. Vera* than any other herbaceous perennial tested from a large common garden. The allelopathy demonstrated by aromatic herbs has been compared with field control herbs that neither demonstate allelopathy nor are aromatic. Two aspects of allelopathy, decrease in per cent seed germination and decease in the growth rate of seedlings that do germinate, have been found in bioassays using the following: soil beneath the foliar canopies; and water, alcohol, and benzene extracts of foliage. Although the water-soluble constituents of *L. Vera* show allelopathy in rather dilute solutions, marked effects are obtained with the dilute terpenoid (aromatic) fractions present in the organic solvent extracts. Using thin-layer chromatographic techniques, the most active terpenoid component of *L. Vera* has been isolated.

MIKESELL, JAN. Department of Biology, Gettysburg College, Gettysburg, PA 17325. EFFECTS OF STERIODS AND

PHOTOPERIOD ON THE VEGETATIVE AND REPRO-DUCTIVE CAPACITY OF *CANNABIS SATIVA* L.—Mammalian sex hormones such as estradiol, estrone and testosterone are known to occur endogenously within man plants. Presently there is no precise indication as to whether these compounds have an effect on vegetative or reproductive growth in plants. Two separate investigations were performed to determine the effects of these steriods on the vegetative and reproductive development of marijuana maintained under long and short days (LD & SD)—16 and 8 hours respectively. One investigation utilized a high hormone concentration, while the second revealed results with a 10-fold lower concentration. Multiple steroid applications were made throughout the relatively long-term studies—58 and 66 days respectively. Aspects of vegetative growth which were examined include the effects of steriods on axis elongation. Biomass allocation to vegetative and reproductive organs of micro- and megasporangiate plants was calculated at the end of both studies. Extension growth of leaves, inernodes and hypocotyls was determined throughout the investigation in which high concentrations of steroids were applied. Investigated parameters of reproductive development within steroid-treated and control groups were the % flowering, the age of first flower production, the ratio of micro- and megasporangiate flower differentiation, the node at which flowers first developed and the distance above soil level at which the first expanded flowers occurred. General observations, inclusive of both studies were: 1) greater flowering in SD, 2) similar timing of floral differentiation in SD, 3) closer production of flowers to soil level in steroid-treated platns, 4) nearly static hypocotyl growth in both SD and LD, 5) greatest vegetative growth in testosterone-treated plants grown under LD, 6) greatest vegetative growth in SD controls and 7) increased axis length in LD.

SWIGART, KIMBRA G. and MELVIN C. ZIMMERMAN. Department of Biology, Lycoming College, Williamsport, PA 17701. A DESCRIPTION OF SOIL CHEMISTRY AND SOIL INVERTEBRATE POPULATIONS IN HOLLOWS IN NORTH-CENTRAL PENNSYLVANIA.—In order to describe the ecology of hollows in north-central Pennsylvania, soil chemistry for 12 hollows was determined. In addition, the soil from two hollows was sampled on a monthly basis (April-August) to determine the temporal changes in soil chemistry and soil invertebrate populations. This study is part of a larger study which analyzes the vegetational diversity of hollows. Rand Sum analysis and Student's t-test indicated no significant differences ($\delta = .05$) between any hollows for soil chemistry, relative humidity, and soil temperatures. The atmospheric temperatures for all months (April-August) were significantly different ($\delta = .05$) with the exception of the maximum temperature ranges for July and August. Soil invertebrate population data showed no significant differences (Rank Sum Test, $= .05$) in the nematode densities (May-August), and significant differences in ($\delta = .05$) in the invertebrate densities for May and June only. Analysis of the Simpson and Shannon-Weiner species diversity indices indicated significant differences ($\delta = .05$) for only the Simpson index values for June. Monthly similarity indices of invertebrates (Jaccard, Sorensen, Bray-Curtis, %) for the two hollows indicated an average value of 68% over the five month study (April-August). Study data indicate that, while the soil chemistry, relative humidity, and soil temperature in the hollows show little significant differnce due to hollow location

and temporal change, atmospheric temperature and soil invertebrate density within the hollows do exhibit significant changes, especially over time. These results will be related to the importance of hollows to wildlife.

POWERS, RONALD E. and MELVIN C. ZIMMERMAN. Department of Biology, Lycoming College, Williamsport, PA 17710. VEGETATIONAL HABITAT DESCRIPTION AND DIVERSITY OF HOLLOWS IN NORTH-CENTRAL PENNSYLVANIA.—This study attempts to determine the vegetational diversity and ecology of hollows in North-Central Pennsylvania. This is part of a larger study which examines the soil chemistry and invertebrates of twelve hollows. Trees, saplings and seedlings were sampled with the point-centered quarter technique to determine relative density, dominance, frequency, importance values and species diversity. Percentage ground cover and canopy heights were also determined. The vegetational diversity of two of the twelve hollows are compared to their slopes. Whereas slopes are dominated by mixed oaks (*Quercus*), hollows vary in their dominance of hemlock (*Tsuga canadensis*). Cluster Analyses, which use similarity indices (Jaccard and Sorensen coefficients) are used to associate hollows most similar in flora. These results will be related to the importance of hollows to wildlife.

O'TOOLE, AUSTIN J. Department of Biology, Gannon University, Erie, PA 16541. A CRITIQUE OF THE ECOLOGICAL LAND TYPE CONCEPT IN THE DETERMINATION OF ECOLOGICAL PATTERNS WITHIN THE ALLEGHENY NATIONAL FOREST.—An Ecological Land Type (ELT) is a system of identifying, classifying, and characterizing the landscape using natural factors such as geology, landform, soils, flora, and fauna. During the summer of 1980, vegetation (tree and ground cover) of the Allegheny National Forest (ANF) was sampled within 41 ELT's. One purpose of the study was to conduct a vegetational survey of the ANF. (Results of the general vegetational distribution pattern will be published in the *Proceedings of the Pennsylvania Academy of Science,* vol. 55, #2, 1981.) A second purpose of the study was to verify the ELT concept by identifying plant indicator species unique to each ELT which could be utilized in the classification and separation of each of the ELT's. Results show that, because of the widespread distribution of most plant species, there are not 41 separate ELT's within the ANF. The 41 ELT's were, therefore, grouped into four higher units of organization called Land Type Associations (LTA). The Land Type Associations are: Wet-Lowlands; Wet-Uplands; Moist Areas; and, Dry-Oak Areas.

DeSANTIS, JUDY and C. Y. CHENG. Department of Chemistry, East Stroudsburg State College, East Stroudsburg, PA 18301. A CHEMICAL STUDY OF PRECIPITATION IN SOUTHEASTERN MONROE COUNTY, PENNSYLVANIA.—A study on the chemical nature of the precipitation in Southeastern Monroe County has been conducted during the past year. Water samples have been collected for each precipitation and analyzed for pH, acidity, specific conductance, sulfate and nitrate. The experimental data have been analyzed to determine the relationship among the chemical parameters examined. The results indicate that although Southeastern Monroe

County is not heavily industrialized, the precipitation shows the characteristics of acid rain because geographically the testing area is situated downwind from the Ohio industrial valley.

HUNTER, NICK B. and DANIEL TAYLOR. Department of Forestry, The Pennsylvania State University, Mont Alto Campus, Mont Alto, PA 17237. ECOLOGICAL INVESTIGATIONS OF SIKA AND WHITE-TAILED DEER ON ASSATEAGUE ISLAND.—Sympatric populations of Sika (*Cervus nippon*) and white-tailed (*Odocoileus virginianus*) deer were studied on the northern Maryland portion of Assateague Island in summer and fall, 1981. Date from fecal counts and analyses, browse surveys, a hunting season harvest and direct field observations were assessed to determine: 1) population dynamics, 2) food habits, 3) habitat use and 4) interspecific relationships. Results should prove helpful in establishing guidelines for managing large herbivores on Assateague Island.

KASPAR, JAMES and RONALD R. KEIPER. Department of Biology, The Pennsylvania State University, Mont Alto Campus, Mont Alto, PA 17237. FECAL pH OF SIKA AND WHITE-TAILED DEER.—Fecal pH has been used by a number of investigators to differentiate between the dung of two or more sympatric species. In a study of the food habits of Sika and White-tailed deer living on Assateague Island, Maryland, we used fecal pH as a means of determining the diet of the two species. Recently deposited pellet groups were collected along transects on Assateague and frozen. Later in the laboratory the pellets were air dried, then oven dried at 75 °C for 48 hours. Two grams of samples were placed in 100 ml of dwater then mixed in a blender for 5 minutes. Samples were removed and testd using a Corning Model 7 pH meter with a Thomas Universal Universal pH glass electrode. Most samples were rather close in pH with the range being only from 5.6 to 7.2. However, there were two "peaks" when the frequency of pH

was plotted, suggesting that this method can be used as a way of identifying pellet groups collected when the identity of the animal was unknown.

KLEM, DANIEL JR., CHRIS R. BRANCATO, JOSEPH F. CATALINO and FRANK L. KUZMIN. Department of Biology, Muhlenberg College, Allentown, PA 18104. GROSS MORPHOLOGY AND GENERAL HISTOLOGY OF THE ESOPHAGUS, INGLUVIES AND PROVENTRICULUS OF THE HOUSE SPARROW (*PASSER DOMESTICUS*).—The esophagus, ingluvies and proventriculus of the House Sparrow were prepared for and examined with light and scanning electron microscope techniques. The esophagus is divided into anterior (*pars cervicalis*) and posterior (*pars thoracica*) regions. Both regions are qualitatively similar; and in general, the esophagus is a narrow distensible tube with marked internal folding. Histologically, the esophagus, ingluvies and proventriculus consists of four primary tissue layers and their subdivisions; the tissue layers are the mucosa (*tunica mucosa*), submucosa (*tlea submucosa*) which is typically not well developed compared to the other layers, muscularis externa (*tunica muscularis*), and adventitia (*tunica adventitia*). The esophagus and ingluvies are histologically similar with the exception that the ingluvies tissue layers are generally less thick and the mucous-type glands are not distributed as densely. Both structures show a prominent stratified squamous epithelium and well developed muscular tissue. Macroscopically, the proventriculus is cone-shaped and appears to be no more than an expanded portion of the esophagus. It is lined by a simple columnar epithelium beneath which are compound glands. The compound glands are the most characteristic feature of the proventriculus although other than the submucosa, the other tissue layers are also prominently developed. Generally, the anterior alimentary tract of the House Sparrow exhibit structural adaptations which are similar to those of other avian species that feed primarily on seeds.

*The abstracts published herein have not been subjected to editorial scrutiny.

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PENNSYLVANIA ACADEMY OF SCIENCE

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