Proceedings of the Arkansas Academy of Science - Volume 29 1975

Academy Editors

Proceedings of the

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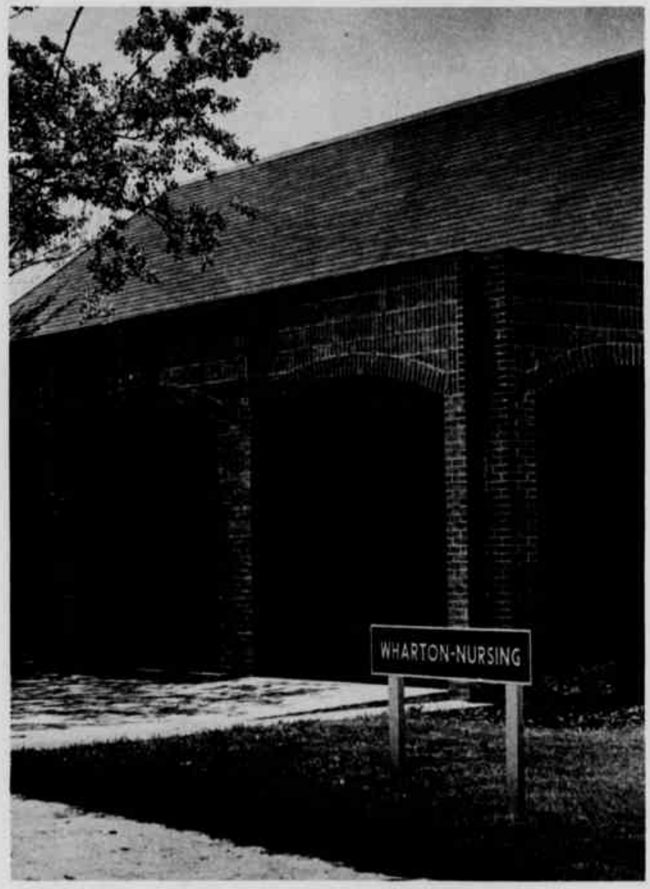

ARKANSAS ACADEMY OF SCIENCE
UNIVERSITY OF ARKANSAS BOX 2407
FAYETTEVILLE, ARKANSAS 72701

SPECIAL 4th CLASS
BOOK RATE

Arkansas Academy of Science, University of Arkansas, Box 2407
Fayetteville, Arkansas 72701

INSTITUTIONAL MEMBERS

The Arkansas Academy of Science recognizes the support of the following institutions through their Institutional Memberships in the Academy.

Arkansas College
Batesville

Arkansas Polytechnic College
Russellville

Arkansas State University
State University

College of the Ozarks
Clarksville

Harding College
Searcy

Henderson State University
Arkadelphia

Hendrix College
Conway

John Brown University
Siloam Springs

Ouachita Baptist University
Arkadelphia

Southern State College
Magnolia

University of Arkansas
Fayetteville

University of Arkansas
at Little Rock

University of Arkansas
at Pine Bluff

University of Central Arkansas
Conway

Westark Community College
Fort Smith

COVER PHOTO: Nursing Education Building on the campus of Southern State College, headquarters for the 1975 meeting of the Arkansas Academy of Science.

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CARL EMIL HOFFMAN

Dr. Hoffman was a former President of the Arkansas Academy of Science (1959) and served as Editor of the Academy for several years. A member of the University of Arkansas faculty for 36 years, he was Emeritus Professor of Zoology at the time of his death on 25 June 1975. He was widely recognized for his research on aquatic environments and his studies contributed to our basic understanding of fresh-water biology and to the economic growth of Arkansas.

PROCEEDINGS OF THE

ARKANSAS ACADEMY OF SCIENCE

1975

ARKANSAS ACADEMY OF SCIENCE

Volume XXIX **1975**

Proceedings

Edward E. Dale
President

Joe M. Guenter	**John Gilmour**	**William L. Evans**	**Dwight M. Moore**
President-Elect	**Secretary**	**Treasurer**	**Historian**

Secretary's Report

MINUTES OF THE FIFTY-NINTH ANNUAL MEETING - 11-12 APRIL 1975

FIRST BUSINESS MEETING

The first business meeting of the 59th Annual Meeting of the Arkansas Academy of Science was called to order by Dr. E.E. Dale, President of the Academy. Dr. Dale introduced Dr. Henry Robison, Chairman of the Local Arrangements Committee. Dr. Robison introduced Dr. Imon Bruce, President of Southern State College, for the formal welcome.

President Dale then called for reports from representatives of organizations sponsored by the Academy and from Officers of the Academy.

Secretary:

The Secretary, Dr. J.T. Gilmour, reported that the minutes of the 58th Meeting were being distributed as a part of the 28th Proceedings. Dr. Gilmour noted that a motion to approve the minutes would be made at the second business meeting.

The Secretary discussed 1974 membership which totaled 179. There were 141 regular, 20 sustaining and 18 associate members.

Treasurer:

Dr. W.L. Evans, Treasurer, distributed the financial statement and summary for the Academy during 1974. Dr. Evans noted that a motion to approve the financial statement would be made at the second business meeting.

Financial Statement

March 31, 1975

Cash Balance in Checking Account, April 1, 1974	$1,807.64
Reserve Funds, Savings Certificate, FSLA, April 1, 1974	1,238.74
Reserve Funds, Passbook Savings Acct., FSLA, April 1, 1974	576.82
Total Funds, April 1, 1974	$3,623.20

Income (April 1, 1974 through March 31, 1975)

1. Memberships	
a. Sustaining	160.00
b. Regular	904.00
c. Associate	116.00
2. Institutional Dues	800.00
3. Subscriptions to PROCEEDINGS	685.00
4. Page Charges for the PROCEEDINGS	124.25
5. Interest on Reserve Funds	
a. Certificate 13-080 (5.75%)	62.89
b. Certificate 71-950 (6.5%)	8.67
c. Passbook Acct OP 7679 (5.25%)	72.89
Total Income	$2,933.70

Disbursements

1.	Danny Thomas Berry, Science Talent Winner	$ 20.00
2.	Mary Jane Post, Science Talent Winner	15.00
3.	Carolyn Lou Miller, Science Talent Winner	10.00
4.	Phillips Litho, Inc., Vol. 27, PROCEEDINGS	1,423.15
5.	Internal Revenue Service, Income Tax WH	2.30
6.	Dept. of Finance & Administration, Tax WH	1.10
7.	University of Arkansas, Receipt Book	1.81
8.	University of Arkansas, Copy Work	7.90
9.	Postmaster, Fayetteville, Stamps	35.00
10.	Postmaster, Box Rent	.75
11.	University of Arkansas, Receipt Book	2.22
12.	University of Arkansas, Copy Work	1.20
13.	Emily P. Tompkins, Editorial Assistant	118.30
14.	Internal Revenue Service, Tax WH	12.30
15.	Dept. of Finance & Administration, Tax WH	1.40
16.	Association of Academies of Science, 1975 Dues	10.00
17.	Arkansas Science Fair Assn., Auth. Support	100.00
18.	Arkansas Collegiate Academy of Science, Auth. Support	175.00
19.	Emily P. Tompkins, Editorial Assistant	82.90

Disbursements

20.	Dr. J. L. Wickliff, Stationery & Supplies	31.96
21.	Emily P. Tompkins, Editorial Assistant	32.10
22.	University of Arkansas, Copy Work	21.50
23.	University of Arkansas, Receipt Book	2.22
24.	Dr. Henry W. Robison, Postage, 1st Mailing	19.00
25.	Dr. Henry W. Robison, Postage, 2nd Mailing	18.70
	Total Disbursements	$2,145.81

Summary

Beginning Balance, Checking & Reserve, April 1, 1974	$3,623.20
Total Income	+2,933.70
Less Expenditures	-2,145.81
Total Funds, March 31, 1975	$4,411.09

*****

Balance in Checking Acct., McIlroy Bank	$1,451.08
FSLA Savings Certificate 71-950 (6.5%)	1,008.67
FSLA Passbook Acct. OP 7679 (5.25%)	1,951.34
Total Funds, March 31, 1975	$4,411.09

Respectfully submitted,

William L. Evans
Treasurer

April 11, 1975

Editor:

Dr. James Wickliff, Editor, noted that the tables and figures submitted were much improved, but that the text of many manuscripts needed revision. He appealed to Academy members to proofread manuscripts before submission to ease editorial problems.

Dr. Wickliff commended Mrs. Emily Tompkins for her efforts as copy editor.

Dr. Wickliff noted that he would move for more editorial assistance monies and for the establishment of a cumulative index during the second business meeting.

Historian:

Dr. Dwight Moore, Historian, stated that this was the 60th meeting of the Academy and the first held at Southern State College. Dr. Moore then discussed some of the history of the Academy.

State Science Fair:

Professor Robert Saunders reported on the State Science Fair. Professor Saunders noted that monetary contributions for the Science Fair were lower than before, but that student enthusiasm appeared to be high. This year, 88 exhibits or 22 from 4 regions were entered.

Junior Academy of Science:

President Dale asked for the report from the Junior Academy of Science. He noted it would be given at the second business meeting.

Collegiate Academy of Science:

President Dale asked for the report from the Collegiate Academy of Science. He noted it would be given at the second business meeting.

Junior Science and Humanities Symposium:

Dr. E.B. Wittlake, Director, reported that 93 students and 53 teachers attended the 9th Symposium held November 7-9, 1974, at the Grady Manning Hotel and the Arkansas Power and Light Auditorium in Little Rock. The winners selected were: Mark Kinion, Prairie Grove; John Stewart, Texarkana; Bob Barnes, Arkansas School for the Blind, Little Rock; Jenny Johnston and H. Allen McPherson, Fayetteville; and Helen Oyler, Mountain View. They will be accompanied by Mrs. Sid Purtle to the National Symposium. Dr. Wittlake thanked those who have contributed their time, facilities and finances. He also indicated that he will supervise next year's activities, but would like to be replaced before the 11th Symposium.

Unfinished Business:

President Dale noted that there were no reports from the Constitutional Revision Committee or the Nominating Committee. Dr. Evans reported that the Committee to Screen Junior Academy of Science Research Projects had approved 1 project for $40.

New Business:

President Dale nominated the following committees: Auditing (Dr. Gary Tucker, Dr. George Harp); Resolutions (Dr. Bill Guest, Chairman, Dr. Clark McCarty, Dr. Arthur Johnson); Meeting Place (Dr. Ron Beadles, Chairman, Professor Robert Saunders, Dr. Clarence Sinclair, Dr. W.L. Evans, Dr. Henry Robison, Dr. Terry Webb, Dr. John Bridgman); Research Proposal Screening Committee (Dr. George Templeton, Chairman, Dr. Earl Hannebrink, Dr. W.L. Evans); Membership (Dr. Neal Buffaloe, Dr. Les Howick, Dr. E.E. Dale, Dr. J.T. Gilmour, Dr. Leon Richards).

Dr. Henry Robison stated that he would be making a motion for reactivation of the Academy Newsletter during the second business meeting.

There being no further business, President Dale adjourned the first business meeting.

SECOND BUSINESS MEETING

President Dale called the second business meeting of the Arkansas Academy of Science to order 12 April 1975.

President Dale recognized Dr. Maurice Lawson, who discussed the Science and Technology Council. He indicated that the Governor had declined to approve funds for the Council operation. Thus, the financial viability of the Council appeared to be in doubt until funds might be made available.

President Dale recognized Dr. W.L. Evans, who presented the following motion:

> I move that a copy of the PROCEEDINGS be supplied to the administrator who authorizes institutional membership. This is to be construed as providing one copy in addition to the copy currently being sent to the library of each institutional member.

The motion was seconded and approved.

President Dale recognized Dr. Leo Paulissen, who presented the following motion:

> I move that the Arkansas Academy of Science sponsor a survey of Arkansas biota and that a committee or board of 5 members serve as a board of governors to undertake the operation of the survey and report progress at our next meeting.

The motion was seconded. During the discussion, Dr. Paulissen amended the motion to include Drs. Gary Heidt, Art Johnson, Leo Paulissen, Henry Robison and Gary Tucker as the board of governors for the first year. He stated that they would report progress to the Academy next year. The motion as amended carried.

President Dale asked Dr. Paulissen to report on the Science Talent Search. He stated that Arkansas winners had placed nationally which is a tribute to the participants within Arkansas.

President Dale recognized Professor R.O. Saunders to discuss the State Science Fair. Professor Saunders said that the program was a success again this year because of the efforts of the students and their advisors. He announced the winners (Kevin Williams, Green County Tech.; Donnie Keller, Weiner High School) and noted that because of lack of contributions to the Science Fair Program, additional monies were needed to send the second student to the International Science and Engineering Fair. Professor Saunders then presented the formal motion:

> I move that the Academy appropriate $100 to help

> defray the expenses of a second student, Donnie Keller of Weiner High School, to the International Science and Engineering Fair at Oklahoma City, Oklahoma.

The motion was seconded and passed.

President Dale recognized Dr. Maxine Manley, Director of the Junior Academy of Science. Dr. Manley reported that the papers were excellent this year. Dr. Manley then moved that Professor Marie King become the new Director of the Junior Academy. The motion was seconded and passed.

President Dale recognized Dr. John Bridgman of the Arkansas Collegiate Academy of Science. Dr. Bridgman announced the winners and noted the high quality of papers presented this year. Dr. Bridgman moved that Dr. Wilson of Harding College become a co-sponsor of the Collegiate Academy next year and become the sponsor of the Collegiate Academy the following year. The motion was seconded and passed. Dr. Bridgman also moved that $175 be appropriated from the Arkansas Academy of Science for the Collegiate Academy. The motion was seconded and passed.

President Dale recognized Dr. Maxine Manley, who moved that the Arkansas Academy of Science appropriate $200 for business purposes of the Junior Academy. The motion was seconded and passed.

President Dale recognized Dr. J.T. Gilmour, Secretary, who thanked the institutional members for their participation in the Arkansas Academy of Science. Dr. Gilmour then presented the motion:

> I move that the minutes of the 58th Annual Meeting contained in the 28th Proceedings of the Arkansas Academy of Science be approved as written.

The motion was seconded. During the discussion, it was noted by Dr. Clark McCarty that the officers listed in the 28th Proceedings needed correction. The motion passed.

President Dale recognized Dr. James Wickliff, Editor of the PROCEEDINGS. Dr. Wickliff presented the following motion:

> I move that the Academy allocate $300 for editorial assistance expenses for preparation of the 1975 issue of the PROCEEDINGS (Vol. 29).

The motion was seconded and passed. President Dale recognized Dr. Spaeirs, who moved that the Academy commend Dr. Wickliff for a job well done. The motion was seconded and passed.

President Dale recognized Dr. W.L. Evans, Treasurer. Dr. Evans presented the following motion:

> I move the acceptance and approval of the Treasurer's financial statement for the period of April 1, 1974, through March 31, 1975, as submitted at the first business meeting and verified by the Auditing Committee.

Dr. G.L. Harp of the Auditing Committee presented the following statement:

> The Auditing Committee has examined the financial statement of the Arkansas Academy of Science for the period 1 April 1974 through 31 March 1975. Said statement is hereby verified. Dr. William L. Evans, Treasurer, is to be commended for his efforts in this capacity.

The motion by Dr. Evans was then seconded and passed.

President Dale recognized Dr. John Beadles, Chairman of the Meeting Place Committee. Dr. Beadles reviewed recent meeting places and proposed meeting sites. Dr. Beadles noted that a central location was favored by the Meeting Place Committee for next year, and so moved that Little Rock be the location for the 60th Annual Meeting of the Arkansas Academy of Science. The motion was seconded. During discussion, Dr. Beadles stated the UALR would be the sponsor. The motion carried. President Dale then led a discussion of meeting dates. After much discussion, Dr. Spaeirs moved that a committee be formed composed of the Immediate Past President, President and President-Elect to recommend a meeting date. The motion was seconded and passed. President Dale pointed out that a recommendation would be made at the next Annual Meeting of the Academy.

President Dale noted again that a membership committee had been formed. He stated that he would convene the committee and that the committee would make a recommendation to the Executive Committee by October 15, 1975. Dr. Manley suggested that more high school teachers might register if the Junior Academy registered in the same area as the Senior Academy. Mrs. Wills, a high school teacher, pointed out that high school teachers would support the Academy.

President Dale recognized Dr. Lawson of the Nominating Committee. Dr. Lawson nominated Dr. Jewel Moore for President-Elect. Dr. Jack Sears moved that the nominations cease, and that Dr. Moore be elected by acclamation. The motion was seconded and passed. Dr. Dwight Moore, Historian, noted that Dr. Moore would be the third woman President of the Academy.

President Dale recognized Dr. W.C. Guest, Chairman of the Resolutions Committee. Dr. Guest moved that the following resolutions be adopted:

> Be it resolved, that the Arkansas Academy of Science express its sincere appreciation to the Administration and Faculty of our host institution, Southern State College, for the use of their excellent facilities and for their warm hospitality.
>
> The Academy also expresses its appreciation to the following people for their part in making the 1975 meeting a success: The Arrangements Committee at Southern State College, Dr. Henry Robison, Chairman, Dan England, Marie King and Hugh Johnson; the Chairmen of the Sections of the Academy; Dr. Maxine Hite Manley, Director of the Junior Academy of Science; Dr. Michael Condren and Dr. John Bridgman, Co-Sponsors of the Collegiate Academy of Science; Dr. E.B. Wittlake, Director of the Junior Science and Humanities Symposium; Mr. Phillip Easley, Director of the State Science Fair; and Professor Robert O Saunders, President of the Arkansas Science Fair Association.
>
> The Academy also wishes to express its thanks to Dr. Edward E. Dale, President of the Academy; Dr. John Gilmour, Secretary; Dr. William L. Evans, Treasurer; Dr. James Wickliff, Editor; and Dwight

M. Moore, Historian, for the excellent manner in which they have discharged their duties during the year.

The motion was seconded and passed.

President Dale asked for other business. Dr. Henry Robison was recognized. Dr. Robison moved to reactivate the Arkansas Academy of Science Newsletter and to set aside $100 for its publication and distribution. The motion was seconded. During discussion, President Dale noted that Dr. Robison would coordinate the Newsletter. The motion carried.

President Dale relayed his appreciation as President to all those who contributed to the Academy program during his term of office. He introduced the President-Elect, Dr. Joe Guenter, and passed the gavel to him. President Guenter appointed the Nominating Committee of Dr. Bob Kirkwood, Chairman, Dr. Robert Bustin and Dr. Alex Nisbit to report at the next Annual Meeting of the Academy.

President Guenter adjourned the second business meeting.

Respectfully submitted,

John T. Gilmour, Secretary

PROGRAM
Arkansas Academy of Science

Fifty-Ninth Annual Meeting

SOUTHERN STATE COLLEGE
Magnolia

Meeting concurrently with sessions of:

The Collegiate Academy of Science

The Junior Academy of Science

Arkansas State Science Fair

Friday, 11 April

SENIOR, COLLEGIATE, JUNIOR ACADEMIES -- Registration

ARKANSAS STATE SCIENCE FAIR -- Registration

SENIOR ACADEMY -- Executive Committee

COLLEGIATE ACADEMY -- Executive Committee

SENIOR ACADEMY -- Business Meeting

JUNIOR ACADEMY -- Papers (Westinghouse Talent Search)

SENIOR ACADEMY -- Discussion Group on the Arkansas Biota

COLLEGIATE ACADEMY -- Papers (Biological Sciences)

JUNIOR ACADEMY -- Papers (Biological and Physical Sciences, Concurrent Sessions)

SENIOR ACADEMY -- Papers (Science Education)

SENIOR ACADEMY -- Papers (Environmental Science and Technology)

COLLEGIATE ACADEMY -- Special Lecture: A.W. Cordes, "Some Fun With Symmetry in Two and Three Dimensions"

JUNIOR ACADEMY -- Executive Committee

SENIOR, COLLEGIATE, JUNIOR ACADEMIES -- Banquet and Program

Saturday, 12 April

SENIOR ACADEMY -- Papers (Concurrent Sessions)

COLLEGIATE ACADEMY -- Business Meeting

JUNIOR ACADEMY -- Business Meeting

COLLEGIATE ACADEMY -- Papers (Physical Sciences)

JUNIOR ACADEMY -- Awards Presentation

COLLEGIATE ACADEMY -- Awards Presentation

SENIOR ACADEMY -- Business Meeting

SECTION PROGRAMS

SCIENCE EDUCATION SECTION
Chairman: Dr. B. C. Dodson

HONORS ORGANIC CHEMISTRY: A NOVEL MELODY ON AN OLD INSTRUMENT.
Arthur Fry, M. Oka, J. Mattice and T.D. Roberts

A TEAM TAUGHT PHYSICAL SCIENCE COURSE FOR ELEMENTARY EDUCATION MAJORS.
Jerry Webb, Joe Guenter and Rene Dehon

A NEW ENVIRONMENTAL CHEMISTRY COURSE FOR NON-SCIENCE MAJORS AT THE UNIVERSITY OF ARKANSAS.
A. Wallace Cordes

THE USE OF THE COMPUTER IN UNDERGRADUATE EDUCATION IN BIOLOGY.
Robert T. Kirkwood

POLE STARS OF THE PLANETS.
Paul C. Sharrah

ENVIRONMENTAL SCIENCE AND TECHNOLOGY SECTION
Chairman: Dr. Henry W. Robison

PATHOGENIC FREE-LIVING AMOEBAE IN ARKANSAS.
Leon W. Bone and David A. Becker

ADDITIONS TO THE ARKANSAS FLORA.
Edwin B. Smith and Barney Lipscomb

A PRELIMINARY CHECKLIST OF THE FISHES OF THE ILLINOIS RIVER, ARKANSAS.
Michael R. Geihsler, Edgar D. Short and Paul D. Kittle

BENTHIC MACROINVERTEBRATE FAUNA OF AN OZARK AND A DELTAIC STREAM.
Mary R. Cather and George L. Harp

NEW DISTRIBUTIONAL RECORDS OF FISHES FROM THE LOWER OUACHITA RIVER SYSTEM IN ARKANSAS.
Henry W. Robison

ANTHROPOLOGY SECTION
Chairman: Dr. Timothy C. Klinger

SITE ABANDONMENT AND THE ARCHEOLOGICAL RECORD: AN EMPIRICAL CASE FOR ANTICIPATED RETURN.
Charles M. Baker

THE CONTEMPORARY STATUS OF WOMEN AMONG THE ZAPOTEC INDIANS OF MEXICO.
Judith Brueske

ALPHA-RECOIL DATING IN ARCHEOLOGY.
Ervan Garrison

COLES CREEK SOCIETY.
Michael P. Hoffman

MISSISSIPPIAN SETTLEMENT STRATEGICS IN THE ST. FRANCIS BASIN, ARKANSAS.
Timothy C. Klinger

ANTHROPOLOGY AND THE ACADEMY OF SCIENCE: THE NEED FOR A NEW ROLE.
Timothy C. Klinger

ATTITUDES TOWARD INSTITUTIONAL CARE IN TWO WESTERN ARKANSAS COUNTIES.
Allan May

DETERMINING THE MINIMUM NUMBER OF INDIVIDUALS: A COMPARISON OF SEVERAL DIFFERENT TECHNIQUES.
Raymond Medlock

ARCHEOLOGICAL SITE SURVEYING IN NORTHERN MADISON COUNTY, ARKANSAS.
Kenneth A. Mueller and Kenneth L. McKinney

PROBABILITY AND PREDICTIVE STATEMENTS IN ARCHEOLOGY.
Robert Taylor

BIOLOGY SECTION I
Chairman: Dr. Hugh Johnson

SOMATIC PAIRING IN *DROSOPHILA VIRILIS* MITOSIS.
William C. Guest

THE PRODUCTION OF SEED BY *GINKGO BILOBA* L. IN RELATION TO TEMPERATURE AND PHOTOPERIOD.
Michael I. Johnson

CASTANEA PUMILA VAR. *OZARKENSIS* (ASHE) TUCKER, COMB. NOV.
Gary E. Tucker

DISTRIBUTION OF RUBIDIUM-86 IN SINGLE AND DOUBLE ROOTED SOYBEAN PLANTS INFECTED WITH BEAN POD MOTTLE VIRUS.
Paul R. Nester and H. J. Walters

EFFECTS OF WATER STRESS ON POTASSIUM UPTAKE IN SOYBEANS INFECTED WITH *PYTHIUM APHANIDERMATUM*.
David R. Holliday and H. J. Walters

VARIATION OF ESTROGENIC COMPOUNDS IN SOYBEAN VARIETIES.
W. A. North, A. L. Hoggard and G. A. Berger

SPOTTING-FOREHEAD BLAZE LINKAGE IN MICE.
W. A. North, Albert L. Hoggard and Nesh' e E. North

EFFECTS OF BORON ON THE FORMATION OF HETEROCYSTS IN THE BLUE-GREEN ALGAE, *ANABAENA CYLINDRICA* LEMM. AND *ANABAENA SPHAERICA* BORN. ET FLAH.
Chuphan Chivaratanond

BIOLOGY SECTION II
Chairman: Dr. Daniel England

PARASITES OF SELECTED GAME FISHES OF LAKE FORT SMITH, ARKANSAS.
David A. Becker and Donald G. Cloutman

AGE AND GROWTH OF THE BLUEGILL, *LEPOMIS MACROCHIRUS*, FROM LAKE FORT SMITH, ARKANSAS.
Raj V. Kilambi and Jacob J. Hogue

FECUNDITY OF THE YOKE DARTER, *ETHEOSTOMA JULIAE* MEEK, FROM THE BUFFALO RIVER, ARKANSAS.
Michael R. Geihsler

DESCRIPTIVE EMBRYOLOGY OF THE PRE-HATCHING STAGES OF THE RED SHINER, *NOTROPIS LUTRENSIS*.
John K. Beadles

AN OCCURRENCE OF THE PUMA, *FELIS CONCOLOR*, FROM SVENDSEN CAVE, MARION COUNTY, ARKANSAS.
William L. Puckette

PRELIMINARY DOVE BANDING STUDIES IN CLARK COUNTY, ARKANSAS.
Thurman W. Booth, Jr., Peggy R. Dorris, William N. Hunter and Charles B. Mays

NOTES ON ARKANSAS BUTTERFLIES AND SKIPPERS.
Leo J. Paulissen

LIFE HISTORY AND SECONDARY PRODUCTION OF THE HELLGRAMMITE, *CORYDALUS CORNUTUS*.
Arthur V. Brown

RANGE AND STATUS OF THE BRUSH MOUSE (*PEROMYSCUS ATTWATERI*) IN ARKANSAS.
Gary A. Heidt and David Saugey

A PRELIMINARY REPORT ON THE FAUNA OF CLAY CAVE, IZARD COUNTY, ARKANSAS.
Richard R. Rockwell and V. R. McDaniel

CHEMISTRY SECTION
Chairman: Mr. John Smart

THEORY OF MOLECULAR ELECTRONIC COLLISIONS.
Neil S. Ostlund

PERTURBATION CALCULATIONS OF CORRELATION ENERGIES FOR H_2 AND THE VINYL AND ETHYL CARBONIUM IONS.
Neil S. Ostlund and M. Fillmore Bowen

POLYMER CHEMISTRY IN THE UNDERGRADUATE CURRICULUM.
Roderic P. Quirk

GEOLOGY SECTION
Chairman: Dr. Walter L. Manger

STRATIGRAPHY AND PALEOGEOGRAPHY OF THE CALICO ROCK SANDSTONE (ORDOVICIAN).
Raymond W. Suhm

PRIMARY REFERENCE SECTION, IMO FORMATION (UPPERMOST MISSISSIPPIAN), NORTH-CENTRAL ARKANSAS.
Walter L. Manger

RELATIONSHIP OF STREAM SEDIMENT COMPOSITION AND LEAD MINERALIZATION, NORTHERN ARKANSAS.
Kenneth Steele and William S. Bowen

Arkansas Collegiate Academy of Science

Michael Wish
President

Patricia Alexander
President-Elect

Barbara Collins
Secretary

Hattie Thompson
Treasurer

Sponsor: Dr. Michael Condren
Co-sponsor: Dr. John F. Bridgman

MINUTES OF THE BUSINESS MEETING, 12 APRIL 1975

The business meeting of the Arkansas Collegiate Academy of Science was called to order by the presiding President, Michael Wish. The minutes of the last meeting were read and approved.

The following officers were elected for 1975-76:

President -- Patricia Alexander, College of the Ozarks

President-Elect --

Secretary -- Kathleen Shankle, College of the Ozarks

Treasurer -- Curtis Paul Shankle, College of the Ozarks

Sponsor -- Dr. John F. Bridgman, College of the Ozarks

Co-sponsor -- Dr. E.W. Wilson, Harding College

The new President, Patricia Alexander, took charge and called a recess until 11:00 a.m. At that time, nominations for President-Elect were continued. A President-Elect was not chosen, but Dr. Wilson of Harding College said that he could find a volunteer from his school. A Treasurer's report was requested. The Treasurer was absent; however, Dr. Condren reported that, at present, the Collegiate Academy has $225.92 minus $25.00 for postage and the expenses for the speaker. Dr. Condren remarked upon his problems in contacting the Treasurer; therefore, it was suggested that the Treasurer be a student at the same college as either the President or the President-Elect. It also was suggested that the Sponsor be given authority to sign checks in addition to the Treasurer. A motion was made, seconded and passed that the money left over this year would be kept in case of emergency, but that any money left over in the future would be returned to the Senior Academy of Science. A motion was made, seconded and passed that the Collegiate Academy request $175.00 from the Senior Academy for next year's expenses. Awards were made to the winning presenters of papers. In the Biological Science section the first place certificate was awarded to Beth Kunkel of the University of Central Arkansas. The second place certificate was awarded to Sherrye Briggler also of the University of Central Arkansas. In the Physical Science section the first place certificate was awarded to Phil Hart of Harding College. The second and third place certificates were awarded to David Goff of Harding College and D. L. Merrifield of the University of Arkansas, respectively. The meeting was adjourned by the new President.

Respectfully submitted,

Kathleen Shankle, Secretary

PAPERS PRESENTED

BIOLOGICAL SCIENCE

ESTIMATED INTAKES OF ENERGY, FAT AND CHOLESTEROL FROM FOODS CONSUMED BY A COLLEGE-AGE POPULATION.
Sherrye Briggler (University of Central Arkansas, Conway).

Diet histories and 24-hour recall methods were used to estimate the intakes of energy, fat and cholesterol by a group of college men and women interested in physiological improvement through diet and exercise programs. Relationships between the nutrients were evaluated.

EFFECTS OF ENVIRONMENTAL FACTORS ON CONSUMER BEHAVIOR RELATIVE TO FOOD PURCHASING.
Karen Hug (University of Central Arkansas, Conway).

Environmental factors such as location, hours of operation and food item costs for various markets were evaluated for relativity to consumer market choices. A survey of consumers was used to determine the frequency with which markets of various types were selected for purchase of food.

PRESENT NUTRITIONAL STATUS AND PREDICTED CIRCULATORY PROBLEMS FROM ESTIMATES OF SERUM CHOLESTEROL LEVELS OF COLLEGE-AGED STUDENTS.
Beth Kunkel (University of Central Arkansas, Conway).

Serum cholesterol levels of 24 college students were estimated by the method of Abell et al. Intake of energy, fat and cholesterol was correlated with serum cholesterol levels. The various constituents were evaluated for their use in predicting probable circulatory problems.

PHYSICAL SCIENCE

RADIAL VARIATION OF g WITHIN THE EARTH.
Dale Burton (University of Arkansas at Monticello).

The variations in gravitational acceleration (g) within the Earth are discussed and those points were g is a relative maximum are described. If it is assumed that the density variation within the Earth can be represented by a series of straight lines of the form $\rho_i = m_i \gamma + b_i$, then by substituting this representation for the density distribution into Gauss's Theorem (or the Adams-Williamson equation) a formula for g (r) at any given point is obtained.

To evaluate this formula at several points within the Earth's surface, a Fortran computer program was written. The results of that program show that g has a maximum of 1028 cm/sec^2 at 3491 km and a second maximum of 994 cm/sec^2 at 5800 km from the center of the Earth.

AN INTEGRATED MIXING CHAMBER-FLOW CELL FOR FAST REACTION KINETICS.

David Goff (Harding College, Searcy).

A flow cell for studies of fast reaction kinetics is described. The cell, with a tandem version of the tangential mixing chamber, was built from a half-inch square lucite rod. The observation chamber which was machined into the cell allows the study of a reaction by spectrophotometric methods very soon after the reaction solutions are mixed. Forcing the solutions into the flow cell by nitrogen pressure monitored by a mercury manometer gave linear flow rates of 1 m/sec through the observation chamber. Studies of the ferric thiocyanate complex formation indicated that reactions with half-lives of three milliseconds could be studied with this apparatus. Studies of the copper-cysteine complex formation with this continuous flow method are anticipated.

CONSTRUCTION OF A THERMOMETRIC TITRATION CALORIMETER.

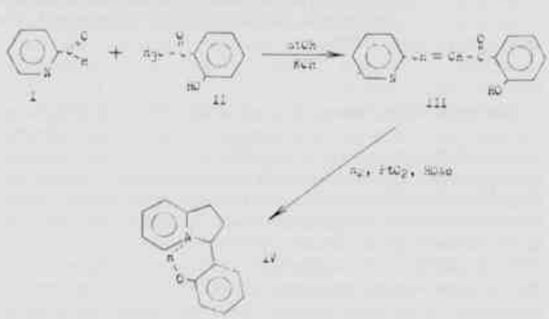
Blair Hill (Harding College, Searcy).

A thermometric titration calorimeter was constructed that allows evaluation of the thermodynamic properties of a reaction such as ΔE, ΔH, ΔS, ΔG and the equilibrium constant K from a single determination. The components of the calorimeter include a temperature monitoring system, a titration cell and an automatic buret. By use of a Thermistor, precise measurements can be made to monitor the change in temperature of the system caused by a reaction. This change in temperature, being universal for almost all reactions, is the basis for evaluating the thermodynamic properties of the reaction.

PRELIMINARY INVESTIGATION OF THE REDUCTIVE CYCLIZATION OF 2-PYRIDAL-o-HYDROXYACETOPHENONE.

Phil W. Hart (Harding College, Searcy).

A chalcone, 2-pyridal-o-hydroxyacetophenone (III), has been synthesized from 2-pyridine-3-(o-hydroxyphenyl)-indolizidine (I) and o-hydroxyacetophenone (II). Then (III) has been cyclized reductively to 3-(o-hyroxyphenyl)-indolizidine (IV). Through the course of the cyclization reaction five samples of the reactive intermediates were extracted at equal time intervals and analyzed by infrared spectroscopy. Such analysis indicated that the ethylenic linkage in the α, β position to the carbonyl was initially reduced, rendering the carbonyl vulnerable to nucleophilic attack. As cyclization occurs conversion of the carbonyl to a tertiary alcohol and subsequent hydrolysis to form a double bond is the sequence suggested by the evidence. Saturation of this bond would allow interaction of the phenolic proton with the ring nitrogen as indicated by characteristic infrared absorptions. The Bohlmann peaks in the 2920 to 2790 cm^{-1} region provided further evidence that cyclization had occurred.



GHOST ORBITALS.

N. S. Ostlund and D. L. Merrifield (University of Arkansas, Fayetteville).

A study of intermolecular interactions has revealed a tremendous dependence on the basis set extension effect commonly found by researchers using the "supermolecule" treatment in their calculations. A practical procedure for avoiding this dependence has been developed and some of the results of this new method are discussed. There are suggestions that, to obtain much better qualitative results, this new technique should replace the current procedures in which small basis set "supermolecule" calculations are used.

ELECTRICAL PROPERTIES OF VACUUM-EVAPORATED THIN FILMS.

John William Alred (University of Central Arkansas, Conway).

A study of the electrical properties of dielectrics in a metal-dielectric-metal film structure has been made. The metal layers were vacuum evaporated, whereas the dielectrics were either similarly evaporated or anodically oxidized. The dielectric constants and breakdown voltages were measured as a function of the dielectric thicknesses. The thicknesses of the dielectrics studied, Al_2O_3 and cryolite (Na_3AlF_6), range from 100 A to 1000 A.

Site Abandonment and the Archeological Record: An Empirical Case for Anticipated Return

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ABSTRACT

Cultural formation processes of abandonment are examined in light of recently discovered hammerstone caches at an aboriginal novaculite quarry site. De facto refuse formation is shown to vary according to the conditions under which site abandonment took place.

The archeological record is a set of material evidence about the past which includes the preserved remains of past cultural systems. Artifacts and other tangible evidence of past cultural systems, which in part constitute the archeological record, no longer participate in the behavioral system which was originally responsible for their deposition. These items now are observed in an "archeological context" (Schiffer, 1972).

Obviously the archeological context is vastly different from that of a past human behavioral system. Thus, in order to make inferences about past cultural behavior based on present observations of material items in archeological context, it is necessary to take into account the natural and cultural processes which operated in the past to render the current archeological record.

The archeological record of a particular cultural system is developed primarily by a finite set of activities which contribute materially to its formation. These activities, known as "cultural formation processes" (Schiffer, 1973), transform materials from a cultural systemic context to an archeological context. In this paper, certain cultural formation processes are discussed in light of recent observations of the archeological record.

The archeological data examined consist of a set of observations: (1) an extensively used prehistoric lithic resource extraction site, (2) activity areas within the site and (3) several groups of primary manufacturing tools found proximal to the activity areas.

The archeological site (3GA48) is in Garland County, Arkansas. The lithic material that was exploited aboriginally is novaculite, a type of siliceous stone suitable as a raw material for the manufacture of chipped stone tools. That the site was used very extensively is evidenced by large numbers of aboriginal quarry pits and trenches distributed widely over many acres. Typically, large quantities of artifactual materials surround these features indicating not only quarrying activities, but also various stages of raw material refinement.

Unique artifacts commonly found at this and other quarry sites are hammerstones. These artifacts, both complete and fragmentary, are found within the quarry pits and trenches, within lithic refuse deposits, and also scattered about other activity areas proximal to these features. Recently several individual groups of hammerstones were discovered at the site (Baker, 1974). Each of these groups was found in undisturbed archeological context. Each group consisted of either four or six hammerstones, neatly arranged in an orderly manner. Though many hammerstones have been found scattered in the general context of aboriginal novaculite quarry sites (Holmes, 1891; Jenney, 1891), groups of these artifacts have not been reported.

Hammerstones are related systematically to the activities of lithic raw material extraction, refinement and tool manufacture. Though these tools are also well suited for other activities such as driving stakes or pulverizing plant materials, their primary function was associated with stone working. When activities directed toward procuring and working stone are terminated, the hammerstones and other tools involved in these activities might be treated in a number of ways. The tools might be discarded in the area where they were used, such as in a quarry pit, and thus become "primary refuse" (Schiffer, 1972). They may be carried away from the activity area and discarded along with other items and become "secondary refuse" (Schiffer, 1972). The items may be stored or they may be transported for use in another area.

Many of the hammerstones found at the quarry site seem likely to have been deposited via "normal processes" of discard (Schiffer, 1975). Under these conditions, the hammerstones were committed to the archeological record because they were either worn out or broken, or for some other reason the replacement of these items at a later time was easier than salvaging and transporting them for use in another area.

The groups of hammerstones, however, do not appear to have been deposited by discard processes. All of the hammerstones in each group are whole, not fragmentary, and thus still usable for stone working activities. Also, the hammerstones are arranged in an orderly grouping as opposed to being randomly strewn about an activity area.

An obvious interpretation of this phenomenon is that the artifacts were arranged in such a manner for storage. Storage of course is a common activity, but surprisingly one whose transformational properties have not been examined in great detail. The following discussion seeks to identify the variable conditions under which items are stored and subsequently abandoned at a resource extraction site and also the formal properties of these items in archeological context.

The technological success of any society is based in part upon its ability to maintain supplies of necessary resources. Thus, periodically, known resource locations are frequented to obtain needed materials. It is very likely that an extensive resource deposit of suitable quality is revisited again and again as raw material needs become apparent. Though considerable time may elapse between visits, return to the resource location is expected as raw material supplies on hand become depleted.

In the case of a resource extraction site, abandonment will occur once a desired quantity of a particular resource has been acquired. Whether certain items in use during procurement activities are transported to another site or are abandoned with the activity area depends upon several factors.

For example, the relative difficulty of transporting an item will determine its treatment during abandonment (Schiffer, 1972). Though technological development largely determines transport capability, the rate at which an item is transported from an activity area is expected to vary inversely with the item's gross size. Thus, the probability that an item will be abandoned with an activity area increases proportionately with the difficulty of its transport. Also it should be obvious that the difficulty of transporting tools away from their area of use varies directly and proportionately with the quantity of extracted materials that must be transported from the resource location.

If the subsequent use of a tool related to resource extraction activities is not anticipated at the area of relocation, it is likely that the item will be abandoned within the resource area. In essence, then, tools which are activity-specific are likely to be abandoned in their area of use. Because hammerstones are associated primarily with stone working activities, the rate at which these items were abandoned is proportionately greater than the rate at which they were transported.

This brief discussion has outlined several conditions under which items are abandoned with an activity area, but there is still the matter of the items' treatment prior to abandonment. Several reasons for item discard have been pointed out, but the reasons for the storage of certain items needs to be discussed.

Obviously there is no need to store something which is not intended for further use. Initially, then, it seems reasonable to suggest that an item will be placed in storage only when return to an activity area is anticipated. Even if return is anticipated, however, there are still more basic conditioning factors which influence the storage of certain items. The most important of these appear to be protection and ease of relocation.

If, for example, a common quarry area was revisited intermittently by several social groups, specialists within any particular group upon termination of procurement activities might store their quarry tools inconspicuously to avoid their loss through pilfering. This might be true especially if one or more hammerstones were found to be particularly well suited for certain activities. Storage for protection might also occur if a particular type of hammerstone was difficult to obtain.

A second type of protective storage might relate to the upkeep of an item. Some tools, if left unprotected, might deteriorate and become unserviceable for later use. The storage of hammerstones perhaps was intended for their protection against the elements. Also, if these items were buried purposefully, ground moisture absorption may have rendered tools better suited for certain activities.

Finally, the storage of certain items may be intended to facilitate their rediscovery at a later time. In the context of an extraction site, if scavenging by other groups is no concern, a group of tools may be stored conspicuously within the activity area to insure their relocation upon return.

The formal properties of stored items in archeological context are expected to be different from those of other items committed to the archeological record by processes other than abandonment. Even within the domain of abandonment processes, stored items which subsequently are abandoned should exhibit attributes that are distinctive from those of other items which are abandoned.

"De facto refuse" has been defined as the primary refuse type which is transformed to the archeological record during the abandonment of an activity area (Schiffer, 1972). Specifically, de facto refuse "consists of the tools, facilities and other cultural materials which, though still usable, are abandoned" when an area is deserted (Schiffer, 1975).

It is very clear that under variable conditions, abandonment processes may yield vastly different arrangements of "still usable" items to the archeological record. On the basis of a recent study (Ascher, 1968), Schiffer offers a general hypothesis in this regard which suggests that "differential abandonment of a site changes the...normal spatial distribution of elements" in their cultural systemic context (Schiffer 1972, p. 160). Thus, though abandonment causation may be somewhat difficult to explain, the character of an abandonment process may be suggested by the character and arrangement of various types of de facto refuse.

The foregoing discussions of resource area desertion and stored de facto refuse should serve to help one distinguish between permanent and temporary processes of abandonment. The conceptual distinction of these processes is facilitated by use of the following hypothesis: the orderly arrangement of de facto refuse proximal to an identified activity area reflects the anticipated return to the area; conversely, the random arrangement of de facto refuse may suggest more permanent abandonment.

The identification of the correct abandonment process is crucial to making a sound interpretation of the conditions under which de facto refuse was produced. This identification is especially important in lithic resource studies where the significance of a particular resource is in question. For example, quarry sites with large amounts of stored de facto refuse are likely to have been more important than quarry sites with little or no de facto refuse. Obviously, the areal extent of a quarry site would be an additional clue in this regard.

The study of cultural formation processes in archeology has, unfortunately, a relatively short history. However, the identification and understanding of these processes is extremely important if archeologists are to make sound interpretations of past human behavior. In this paper, an attempt was made to understand some of the processes by which a part of the archeological record is formed through abandonment. Though many of the principles discussed warrant further testing, the data presented should be useful for broader comparative studies of abandonment processes.

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Parasites of Selected Game Fishes of Lake Fort Smith, Arkansas

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ABSTRACT

Surveys during 1961 and 1970 of the helminth parasites of selected game fishes of Lake Fort Smith, Arkansas, are compared. New host records are established in the State of Arkansas for the monogenetic trematode and crustacean parasites of the channel catfish, warmouth, bluegill, white crappie and black crappie.

INTRODUCTION

The first survey of the helminth parasites of selected game fishes of Lake Fort Smith was made in 1961 by Becker and Houghton (1969) to determine the parasite species and number, and the extent of parasitism. The present survey, conducted 10 years later, was an attempt to compare any subsequent diversification of the helminth parasites of seven of the fish hosts originally surveyed, and to make the first report of their monogenetic trematode and crustacean parasites in Lake Fort Smith to include any new host records for the State of Arkansas. This information is necessary for future determinations of geographic distribution and host-parasite relationships as they apply to the various facets of aquatic ecology.

DESCRIPTION OF STUDY AREA

Clear Creek (Frog Bayou) was impounded in 1936 to form Lake Fort Smith. This reservoir is in the Boston Mountains 18 km northeast of Fort Smith in Crawford County, Arkansas. The surface area of the reservoir is 213 ha and surface elevation is 258 m above mean sea level. The maximum depth is approximately 18 m. The watershed is a 168 km² area of mountainous oak-hickory forest (Nelson, 1952). Lake Fort Smith is classified as an oligotrophic, warm monomictic reservoir stratifying from April or May through October, and circulating during the other months (Hoffman et al., 1974).

MATERIALS AND METHODS

Fishes were collected semimonthly from July 1970 through June 1971 by electrofishing, gill nets and angling. Fishes were transported alive to the laboratory where they were segregated and maintained temporarily in aerated aquaria before necropsy for parasite recovery.

Monogenetic trematodes, strigeid trematodes and nematodes were fixed in 70% ethanol and mounted in a 4:1 solution of Turtox CMC-10 and Turtox CMC-S nonresinous fixative-stain-mountant (Becker and Heard, 1965). Digenetic trematodes (except strigeids), cestodes, acanthocephalans and leeches were fixed in alcohol-formalin-acetic acid (AFA), stained with Delafield's hematoxylin (Cable, 1961), cleared in terpineol and mounted in Permount. Crustaceans were preserved and identified in 70% ethanol.

The data were analyzed with the aid of an IBM 360-50 computer.

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RESULTS

The survey by Becker and Houghton (1969) showed that of 107 fishes examined representing 10 species, 96.3% were infected with at least two species of helminths. A total of 16 species of helminths were recovered. Of the 385 fishes examined in the investigation 10 years later, all were infected with at least one species of helminth or crustacean parasite. Thirty-eight species of parasites were recovered among seven of the same host species as surveyed by Becker and Houghton (1969). Table I compares the incidences and intensities of infections by the various helminths and crustaceans recovered in 1961 from seven host species collected by Becker and Houghton (1969) with those for parasites in 1970 and reported herein. The mean numbers of parasites per fish recovered in 1961 were not reported by Becker and Houghton (1969). Becker and Houghton (1969) did not include the monogenetic trematodes or crustaceans in their survey; thus the recovery of these parasites during the present investigation resulted in new host records for the channel catfish, warmouth, bluegill, white crappie and black crappie in the State of Arkansas.

DISCUSSION

As a reservoir ages, the ichthyoparasitofauna undergoes successional changes (Bauer, 1954). The primary objective of the present investigation was to determine any changes in the ichthyoparasite population of selected Lake Fort Smith game fishes which might have occurred subsequent to the 1961 survey of helminth parasites in this reservoir by Becker and Houghton (1969).

In general, the range in numbers of parasites in their respective hosts was larger in the present study than in the 1961 survey. This finding is presumed to be due to the larger number of fish hosts collected during the present investigation. Therefore, it is doubted that very many of the parasites increased in abundance as the larger numbers in the ranges might imply.

An unknown species of Bucephalidae and *Vietosoma parvum* (digenetic trematodes) and the cestode *Bothriocephalus cuspidatus* recovered during the present study were not recorded during the 1961 survey. The comparatively small number of their respective hosts collected in the 1961 survey may explain why these parasites were not recovered.

There appears to have been a tremendous increase in the prevalence of the metacercaria of the digenetic trematode *Posthodiplostomum minimum* subsequent to the 1961 survey. In that study, *P. minimum* was observed only in two largemouth bass with a maximum of 14 found in one fish. During the present study *P. minimum* was present in all centrarchid hosts examined, often in large numbers (up to

1,249 in one bluegill). Wisniewski (1958) and Esch (1971) observed higher prevalences of larval parasites in fishes from eutrophic lakes than in those from oligotrophic lakes. It thus appears that the metacercaria of *P. minimum* followed a pattern of population increase as Lake Fort Smith aged.

The acanthocephalan *Leptorhynchoides thecatus* was observed in small numbers during the 1961 survey, but not in the present study. Apparently *L. thecatus* has disappeared from Lake Fort Smith. It is postulated that either the amphipod intermediate host could not tolerate the conditions in Lake Fort Smith after impoundment, or the population density of these amphipods is too small to support this acanthocephalan. Another plausible explanation is that *L. thecatus* occasionally may be introduced into Lake Fort Smith with bait fishes, but a viable population cannot be sustained.

It is anticipated that the present study will provide baseline information for investigators involved in the preparation of impact statements, reservoir management, fisheries science and parasitology and the modeling of aquatic ecosystems.

ACKNOWLEDGEMENTS

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Table I. Comparative Ichthyoparasite Surveys of Lake Fort Smith*

		1961		1970		
		Parasites per Fish	Percent Infected	Parasites per Fish		Percent Infected
Hosts	Parasites	Range	Fish	Range	Mean	Fish
Channel catfish:						
1961 (3), 1970 (10)	Monogenetic trematodes					
	Cleidodiscus floridanus Mueller	-	-	19-240	86.6	100.0
	Digenetic trematodes					
	Alloglossidium corti (Lamont)	0-8	66.7	0-238	33.7	80.0
	Crepidostomum cornutum (Osborn)	0-3	33.3	0-5	0-5	10.0
	Vietosoma parvum Van Cleave and Mueller	0	0.0	0-730	133.8	80.0
	Cestodes					
	Corallobothrium fimbriatum Essex	5-18	100.0	0-2	0.3	20.0
	Corallobothrium giganteum Essex	0	0.0	0-40	6.3	50.0
	Proteocephalus ambloplitis (Leidy)	0-3	33.3	0-29	4.5	50.0

Hosts	Parasites	1961 Parasites per Fish Range	1961 Percent Infected Fish	1970 Parasites per Fish Range	1970 Mean	1970 Percent Infected Fish.
	Nematodes					
	Camallanus oxycephalus Ward and Magath	0	0.0	0-12	1.3	20.0
	Spinitectus carolini Holl	0	0.0	0-29	5.9	80.0
Black crappie:						
1961 (10), 1970 (15)	Monogenetic trematodes					
	Cleidodiscus vancleavei Mizelle	-	-	0-60	14.5	86.7
	Digenetic trematodes					
	Diplostomulum scheuringi Hughes	-	-	0-11	0.8	13.3
	Pisciamphistoma stunkardi (Holl)	0-1	20.0	0-4	0.7	26.7
	Posthodiplostomum minimum (MacCallum)	0	0.0	0-22	1.5	13.3
	Cestodes					
	Proteocephalus ambloplitis (Leidy)	0	0.0	0-2	0.1	6.6
	Nematodes					
	Camallanus oxycephalus Ward and Magath	15-75	100.0	1-30	12.9	100.0
	Spinitectus carolini Holl	0-35	10.0	0-3	0.2	6.6
White crappie:	Monogenetic trematodes					
1961 (22), 1970 (27)	*Cleidodiscus vancleavei* Mizelle	-	-	0-37	18.3	85.2
	Digenetic trematodes					
	Crepidostomum cornutum (Osborn)	0	0.0	0-1	...	3.7
	Diplostomulum scheuringi Hughes	-	-	0-21	0.9	11.1
	Pisciamphistoma stunkardi (Holl)	0-8	40.9	0-20	0.9	14.8
	Posthodiplostomum minimum (MacCallum)	0	0.0	0-20	1.7	22.2
	Cestodes					
	Proteocephalus ambloplitis (Leidy)	0	0.0	0-2	0.1	11.1
	Nematodes					
	Camallanus oxycephalus Ward and Magath	0-75	77.3	0-15	4.1	92.6
	Spinitectus carolini Holl	0-12	18.2	0-4	0.3	14.8
	Acanthocephalans					
	Neoechinorhynchus cylindratus (Van Cleave)	0	0.0	0-4	0.1	3.7

Hosts	Parasites	1961 Parasites per Fish Range	1961 Percent Infected Fish	1970 Parasites per Fish Range	1970 Mean	1970 Percent Infected Fish
	Mollusks					
	Glochidia	-	-	0-1	...	3.7
Bluegill:						
1961 (21), 1970 (115)	Monogenetic trematodes					
	Actinocleidus fergusoni Mizelle	-	-	0-21	4.8	77.4
	Anchoradiscus triangularis (Summers)	-	-	0-1	0.1	6.0
	Clavunculus bursatus (Mueller)	-	-	0-2	0.1	4.3
	Urocleidus acer (Mueller)	-	-	0-11	1.8	49.6
	Urocleidus dispar (Mueller)	-	-	0-19	4.4	74.8
	Urocleidus ferox Mueller	-	-	0-160	11.1	73.9
	Digenetic trematodes					
	Clinostomum marginatum (Rudolphi)	0	0.0	0-1	...	0.9
	Crepidostomum cornutum (Osborn)	0-53	57.1	0-163	11.1	67.8
	Diplostomulum scheuringi Hughes	-	-	0-18	3.1	33.1
	Pisciamphistoma stunkardi (Holl)	-	-	0-1	...	2.6
	Posthodiplostomum minimum (MacCallum)	0	0.0	0-1249	36.9	79.1
	Cestodes					
	Bothriocephalus cuspidatus Cooper	0	0.0	0-5	0.2	8.7
	Proteocephalus ambloplitis (Leidy)	0-26	81.0	0-78	1.6	23.7
	Nematodes					
	Camallanus oxycephalus Ward and Magath	0-8	23.8	0-5	0.6	35.3
	Contracaecum spiculigerum (Rudolphi)	0	0.0	0-3	0.1	10.4
	Spinitectus carolini Holl	0-25	66.7	0-122	12.7	84.4
	Acanthocephalans					
	Neoechinorhynchus cylindratus (Van Cleave)	0-6	5.0	0-4	0.1	4.3
	Crustaceans					
	Argulus mississippiensis Wilson	-	-	0-1	...	0.9
	Mollusks					
	Glochidia	-	-	0-13	0.5	13.9
	Leeches					
	Myzobdella moorei (Meyer)	-	-	0-2	0.1	3.5

		1961		1970		
		Parasites per Fish	Percent Infected	Parasites per Fish		Percent Infected
Hosts	Parasites	Range	Fish	Range	Mean	Fish
Largemouth bass:						
1961 (22), 1970 (89)	Monogenetic trematodes					
	Acolpenteron ureteroecetes Fischthal and Allison	-	-	0-2	...	2.2
	Actinocleidus fusiformis (Mueller)	-	-	0-32	5.3	57.3
	Clavunculus bursatus (Mueller)	-	-	0-21	1.4	45.0
	Urocleidus furcatus (Mueller)	-	-	0-160	27.2	80.9
	Urocleidus principalis (Mizelle)	-	-	0-244	47.4	80.9
	Digenetic trematodes					
	Clinostomum marginatum (Rudolphi)	0-7	11.1	0	0.0	0.0
	Crepidostomum cornutum (Osborn)	0	0.0	0-1	...	2.2
	Diplostomulum scheuringi Hughes	-	-	0-3	0.2	11.2
	Pisciamphistoma stunkardi (Holl)	0-2	13.6	0-3	0.2	11.2
	Posthodiplostomum minimum (MacCallum)	0-14	11.1	0-483	58.1	71.9
	Cestodes					
	Proteocephalus ambloplitis (Leidy) adults	0	0.0	0-11	0.3	7.9
	Proteocephalus ambloplitis (Leidy) larvae	0-54	59.1	0-52	5.0	63.0
	Nematodes					
	Camallanus oxycephalus Ward and Magath	0-46	36.4	0-29	1.5	50.5
	Contracaecum spiculigerum (Rudolphi)	0-1	5.0	0-8	0.8	26.9
	Spinitectus carolini Holl	0-6	18.2	0-17	1.8	38.2
	Acanthocephalans					
	Leptorhynchoides thecatus (Linton)	0-3	5.0	0	0.0	0.0
	Neoechinorhynchus cylindratus (Van Cleave)	0-62	81.8	2-287	41.1	100.0
	Crustaceans					
	Argulus mississippiensis Wilson	-	-	0-1	...	3.4
	Achtheres micropteri Wright	-	-	0-4	0.3	31.4
	Ergasilus centrarchidarum Wright	-	-	0-88	4.9	47.2
	Lernaea cruciata (Le Sueur)	-	-	0-1	...	3.4
	Mollusks					
	Glochidia	-	-	0-159	3.0	7.9

		1961		1970		
		Parasites per Fish	Percent Infected	Parasites per Fish		Percent Infected
Hosts	Parasites	Range	Fish	Range	Mean	Fish
Spotted bass:						
1961, (2), 1970 (54)	Monogenetic trematodes					
	Acolpenteron ureteroecetes Fischthal and Allison	-	-	0-2	0.1	3.7
	Actinocleidus fusiformis (Mueller)	-	-	0-2	0.1	3.7
	Clavunculus bursatus (Mueller)	-	-	0-8	1.1	33.4
	Urocleidus furcatus (Mueller)	-	-	0-11	0.2	5.6
	Urocleidus principalis (Mizelle)	-	-	0-55	5.9	59.3
	Digenetic trematodes					
	Clinostomum marginatum (Rudolphi)	0	0.0	0-2	...	1.8
	Crepidostomum cornutum (Osborn)	0	0.0	0-36	0.7	5.6
	Diplostomulum scheuringi Hughes	-	-	0-2	0.1	5.6
	Pisciamphistoma stunkardi (Holl)	0	0.0	0-1	0.1	11.1
	Posthodiplostomum minimum (MacCallum)	0	0.0	0-20	1.6	46.3
	Cestodes					
	Bothriocephalus cuspidatus Cooper	0	0.0	0-1	...	1.8
	Proteocephalus ambloplitis (Leidy)	50-68	100.0	0-145	30.5	98.2
	Nematodes					
	Camallanus oxycephalus Ward and Magath	0-7	50.0	0-41	9.6	92.6
	Contracaecum spiculigerum (Rudolphi)	0	0.0	0-5	0.3	9.3
	Spinitectus carolini Holl	0	0.0	0-6	0.6	24.1
	Acanthocephalans					
	Neoechinorhynchus cylindratus (Van Cleave)	5-22	100.0	0-81	20.5	96.4
	Crustaceans					
	Achtheres micropteri Wright	-	-	0-4	0.2	14.8
	Ergasilus centrarchidarum Wright	-	-	0-9	1.3	37.0
	Mollusks					
	Glochidia	-	-	0-128	2.4	1.8
	Leeches					
	Myzobdella moorei (Meyer)	-	-	0-4	0.1	5.6

Hosts	Parasites	1961 Parasites per Fish Range	1961 Percent Infected Fish	1970 Parasites per Fish Range	1970 Mean	1970 Percent Infected Fish
Warmouth:						
1961 (21), 1970 (75)	Monogenetic trematodes					
	Actinocleidus flagellatus Mizelle and Seamster	-	-	0-65	9.6	85.3
	Clavunculus okeechobeensis (Mizelle and Seamster	-	-	0-7	1.0	37.3
	Urocleidus chaenobryttus Mizelle and Seamster	-	-	0-70	18.6	90.6
	Urocleidus grandis Mizelle and Seamster	-	-	0-20	3.1	64.0
	Digenetic trematodes					
	Bucephalidae Poche	0	0.0	0-1	...	2.6
	Clinostomum marginatum (Rudolphi)	0-1	5.0	0-1	...	2.6
	Crepidostomum cornutum (Osborn)	0-1	5.0	0-25	2.6	37.3
	Diplostomulum scheuringi Hughes	-	-	0-45	8.0	66.7
	Pisciamphistoma stunkardi (Holl)	0-9	66.7	0-15	2.4	61.3
	Posthodiplostomum minimum (MacCallum)	0	0.0	0-126	9.8	57.3
	Cestodes					
	Bothriocephalus cuspidatus Cooper	0	0.0	0-1	...	1.3
	Proteocephalus ambloplitis (Leidy)	0-5	28.6	0-8	1.2	45.3
	Nematodes					
	Camallanus oxycephalus Ward and Magath	0-7	19.0	0-4	0.4	33.3
	Contracaecum spiculigerum (Rudolphi)	0	0.0	0-9	0.1	4.0
	Spinitectus carolini Holl	0-16	14.3	0-37	2.7	64.0
	Acanthocephalans					
	Neoechinorhynchus cylindratus (Van Cleave)	0	0.0	0-11	0.6	37.3
	Crustaceans					
	Argulus mississippiensis Wilson	-	-	0-2	0.1	9.3
	Achtheres micropteri Wright	-	-	0-12	0.3	10.6
	Lernaea cruciata (Le Sueur)	-	-	0-1	...	1.3
	Mollusks					
	Glochidia	-	-	0-52	1.7	10.6
	Leeches					
	Myzobdella moorei (Meyer)	-	-	0-5	0.5	17.3

*Numbers in parentheses after dates indicate number of hosts. Those parasites not studied in 1961 are indicated by a dash (-); dots (...) indicate that the mean number of parasites per fish was less than 0.1.

Nonpathogenic Free-Living Amoebae in Arkansas Recreational Waters

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ABSTRACT

Selected recreational waters of Arkansas were sampled for pathogenic free-living limax amoebae. Water quality parameters were determined for correlation with amoebic population densities and species diversity. Cultural criteria and animal inoculation revealed no pathogenic strains. The possibility of introduction and/or induction of pathogenic amoebic strains by environmental factors requires further ecological investigations.

INTRODUCTION

Pathogenic strains of a free-living limax amoeba, *Naegleria gruberi*, cause primary amoebic meningoencephalitis (PAM), a fatal disease occurring in young adults or children after swimming in warm water with a high organic content. Fatalities are reported from several countries and from Georgia, Texas, Pennsylvania, Virginia, California and Florida in the United States.

Drug therapy is ineffective in PAM; thus identification and closure of infective waters is now the only preventive measure.

Symmers (1969) and Neva (1970) suggested PAM results from environmental pollution and emphasized the need for environmental studies. Duma et al. (1971) stated human meningoencephalitis resulting from environmental pollution may be a sizeable problem, especially in the Southeastern United States. Griffin (1972) proposed thermal and coliform pollution promoted growth of pathogenic *N. gruberi*. Therefore, there is a potentiality for the induction of pathogens through thermal or sewage effluents.

This study and others have attempted to isolate pathogenic *N. gruberi* and correlate its presence and density with water quality (Jamieson and Anderson, 1973; Nelson, 1972).

MATERIALS AND METHODS

Water samples were collected from selected recreational waters during July and August 1973-74. A single sample from Dardanelle Reservoir was taken in November 1973. Water quality parameters were monitored by standard Hach field procedures.

Subsurface water samples for physicochemical and organismic analyses were taken within 1 m of the shore. Designated swimming areas were selected as collecting sites. Recreational waters without swimming areas per se were sampled at readily accessible locations, such as boat launching sites.

Amoebae were sampled by Millipore membrane filtration methods. Filter membranes of 5μ porosity were washed repeatedly with 5 ml sterile distilled water before plating of one- and three-drop samples on buffered sucrose tryptose agar (BST) with *Pseudomonas aeruginosa* (Chang, 1971). Plates were incubated at 35C for enumeration of total amoebic densities, or 41C for enumeration of pathogens. After 24-48 hr the 35C plates were incubated at room temperature. Amoebic plaques were counted at 3, 10 and 16 days. Organisms were identified by cultural and morphological criteria (Chang, 1971, 1972, 1974; Page, 1967). Selected plaques of amoebae were cultured on BST agar slants at 35C before intranasal inoculation in white mice for determination of pathogenicity.

Isolation, inoculation and identification phases of this study were conducted in facilities provided by the Division of Laboratory Animal Medicine, School of Medicine, University of Arkansas Medical Center, Little Rock, Arkansas.

RESULTS

Water quality parameters, amoebic population densities and species composition for each collection site are shown in Table I.

The average number of amoebae for all sites was 457/liter. The average species composition for the sites was: *Naegleria gruberi* 56.4%, *Acanthamoeba rhysodes* 35%, *Hartmannella* sp. 4.5%, and *Schizopyrenus russelli* 4.1%.

The highest amoebic density (699/L) was at Goshen Bridge and the lowest density (233/L) was at Horsehead Lake (excluding the seasonally induced low density at Dardanelle Reservoir). *N. gruberi* was the predominant species at all sites except Goshen Bridge. *A. rhysodes* was relatively abundant at all sites and predominant at Goshen Bridge. *S. russelli* and *Hartmannella* sp. were found infrequently (Table I).

Water quality parameters were found to be at acceptable levels for primary contact recreational waters. The water at Goshen Bridge showed higher CO_2, nitrite and nitrate levels and a lower pH which may account for the high average total amoebae population level (Table I).

No pathogenic amoebae were found on the basis of cultural or morphological criteria. Amoebic plaques failed to appear on the 41C plates used for selective growth of pathogens through temperature tolerance. Amoebic plaques also failed to appear on the 35C plates after incubation of 2 wk. Growth under these conditions would indicate the presence of pathogenic free-living strains of *Naegleria*. The intranasal inoculation of white mice with selected strains of amoebae identified as nonpathogenic by cultural characteristics failed to demonstrate any pathogenicity. No deaths occurred in inoculated mice and all animals appeared healthy during a 3 wk postinfection period.

DISCUSSION

The number, species composition and dominance of amoebae in the samples approximate other reported levels (Chang, 1971, 1972). Chang (1971) found *Acanthamoeba* better adapted to adverse conditions than *Naegleria*, thus the prominence of *A. rhysodes* at Goshen Bridge. *N. gruberi* was predominant at the other sites.

Little additional correlation of amoebic densities and composition is apparent, other than increasing population density with increasing water temperature. Water quality parameters probably act synergistically on the population dynamics of amoebae.

Other investigators have attempted to isolate pathogenic free-living amoebae from nondisease-connected sources. Nelson (1972) isolated pathogenic *Naegleria* from a small, nonrecreational pond. The pathogenic strain was one of 226 cultivated strains.

Jamieson and Anderson (1973) cultured 130 strains from 400 sources and identified two pathogenic strains. Chang (1972) reported amoebic population levels from 15 sources. Although numerous strains with high densities were found, all amoebae were nonpathogenic.

These reports indicate pathogenic amoebae are low in population density and constitute a small fraction of amoebic isolates from nondisease areas.

The relationship of environmental pollution and pathogenic amoebae is obscure. Griffin (1972) showed pathogenic *Naegleria* and *Acanthamoeba* grew at temperatures above 37C. Chang (1972) demonstrated nonpathogenic *Naegleria* grew in a simulated natural aquatic environment at 25C whereas pathogenic strains decreased rapidly. Chang did not dismiss the possibility of the extended survival of pathogenic *Naegleria* in a natural habitat under certain conditions.

Water quality in the present study did not favor the survival and/or growth of pathogenic amoebae, hence the apparent absence of pathogenic strains.

A human carrier state may contribute to the occurrence of PAM (Chang, 1972, 1974; Skocil et al., 1971). A carrier state offers epidemiological significance through the introduction of pathogens in uninfected waters, or disease induction in a carrier by certain water quality parameters.

Although no pathogenic amoebae were isolated during the present study, the potential of PAM cannot be discounted. The introduction of pathogenic amoebae in uninfected waters by human carriers or other unknown hosts coupled with a favorable environment, such as thermal effluents from thermonuclear reactors, is a situation for further investigation to answer the question posed by Neva (1970), "Is this another example of a new disease pattern that man creates by fouling his environment?"

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Table I. Water Quality Parameters and Amoebae Population Levels* (Sites Lost Bridge through Goshen Bridge are on Beaver Reservoir)

Site	Date	Temp °F	DO mg/l	CO_2 mg/l	pH	NO_3 mg/l	NO_2 mg/l	O-PO_4 mg/l	T-PO_4 mg/l	Hardness gr/gal	Coliform #/100 ml	Avg. N.g. /l (%)	Avg. A.r. /l (%)	Avg. H.sp. /l (%)	Avg. S.r. /l (%)	Avg. Total Amoebae/l
L. Weddington	7-73	88.6 (88-89)	8.3 (8-9)	25 (10-40)	8.6 (8.5-8.75)	0	0	.2 (0-.5)		4.3 (4-5)	1 (<1-1)	377(69)	178(31)			555
Lost Bridge	7/8-73	88.5 (88-89)	7.5 (7-8)	52.5 (50-55)	8.75	0	0	0	0	3	1 (<1-1)	300(65)	148(31)	19(4)		467
Rocky Branch	7/8-73	88 (87-89)	7.5 (7-8)	25.0 (20-30)	8.75	0	0	.25 (.3-.2)	.25 (.3-.2)	3	<1	208(53)	169(42)	22(5)		399
Prairie Creek	7/8-73	86.8 (82-90)	8.0 (7-9)	25.0 (10-45)	8.70 (8.5-8.75)	0	0	.06 (0-.3)	.1 (0-.3)	3.2 (3-4)	1 (<1-1)	373(58)	213(31)	60(9)	13(2)	659
Horseshoe Bend	7/8-73	86.8 (84-89)	8.2 (7-9)	25.0 (10-45)	8.75	0	0	.2 (0-.5)	.2 (0-.5)	3	<1 (<1-1)	360(52)	226(33)	46(7)	57(8)	689
Monte Ne	7/8-73	87.5 (87-88)	8.5 (8-9)	42.5 (40-45)	8.5	0	0	0	0	3	1 (<1-1)	533(81)	116(18)	11(1)		660
Hickory Creek	7/8-73	84.8 (82-86)	8.2 (7-9)	25.0 (10-35)	8.3 (7.8-8.75)	0	0	.2 (0-.5)	.12 (0-.5)	3.4 (3-5)	<1 (<1-1)	401(59)	199(29)	33(5)	56(7)	689
Goshen Bridge	7-73	82.6 (79-86)	9.3 (4-15)	71.6 (30-125)	7.2 (7-7.5)	.39 (.2-.8)	.51 (.2-.8)	1.0 (.3-1.5)	.8 (0-1.2)	3.7 (3-4)	2 (1-3)	300(42)	311(45)	72(11)	16(2)	699
Dardanelle Res.	11-73	63	8	65	8.5	0	.5	0	0	5	<1	10(27)	26(73)			36
Dardanelle Res.	7-74	88	7	35	8.5	0	0	0	0	3	2	233(61)	125(33)	25(6)		383
Shores L.	7-74	89	8	20	8.7	.1	.3	.2	.6	5	1	300(75)	100(25)			400
Horsehead L.	7-74	90	8	30	8.5	.1	.2	.1	.2	4	2	100(42)	100(42)	33(16)		233
Atkins L.	7-74	89	8	20	8.5	.3	.2	.4	.3	4	1	283(60)	100(21)	84(19)		467
L. Conway	7-74	89	8	45	8.5	.3	.5	.7	.9	4	3	293(61)	117(24)	17(6)	47(9)	474
Big Maumelle L.	7-74	88	9	25	8.7	0	0	0	0	3	<1	118(33)	233(66)		33(7)	616
Harris Brake	7-74	87	8	15	8.7	.3	.5	.3	.3	4	1	350((56)	233(37)		33(7)	616
L. Winona	7-74	88	9	10	8.7	0	0	0	0	3	2	118(50)	118(50)			236
Nimrod L.	7-74	89	8	•25	8.7	0	0	0	0	5	<1	250(65)	100(26)		33(9)	383
Bl. Mountain L.	7-74	90	8	30	8.7	0	0	0	0	3	<1	188(61)	117(39)			305
L. Wilhelmina	7-74	89	7	35	8.5	.7	1.0	.3	.2	4	3	300(50)	200(33)		100(17)	600
DeQueen L.	7-74	88	8	10	8.5	0	0	0	0	2	4	284(54)	150(29)		82(17)	516
Gillham L.	7-74	87	8	20	8.5	0	0	0	0	5	3	318(72)	117(28)			435
Dierks L.	7-74	88	8	45	8.5	0	0	0	0	4	<1	233(50)	200(42)	33(8)		466
Shady L.	7-74	87	8	45	8.7	.1	.3	.05	.1	4	4	250(46)	250(46)		33(8)	533
L. Greeson	7-74	89	7	15	8.5	0	0	0	0	2	2	300(78)	83(22)			383
Millwood L.	7-74	88	9	40	8.5	.2	.3	.2	.2	5	1	233(63)	100(27)	33(10)		366
DeGray L.	7-74	86	8	40	8.7	0	0	0	0	4	2	200(46)	200(46)	17(4)	16(4)	433
L. Hamilton	7-74	86	8	10	8.5	.4	3	.2	.6	5	<1	200(48)	106(25)	27(6)	83(21)	416
L. Ouachita	7-74	87	9	15	8.5	0	0	0	0	3	2	283(85)	33(10)		17(5)	333
L. Catherine	7-74	86	8	30	8.7	.1	.2	.05	.1	4	2	200(46)	200(46)	33(8)		433
Greers Ferry	7-74	88	8	25	8.5	0	0	0	0	3	1	166(46)	133(36)	33(9)	33(9)	365
Buffalo R.	7-74	86	7	35	8.5	.1	.1	.05	.05	5	<1	350(68)	250(42)			600
Norfork L.	7-74	89	8	20	8.7	.2	.3	.1	.2	2	2	233(58)	117(29)	33(8)	18(5)	401
Bull Shoals	7-74	87	9	40	8.7	.1	.2	.1	.3	3	3	266(47)	200(35)	66(11)	33(7)	565

*Coliform numbers exclude fecal coliform.

Preliminary Dove Banding Studies in Clark County, Arkansas

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ABSTRACT

In conjunction with the U.S. Department of Interior Fish and Wildlife Service, Henderson State University Biology Department made a preliminary study of mourning doves in Clark County, Arkansas, during June, July and August 1974. Three hundred seventy-one mourning doves were baited, trapped and banded to obtain information concerning age, sex, populations, retraps, deformities, effects on other animals, migrations and other behaviors.

Henderson State University Biology Department, in conjunction with the U. S. Department of the Interior Fish and Wildlife Service, made a preliminary study of mourning doves in Clark County, Arkansas, during June, July and August 1974.

Three hundred seventy-one mourning doves (*Zenaidura macoura*) were baited, trapped and banded to obtain information concerning age, sex, populations, retraps, deformities, methods, migrations and other habits.

Bait trapping was used because it is the cheapest method which can be undertaken as a one-person project. A modification of the Kniffin modified funnel trap was used in this study. Instead of the square traps suggested by the Kniffin method, 40 traps were assembled in a round form. This structure seemed to produce less injury to captured birds.

The two trapping sites used throughout June, July and August were primarily graveled areas with sparse vegetation. Birds had access to water, trees, power lines or other protective perch areas. Baiting with milo began in May before the traps were set on the banding sites. Prior to June 1, traps were placed upside down in the baited areas to acclimate birds to their presence. On June 1, the traps were turned right side up in their trapping positions and both trapping areas became productive by June 20.

RESULTS

Because doves feed chiefly in the early morning or late afternoon, these periods seemed to be the most productive for capture although traps were left in the trapping position all day. When temperatures rose to almost 95F the traps were checked every 2 hours; otherwise they were left unattended for 4 hours. A complete replenishment of bait was necessary after severe rains because much of the grain washed away and doves were not attracted to rain-soaked bait.

As doves were captured, they were banded and set free. Table I shows data concerning age and sex of the 366 doves trapped, banded and released.

Table I. Age and Sex of Doves Trapped

Age		
Hatching Year (Formerly Called Immature)	After Hatching Year (Formerly Called Adult)	Uncertain
184	174	8

Sex		
Males	Females	Uncertain
96	66	204*

*Sex determination was not attempted on hatching year birds; thus large numbers of doves were classified as "uncertain" with respect to sex. Wood (1969) was used as a guide for sex determination.

Besides doves, other birds such as cardinals, cow birds, red wing black birds, grackles, quail and mocking birds were lured into the traps. Young gray squirrels also occasionally entered the traps. Table II gives data on animals trapped other than mourning doves.

Table II. Animals Trapped Other Than Doves

Date	Mocking Birds	Cardinals	Brown-Headed Cow Birds	Grackles	Bobwhite Quail	Red Wing Black Birds	Squirrels
6/10/74							1
6/11/74		1					
6/12/74		2					1
6/16/74			1				
6/19/74			2		1		
6/20/74	1		11	5			
6/21/74		3	5	5	1	1	
6/22/74			3	4			
6/23/74		1					
6/24/74		3	1		1		
6/25/74		8	4	6			
6/26/74	1	5	8	11	2	1	
6/27/74		9	4	2	1		
6/28/74		2	2	9	1		
6/29/74		2	5	6	1		
6/30/74		2		6			
7/1/74		5	3	6			
7/2/74		6	2	7			
7/3/74		1	1	1			
7/4/74		2		1			
7/8/74		4	5	4			
7/9/74		4		6	1		
7/10/74		4	3	2	1		
7/11/74		3		3		1	
7/16/74		5		2		1	
7/20/74		1					
7/27/74		2					

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TRAPPING PROBLEMS

Many problems were encountered during the trapping season. Occasionally hawks would damage traps in an attempt to get at captured birds. Feral cats constantly were a nuisance as they pursued trapped birds and tried to enter the traps. Crows proved to be most destructive to trapped birds as they pecked the heads of doves, sometimes killing them. Presence of any animal at the trap would frighten the trapped birds and often resulted in death or damage. Heat alone was also a factor in mortality rates. Five doves that had been retrapped and several other species of birds were found dead because of extreme heat. Less serious problems were created by loss of food to other animals such as rodents and squirrels. Sometimes the same dove was trapped as many as four times in one week, and such recaptures also proved to be a nuisance. All of the aforementioned factors made frequent checking of traps mandatory.

DISCUSSION

Several deformities were observed among the 371 doves banded (Table III).

Table III. Deformities

Deformity	Number Trapped
Deformed upper mandible	2
Deformed back toe on left foot	1
Deformed tarsus on toes	1

At the present time, returns on only 10 of the 366 birds banded have been received by the Fish and Wildlife Division. These doves were killed during the last season. Data on the returns are given in Table IV.

Table IV. Returns from Doves Banded in Clark County, Arkansas

	Dove Banded	Date Killed	Site Killed
1.	6/24/74	9/ 2/74	South of Arkadelphia
2.	7/ 1/74	9/ 6/74	South of Arkadelphia
3.	7/ 4/74	9/ 8/74	ESE Waco, Texas
4.	7/15/74	9/ 5/74	Near Arkadelphia
5.	7/22/74	9/21/74	East Troup, Texas
6.	7/28/74	9/ 2/74	South of Arkadelphia
7.	8/15/74	9/ 7/74	South of Arkadelphia
8.	8/17/74	10/23/74	SE Falfarrias, Texas
9.	8/20/74	9/ 1/74	South of Arkadelphia
10.	8/20/74	9/ 5/74	Near Arkadelphia

Entries 3, 5 and 8 in Table IV give information concerning distance traveled, time involved and other pertinent data. Within 2 months of banding, doves were found in Texas and near Mexico. As more band data are returned from future dove kills, more information can be obtained. A follow-up study is being continued during the summer of 1975 to band more doves and to collect data concerning weight, length and parasites. Returns from dove kills also will be considered carefully and a more definitive discussion can be offered at a later date.

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Relationship of Lead Mineralization and Bottom Sediment Composition of Streams, Ponca-Boxley District, Arkansas

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ABSTRACT

Samples from tributaries draining known mineralized areas contain considerably more lead than those from the main stream. The unique sediments (i.e. lead rich) from the tributaries are quickly diluted in the main stream to background levels. The lead content of the sediments from the tributaries apparently is controlled by the presence of lead-rich clasts. Sorption of lead by iron oxide coating grains is more significant in the main stream because the unique clasts are diluted. The mineralization also increases zinc and cadmium levels in the sediments. The concentration of calcium is controlled largely by the presence of limestone, whereas the concentrations of Mg, Mn, Co, Cu, Cr and Ni are controlled primarily by the presence of shale fragments and sorption by iron oxide coating clasts.

INTRODUCTION

The Ponca-Boxley Mining District, in the upper part of the Buffalo River, northcentral Arkansas, is the site of significant lead and some zinc mineralization (Fig. 1). Mining in this area was intermittent from 1860 to 1920. In 1935 McKnight described the lead mineralized "run" from the upper part of Adds Creek to the vicinity of Moore Creek on the northwest side of the Buffalo River. Most of the southeast side was considered barren. The "run" is in the lower part of the Batesville Sandstone Formation immediately above the Boone Limestone Formation, both of Mississippian age. The greatest concentration of mines is in the vicinity of Adds Creek where the dominant lead ore, galena, and the less abundant zinc sulfide and zinc carbonate minerals were mined. A mill was constructed at the town of Ponca to concentrate the ore from the area.

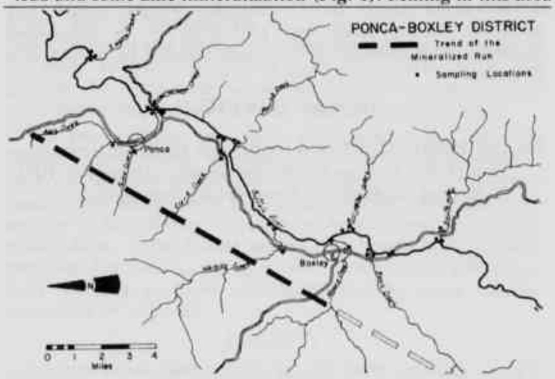

Figure 1. Map showing sample locations for stream bottom samples. Reported mineralized run of Ponca-Boxley District is shown as solid dashed line and data from this study indicate run should be extended (open dashed line).

The objectives of this study were (1) to determine the effect of the mineralization on the bottom sediment composition of the Buffalo River and its tributaries, and (2) to ascertain relationships of lead and other elements in the bottom sediments.

METHODS

Bottom sediment samples were taken in 10 selected tributaries (Fig. 1) upstream from their confluence with Buffalo River. Additionally sediment was collected in the river above and below these points of tributary confluence, except no upstream samples for Moore and Running Creeks were collected. Two of the tributaries' (Adds and Ponca) samples were obtained upstream of the town of Ponca (site of the old mill). All bottom sediment samples were collected near shore and below the water line by hand or plastic shovel to prevent metal contamination. After an initial air drying period, the samples were oven dried for 24 hr at 105C to drive off latent moisture and then 500 grams of sediment from each sample was sieved on a nylon 95 mesh screen with a Plexiglas frame. One gram of the -95 mesh portion was treated with aqua regia for 13 hr to dissolve coatings covering the predominant quartz and chert grains, and also to dissolve sulfide and carbonate ore minerals. The sample then was filtered and diluted to 50 ml in preparation for analysis by atomic absorption spectrometry. The samples were analyzed for the following elements: Ca, Mg, Fe, Cd, Co, Cr, Cu, Ni, Mn, Pb and Zn (Table I). In general, concentrations are within ±10% of the value.

Table I. Bottom Sediment Composition of Streams in Ponca-Boxley District

	River Mile	Pb	Zn	Cd	Fe	Co	Cr	Ni	Cu	Mn	Mg	Ca
Smith Ck (A)		6	48	0.85	2.22	13	17	18	8	1000	575	260
Smith Ck	0	9	73	1.30	2.48	19	21	25	14	1147	787	2500
Smith Ck (B)		9	63	0.85	2.61	13	21	24	10	1000	637	465
Beech Ck (A)		7	48	0.85	1.80	11	16	21	7	812	425	260
Beech Ck	1.5	20	216	1.00	2.20	13	17	19	14	900	575	470
Beech Ck (B)		6	56	0.85	2.42	13	19	23	8	975	587	370
Arrington Ck (A)		5	63	0.85	2.21	14	19	22	7	950	512	465
Arrington Ck	2.0	8	85	0.65	2.91	21	27	30	14	1500	725	2500
Arrington Ck (B)		5	65	0.50	2.48	16	25	22	9	1175	550	1150
Moore Ck	2.4	19	65	1.70	2.12	17	18	29	16	850	600	7500
Moore Ck		8	84	0.85	2.61	16	23	24	10	1062	612	785
Whiteley Ck (A)		8	62	0.65	2.21	14	20	20	5	1125	550	710
Whiteley Ck	3.6	10	52	0.85	2.20	14	18	21	5	1025	712	5000
Whiteley Ck (B)		5	58	0.65	2.30	16	15	19	5	1550	487	475
Running Ck	5.4	7	47	1.0	2.66	19	25	25	10	1125	687	5000
Running Ck (B)		5	69	0.65	2.26	14	21	26	7	1000	850	1030
Clark Ck (A)		9	51	0.50	1.77	9	12	15	1	300	437	365
Clark Ck	5.7	12	65	1.5	1.50	13	11	25	9	1125	525	22750
Clark Ck (B)		5	62	0.50	1.93	9	16	23	3	675	525	2250
Ponca Ck (A)		<1	43	0.55	1.56	8	13	11	1	550	375	230
Ponca Ck	7.0	58	1140	4.25	2.14	11	8	19	5	450	335	9995
Ponca Ck at Ponca	7.0	9	72	1.15	2.50	18	19	33	7	1425	750	15250
Adds Ck	7.0	20	366	57.50	3.52	21	17	38	30	1500	462	16750
Leatherwood Ck	7.0	5	90	1.50	2.28	17	18	24	7	1325	1035	15750
Leatherwood Ck (B)		4	54	0.65	1.46	8	13	14	1	425	425	1350
3 Name Ck (A)		5	67	1.00	2.03	11	18	19	2	775	725	9750
3 Name Ck	9.7	18	90	2.00	1.47	17	28	29	7	1025	1035	10495
3 Name Ck (B)		8	122	0.65	2.07	9	18	20	2	1150	537	375

Fe is expressed in weight percent and all other elements are expressed in ppm by weight.

Samples collected on the Buffalo River above and below tributaries are denoted by (A) and (B) respectively.

River miles are measured downstream along the Buffalo River from Smith Creek which is represented as zero miles.

DISCUSSION

A plot of Pb concentration of bottom sediment from the river and tributaries versus river miles (Fig. 2) corresponds well with

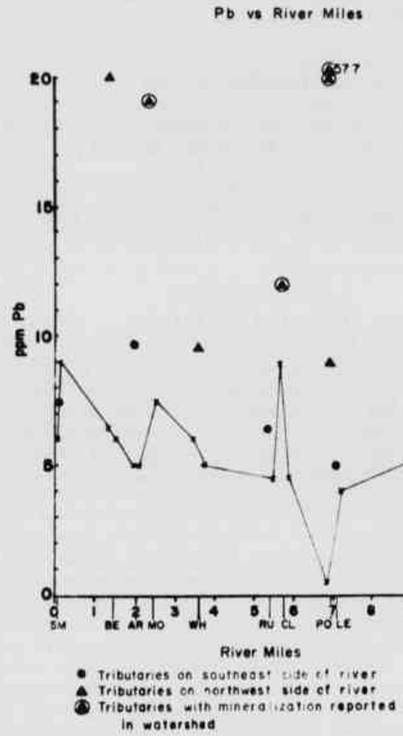

Figure 2. Lead versus river miles. Tributaries are indicated by abbreviations of their names. The Buffalo River sample points are connected by the line. SM = Smith Creek, BE = Beach Creek, AR = Arrington Creek, MO = Moore Creek, WH = Whiteley Creek, RU = Running Creek, CL = Clark Creek, PO = Ponca Creek, LE = Leatherwood Creek, 3N = 3-Name Creek.

reported mineralization. The tributaries on the mineralized side of the Buffalo River have significantly higher values than those on the nonmineralized side and those from the river. There are two anomalously high Pb values. One is from 3-Name Creek which is on the southeast ("nonmineralized") side of the Buffalo River. The other is from Beech Creek which is on the northwest side of the river. If the mineralized zone of McKnight (1935) is extended across the watershed, Beech Creek should be part of the mineralized zone (Fig. 1). Although Whiteley Creek and the upper part of Ponca Creek (upstream from the town of Ponca) are on the northwest ("mineralized") side of the Buffalo River, they have no reported mineralization within their watershed. This is confirmed by the relatively low Pb content of their bottom sediment (Fig. 2). It is interesting to note that the Pb values at the mouth of Ponca Creek are higher than the values for either of the two samples collected upstream from the town of Ponca — Ponca Creek and Adds Creek (Table I. This finding can be interpreted as evidence of additional, unreported mineralization or more likely as contamination from the tailings pile at the old mill just upstream from the collection site.

There is no systematic variation of lead concentration of the bottom sediments along the part of the Buffalo River studied; however, many of the tributaries, whether draining a mineralized or nonmineralized area, contain greater concentrations of many of the elements as indicated by Pb in Figure 2. Perhaps the reason is that much of the material(s) rich in these elements is dissolved in the river. The fact that the tributary flow is composed of a large amount of groundwater also may explain some of the higher element concentrations in the tributary sediments. The groundwater tends to dissolve much more material than surface water but quickly precipitates material upon contact with the air, thus enriching the tributary sediments in some elements. Dilution of the unique (element-rich) sediments from the tributaries by nonunique sediments of the river takes place in an extremely short distance, especially as shown by Beech, Moore and Ponca Creeks (Table I; e.g. Fig. 2).

With the exception of Adds Creek, the tributaries which have the highest Pb values contain relatively low Fe concentrations (Table I). The reason for this phenomenon is not known; perhaps there is a subtle difference in lithology in these two areas which affects the sediments directly, or indirectly by changing groundwater composition and thus leading to concentration of elements in the sediments by precipitation.

The Fe values for sediments in the main stream and also in the tributaries show a decrease downstream. Mn, Co, Cr, Mg and Ni have trends similar to that for Fe, and Cu shows an especially well developed trend of decreasing concentrations downstream (Table I). An optical examination of the sediments indicated that shale fragments make up about 25% of the samples from the upper part of the Buffalo River and the amount of shale fragments gradually diminishes to about 10% near Ponca. The shale has two effects on sediment composition. First, the shale is rich in Fe (and other elements) in comparison with the sandstone and limestone in the area. Second, the groundwater in the area would contain Fe^{+2} leached from shale which is added to the sediments by precipitation as a ferric oxide coating on the sediments. The ferric oxide then sorbs other ions from the water. The Pb-Fe trend (dashed line) in Figure 3 indicates sorption of Pb by the ferric oxide coatings, and the anomalous values indicate the presence of lead-rich clasts. Similar trends were found for Mn, Co, Cr, Cu, Ni and Zn.

The values of Zn show little variance from the background level of about 65 ppm (Table I) except at Beech Creek which also has anomalously high Pb concentrations and at Adds and Ponca Creeks which have reported Zn mineralization. As in the case of lead, zinc values for Ponca Creek near its mouth are higher than the values at the two sites upstream and may indicate mineralization or contamination from tailings.

The Cd/Zn ratio for sediments from the lower part of the river was found to be relatively constant (8-10 ppm Cd to 1000 ppm Zn) and similar to that for ore from the area near Rush, Arkansas (Steele and Wagner, 1975). The Cd/Zn ratio for Buffalo River sediments from the Boxley-Ponca area is within the same range. However, the tributaries show a much greater range which may indicate simply homogenization of sediments with various Cd/Zn ratios by the river.

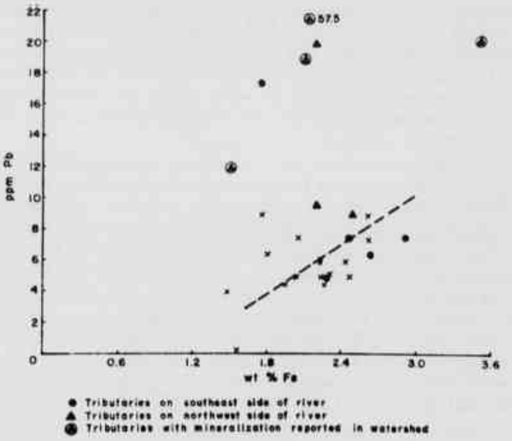

Figure 3. Lead versus iron. Dashed line indicates trend for Buffalo River and tributaries with no reported mineralization.

Ca concentration increases downstream, reflecting the presence of limestone. There is no dolomite in the area and the Mg data agree with this information. Significant correlations of certain elements with Ca+Mg have been reported for the lower part of the Buffalo River (Steele and Wagner, 1975); however, none were found in the study area.

In summary, lead mineralization has a significant effect on the Pb concentration in bottom sediments of the tributaries, but concentrations are diluted quickly in the main stream. The mineralization also increases zinc and cadmium concentration. The concentration of Ca is controlled largely by the presence of limestone, and the concentrations of the other elements are controlled primarily by the presence of shale fragments and sorption by Fe oxide coated clasts.

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ACKNOWLEDGEMENT

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An Observation on Female Cooperation Among the Zapotecs, an Indigenous People of Southern Mexico

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ABSTRACT

Cross-cultural study has suggested that the presence of an extradomestic market for women's produce is one precondition for the development of female solidarity groups, and that such groups seem to be antecedent to female public power and/or authority. If status is defined in these terms, then the Zapotec women of Asunción, a village of the inland Isthmus of Tehuantepec in southern Mexico, have not attained the preconditions of public power and/or authority. The complementary nature of husband and wife in the economic sphere assures women of some domestic power, however, and women do not seem to perceive their status as low. Descriptive studies of female cooperation have relevance to the broader issue in anthropology of how best to account for the development of intrasex solidarity, male or female.

INTRODUCTION

Cross-culturally and throughout history women generally have participated less than men in the organization of public (extradomestic) enterprise, and have exercised a correspondingly lesser share of public power. This "sexual asymmetry is presently a universal fact of human social life" (Rosaldo and Lamphere, 1974, p. 3). To the extent, however, that women have organized themselves in extradomestic groups, as in West African market-women's associations and secret societies, they often have been accorded more public power, both economic and political, than elsewhere (Leis, 1974, p. 223).

That women do not more often organize themselves into public groups can be attributed to the priority of feminine domestic roles. Also, it has been suggested that women are innately less predisposed to form organized groups than are men (Tiger, 1969). If the degree to which women exercise public power is related to their ability to cooperate extradomestically with other women, then it is important to try to understand the conditions under which women do so cooperate and also the conditions that discourage them from cooperation.

According to the cross-cultural study by Sanday (1974), the presence of a market for women's produce is a significant antecedent variable in the formation of female solidarity groups, and these groups, in turn, tend cross-culturally to be antecedent to the development of female extradomestic politcal power and/or authority. In the large Zapotec towns on the Pacific coast of the Isthmus of Tehuantepec in southern Mexico, the public marketplace is a characteristic feature, and is populated almost entirely by women, both as buyers and as sellers. Chiñas, who has described one such coastal town (1973), reports that women are not organized formally into public groups, but that they do cooperate informally in many ways.

Field research was undertaken among the Zapotecs of the hilly country of the interior of the Isthmus of Tehuantepec, partly in order to provide a descriptive basis for comparison with the coastal Zapotecs (see Fig. 1). A small rural village (referred to here by the fictitious name of "Asunción") was chosen which has neither a marketplace nor ready access to one. Fieldwork was carried out during three trips to the isthmus between 1970 and 1973, totalling about 15 months, three of which were spent in intensive investigation in Asunción.

Though the sexual division of labor among the inland Zapotec is more complementary than that on the coast, the economic preconditions for the formation of extradomestic female organizations, as specified by Sanday (1974), seem to be lacking. In the material that follows, all references to San Juan, the (fictitiously named) coastal town studied by Chiñas, derive from a single source (Chiñas, 1973).

WOMEN OF ASUNCION

In both Asunción and San Juan, inheritance of land is bilateral and gives women some measure of economic control. In neither community do women work in the fields or carry nursing infants with them when they have business outside the home. In San Juan, women leave the home to attend to marketing; in Asunción, women often leave the home for purposes of gathering, fishing and gleaning. In both cases such activities may involve considerable travel and absence during a major part of the day.

An important difference is the cash income to each household in the two communities. In San Juan, men raise most crops for cash sale, and many men are, in addition,

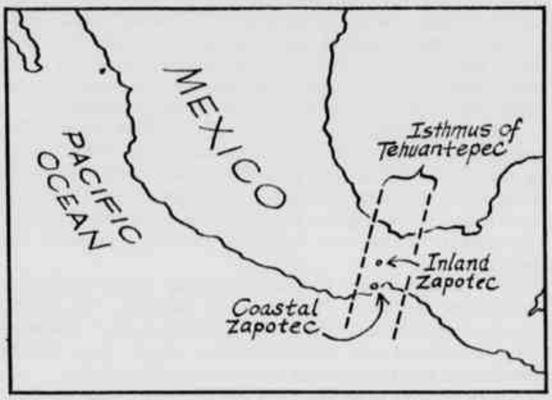

Figure 1. Approximate locations of the coastal and inland Zapotec communities.

employed for cash wages. In Asunción, by contrast, money is scarce during most of the year except immediately after the coffee harvest; most men grow corn for subsistence, and the women process it. The mutual dependence of husband and wife in Asunción is striking, and although separation and remarriage are not rare, in no case did an unmarried women attempt to head her own household. In contrast, on the coast female-headed households constitute about 20% of all households (Litzler, 1970, p. 73).

Although some Asunción women engage in minor house-to-house marketing of food items, in every case the woman, when interviewed, stated that the cash proceeds went to the household as a unit, and were not kept separate for the woman's use or for reinvestment in market goods (although some reinvestment surely occurred). Large cash transactions, such as the buying and selling of land, loans and the selling of coffee, normally are handled by the husband. It is also the husband who represents the family by handing over his share of the annual fiesta funds.

In these representations of the household to the community, it is clearly the husband who has the authority to act for the family. However, the extent to which masculine authority confers on a man real power to control members of his own domestic group, including his wife, is qualified. A husband cannot with impunity mistreat his wife or restrict her movements too severely, because she may leave him, and because she requires a certain amount of autonomy if she is to carry out some of her essential economic activities outside the household, such as gathering and fishing trips in the company of other women. Female autonomy is more important to the less affluent women who need to supplement the household food supply by such activities. Although women enjoy these extradomestic expeditions, it is likely that some (though not all) would give them up if they could, to avoid the considerable expenditure of energy that they entail. Others, who do not obviously need either to gather and fish or to engage in house-to-house marketing, do so because they are upwardly mobile.

When women do travel outside the home, be it to the spring to bathe, wash clothes and fetch water or to the next village to sell bread, fruit and vegetables, they always go in company with other women. In this they share the nearly universal Mexican view that for a woman to be alone is not respectable and invites improper masculine attention. Women need other women, therefore, but for companionship and for protection of their respectability, and not for purposes of economic cooperation.

Each woman's part in gathering, gleaning from harvested fields and fishing is individual, and what each produces is her own. About the only organization required is to agree where to meet and when to leave together for the day's expedition.

Local marketing activities are also individualistic. The product most commonly marketed is homemade bread, which is made by the women and generally taken around from house to house in the early morning by a daughter. Not all women have ovens, but a neighbor's oven may be borrowed or rented. The owner of the oven does not otherwise share in the enterprise.

Nor is there any agreement among bread-makers to coordinate their sales. Thus, on some mornings, four or five bread-sellers may make the rounds, whereas on other mornings there is no bread to be had in the entire village. There is little attempt, in short, to control the market cooperatively.

Two women in Asunción made special sweet breads to sell in a neighboring village, because its ingredients were such that the price of the finished product was beyond the buying capacities of the immediate villagers.

In general, local marketing is limited in two ways: (1) by lack of cash for purchasing goods for sale, and (2) by a disinclination on the part of women to engage in the traveling necessary to market their goods, and also by the husbands' occasional discouragement of their wives' traveling outside the village for fear of improper advances by men of other communities.

Only one woman had attempted to initiate, on her own, marketing in the more distant coastal towns, and did so only when she was desperate for funds to feed her seven children while her husband was disabled. Significantly, this woman had been born outside the isthmus, and thus had more travel experience than is usual for inland isthmus inhabitants. Her experiment was a failure, not only because of the high costs of labor and transportation relative to profits, but primarily because her residential isolation from the marketplaces of the coastal towns did not permit her to know in advance what the market conditions would be. On the day she arrived on the coast with oranges, for example, the market was flooded with oranges, and she earned barely enough to make her way home again.

DISCUSSION

According to Sanday (1974), the presence of an extradomestic outlet for women's produce is an antecedent condition for the development of female solidarity groups. In Asunción women's work often obliges them to engage one another's company, but rarely involves cooperation. There is a local market for what women produce, but it is severely limited, and is dispersed in separate households rather than centered in a marketplace.

Although bilateral inheritance and a large degree of autonomy might permit women to increase their economic control beyond that which they now exercise, the complementary nature of male and female work in Asunción is such as to encourage household solidarity between husband and wife, and to discourage it among women. Women have, in addition to some autonomy and economic control, informal power that prevents men from heavy-handedly wielding their authority over them. Women in fact usually express themselves satisfied with their status relative to men.

Compared with the women in San Juan, as described by Chiñas (1973), women of Asunción have slightly less opportunity for intrasex interaction away from home, especially cooperative interaction. The relatively lesser mutual economic dependence of husbands and wives (though not necessarily of men and women) in San Juan is reflected in the substantially larger proportion of adult women who do not reside with husbands, but head their own households.

If Sanday (1974) is correct in identifying female economic independence from men through marketing, and female solidarity groups, as two conditions that precede the development of high female status relative to male status, then it seems that the women of San Juan are somewhat further along the course of that development than are the women of Asuncion. Although Sanday's study was based on a carefully selected but small sample, and though the comparative analysis between Asunción and San Juan is somewhat tentative, it is hoped that the present report helps to clarify some of the conditions under which extradomestic female cooperative organization may develop.

The work of Tiger (1969) recently has focused attention on solidarity and cooperation among males. Though few female anthropologists would readily accept his implication that males are innately more inclined to form solidarity groups than are females, his views have helped to stimulate greater attention to the conditions under which females interact cooperatively (e.g., Leis, 1974). Perhaps, as a result of further descriptive studies, male and female forms of solidarity can be compared more directly.

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The Aquatic Macroinvertebrate Fauna of an Ozark and a Deltaic Stream

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ABSTRACT

An Ozark and a deltaic stream in northeastern Arkansas were studied to compare physicochemical and aquatic macroinvertebrate parameters and to determine whether the number and kind of organisms increase downstream. Janes Creek, the Ozark-type stream, is clear, spring-fed and alkaline with a steep gradient and high flow velocity; dissolved oxygen values are not limiting. Big Creek, the deltaic stream, is turbid, low in alkalinity and has a slight gradient and low stream velocity. These streams comprise distinct habitats created by differences in substrate, watershed and land use.

A total of 122 taxa were collected in both streams, 62 of which were identified to species. Of the total taxa, 100 were found in Janes Creek and 55 were found in Big Creek. Only 33 taxa were common to both streams. Species diversity indices for Janes and Big Creek stations ranged from 3.272 to 4.454 and 1.822 to 2.905, respectively. Snails which fed on algal film of submerged rocks in pools were characteristic of Janes Creek, whereas oligochaetes which fed on organic detritus were characteristic of Big Creek. Mean numerical standing crop of Big Creek was almost three times that of Janes Creek (726 organisms vs. 265 organisms/m^2). Longitudinal zonation was characterized in each stream by an increase in numbers and kinds of aquatic macroinvertebrates downstream. Diversity index values did not completely support this observation, however.

INTRODUCTION

Few studies have been made of the aquatic macroinvertebrates of streams in the Ozark Plateau region of Arkansas (Aggus and Warren, 1965; McGary and Harp, 1972; Robison and Harp, 1971; Sublette, 1956; Van Kirk, 1962) and none have been published concerning its deltaic streams.

The purposes of this study were to describe and contrast the physicochemical and aquatic macroinvertebrate characteristics of an Ozark and a deltaic stream, and to determine whether the number and diversity of aquatic macroinvertebrates increase downstream. An increased number of species downstream would correlate with greater variety of available riches and moderating environmental conditions (Kendeigh, 1961).

The lotic habitats of northeastern Arkansas are basically of two types. Streams of the Ozark Plateau are typically clear, spring-fed and alkaline, and have a relatively steep gradient. Streams of the St. Francis basin are turbid, low in alkalinity and have low flow velocity.

Janes Creek typifies the Ozark stream habitat. It arises in the northwesternmost corner of Randolph County, meanders for 39 km near the western border, and reaches its confluence with Spring River at the Randolph-Lawrence county line in the Salem Plateau section of the Ozark Plateau province. Limestone and dolomite are dominant rock types, and allow widespread development of large springs in the Salem Plateau (Croneis, 1930; Thornbury, 1965). Climax vegetation in the watershed is oak-hickory. Forest and pasture land result in controlled runoff from the watershed. Aquatic vascular plants present in the stream were water willow, *Justicia americana* (L.) Vahl, and yellow water lily, *Nuphar luteum* var. *ozarkanum* (L.) Sibthorp and Smith. Loose gravel, mostly chert, characterizes the bottom.

Big Creek is comparable to Janes Creek in size and is representative of the deltaic streams of the St. Francis Basin. It arises on Crowley's Ridge in south central Green County, enters Craighead County after 10 km, and is channeled for most of its remaining length, finally becoming Bayou DeView Ditch 8 km east of Cash, Craighead County, Arkansas. Major soils of the watershed are of the Falaya-Collins association. These are deep, rather poorly drained, moderately permeable soils washed from loess (SCS, 1962). Climax vegetation is oak-hickory, but cultivated fields dominate. Big Creek is a drainage ditch, periodically dredged for flood control. Its substrate is mud, silt and hard clays. The high, steep stream banks result in frequently heavy runoff and increased silt deposition.

Two stations were established on each stream. On Janes Creek station I was at an elevation of 110 m in S36, T20N, R3E. Station II, 4 km downstream, was at an elevation of 101 m at the stream's junction with Arkansas State Highway 90 in S7, T19N, R2E. Station I (S35, T15N, R3E) of Big Creek was at an elevation of 87 m, and station II (SE ¼ S10, T14N, R3E) was 4 km downstream at U.S. Highway 63, at an elevation of 84 m.

MATERIALS AND METHODS

Data were collected monthly from both pool and riffle areas of each station from 12 July to 18 October 1969. Physicochemical parameters were measured at streamside. Dissolved O_2 was measured by the sodium azide modification of the basic Winkler method (APHA, 1960). Carbon dioxide and methyl orange alkalinity were measured by standard limnological methods (Welch, 1948). Hydrogen ion concentration (pH) was measured with a colorimetric pH meter. Light penetration was determined by Secchi disk. Current was measured by timing a floating object over a known distance. Temperature was measured with a standard centigrade thermometer. A total of 128 aquatic macroinvertebrate samples were taken, 96 quantitative and 32 qualitative. On each sampling date samples were collected along a transect of each pool by use of a

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36 in^2 (0.023 m^2) Ekman dredge, each sample consisting of one dredge haul. These were washed through a benthic screen having 11.8 sq/linear cm (pore area 0.174 mm^2). In each riffle area, triplicate bottom samples were procured with a 1 ft^2 (0.09 m^2) Surber sampler. Qualitative samples were collected in pool and riffle at both stations by use of a dip net of fine mesh. Preservation of quantitative and qualitative samples was by 10% formalin and 70% ethanol, respectively.

Species diversity indices were calculated for pool and riffle communities at each station by the equation of Wilhm and Dorris (1966). Pool and riffle data were combined to determine species diversity indices for each station.

RESULTS

Janes Creek was found to be a clear, well-oxygenated, spring-fed alkaline stream with a relatively steep gradient (2.3 m/km) and high flow velocity (Table I). The aquatic macroinvertebrate fauna was diverse, 100 taxa being identified (Table II). Snails, mayflies and dipterans dominated in that order. Diversity index values for stations ranged from 3.272 to 4.454 (Table III). Riffles of both stations supported a more diverse aquatic macroinvertebrate community than pools, 63 vs. 42 taxa. This observation is corroborated by the fact that all eight riffle diversity indices were greater than their companion pool diversity indices (Table III). The number of organisms and the number of taxa collected increased downstream. A mean number of 205 and 321 organisms/m^2 constituting 44 and 69 taxa were collected from stations I and II, respectively. Diversity indices reflected this trend as three of the four values were greater at station II (Table III).

Big Creek was found to be turbid and low in alkalinity; it had a lower dissolved oxygen content and a slight gradient (0.7 m/km) with low stream velocity (Table I). It supported an aquatic macroinvertebrate population whose mean numerical standing crop was nearly three times that of Janes Creek, 726 vs. 265 organisms/m^2. However, the population was less diverse, with 55 taxa and a range of diversity indices from 1.822 to 2.905 (Table II, IV). Moreover, the difference in kinds of organisms was dramatic (Table V). Molluscs were scarce in Big Creek. Plecoptera, which more than any other aquatic insect characterizes clear, running water, was absent in Big Creek. Swimming mayflies such as *Baetis* and *Ameletus*, characteristic of Janes Creek, were replaced in Big Creek by burrowing *Hexagenia* and sprawling *Caenis*. Although the numbers of dipteran taxa in the two streams were comparable, Big Creek contained more species of detrital feeding chironomids, and *Atherix* was absent.

Big Creek supported more taxa in riffle than pool areas, 28 vs. 26. Riffle diversity indices were greater in 7 of 8 instances (Table IV). Though 35 taxa with a mean number of 1106 organisms/m^2 were identified at station II, in comparison with 328 organisms/m^2 and 27 taxa at station I, diversity indices did not indicate a clear increase in diversity at station II.

Table I. Physicochemical Characteristics, Expressed as Mean Values, Stations I and II, Janes and Big Creeks, 12 July-18 October 1969

	Janes Creek				Big Creek			
	Sta. I		Sta. II		Sta. I		Sta. II	
Item	P[1]	R	P	R	P	R	P	R
Dissolved O_2 (ppm)	5.8	6.9	7.8	8.1	6.2	7.0	5.4	5.6
CO_2 (ppm)	5.0	6.2	2.4	2.2	9.0	9.6	7.0	6.4
Methvl orange alk. (ppm)	247	249	250	251	70	84	69	70
pH	8.0	7.8	7.9	8.1	6.9	7.2	7.2	7.2
Current (cm/sec)	---	60	---	80	---	40	---	40
Light penetration (cm)	75[2]	---	90[2]	---	26	---	17	---

[1] P = pool, R = riffle.
[2] Reading taken on pool bottom.

DISCUSSION

The aquatic macroinvertebrate fauna in Janes Creek was more diverse than those reported by other investigators of Ozark streams. This is because of sample size (Robison and Harp, 1971; Sublette, 1956), identification of organisms to species where possible rather than use of high levels of classification (Blanz et al., 1969; Brown et al., 1967); and pool area sampling (Blanz et al., 1969; Sublette, 1956).

Gastropods are characteristic of such streams as Janes Creek because the high alkaline salts content facilitates shell formation (Kendeigh, 1961). In addition, the clear water allows photosynthesis to occur at all depths; one result is abundant aufwuchs, an important food for gastropods. In contrast, the scarcity of molluscs in Big Creek was not caused by lower alkalinity (Hutchinson, 1957), but by the combination of unsuitable substrate and reduced photosynthesis which greatly reduced available aufwuchs in this stream.

The greater standing crop of aquatic macroinvertebrates in Big Creek probably resulted from two factors. Enrichment from surrounding fields would provide food suitable for detrital

Table II. Aquatic Macroinvertebrate Taxa, Stations I and II, Janes and Big Creeks, 12 July-18 October 1969

	Janes Creek				Big Creek			
	Sta. I		Sta. II		Sta. I		Sta. II	
Taxa	P[1]	R	P	R	P	R	P	R
TURBELLARIA								
Planariidae	X	_	X	X	_	X	X	X
OLIGOCHAETA	X	_	X	_	X	_	X	_
HIRUDINEA								
Placobdella	_	_	X	_	_	_	X	_

	Janes Creek				Big Creek			
	Sta. I		Sta. II		Sta. I		Sta. II	
Taxa	P[1]	R	P	R	P	R	P	R
GASTROPODA								
Ancylidae	X	X						
Fossaria parva (Lea)							X	
Goniobasis ovoidae (Lea)	X	X	X	X	X			
Pleurocera acuta (Rafinesque)	X	X	X	X				
PELECYPODA								
Carunculina glans (Lea)			X	X				
Elliptio dilatatus (Rafinesque)				X				
Lampsilis reeviana (Lea)				X				
Lasmigona costata (Rafinesque)				X				
Villosa occidentalis (Conrad)				X				
Musculium transversum (Say)								X
Pisidium compressum (Prime)				X				
Pisidium dubium (Say)				X				
Sphaerium striatinum (Lamarck)				X				
CRUSTACEA								
Asellus brevicaudus (Forbes)			X	X		X		
Gammarus fasciatus (Say)	X			X				
Hyalella azteca (Saussure)	X		X		X			
Orconectes virilis (Hagen)		X		X				
HYDRACARINA		X	X					
COLLEMBOLA								
Sminthurides				X				
PLECOPTERA								
Acroneuria				X				
Isoperla				X				
Leuctra		X		X				
Neoperla clymene (Newman)		X						
EPHEMEROPTERA								
Stenonema ares Burks, Stannard, Smith	X	X	X	X		X	X	X
S. gildersleevei (Traver)			X	X		X	X	X
S. nepotellum (McDunnough)		X		X				
S. tripunctatum (Banks)								X
Ephemera guttulata Pictet				X				
Hexagenia limbata (Serville)	X		X	X	X	X	X	
H. rigida (McDunnough)					X		X	
Potamanthus	X	X	X					
Baetis frondalis (McDunnough)		X		X		X		X
B. herodes (Burks)						X		X
B. intercalaris (McDunnough)		X		X		X		X
B. levitans (McDunnough)		X				X		X
Caenis	X	X	X	X	X	X	X	
Choroterpes			X					
Ephemerella deficiens (Morgan)		X		X				
E. frisoni (McDunnough)		X		X				
Isonychia		X		X				
Paraleptophlebia praepedita (Eaton)	X		X					
ODONATA								
Anomalagrion hastatum Say			X					
Argia				X				X
Hetaerina	X		X					
Ischnura	X							
Dromogomphus spinosus (Selys)	X		X					

Taxa	Janes Creek Sta. I P[1]	Janes Creek Sta. I R	Janes Creek Sta. II P	Janes Creek Sta. II R	Big Creek Sta. I P	Big Creek Sta. I R	Big Creek Sta. II P	Big Creek Sta. II R
Lanthus albistylus (Hagen)			X					
Macromia	X		X		X		X	
Perithemis lydia (Drury)	X		X					
P. tenera (Say)							X	
Tetragoneuria cynosura (Say)					X		X	
HEMIPTERA								
Corixidae	X							
Hydrometra	X		X					
Microvelia americana (Uhler)	X		X					
Rhagovelia knighti Drake & Harris		X	X			X		X
Gerris dissortis Drake & Harris	X		X		X		X	
Rheumatobates trulliger Bergroth					X		X	
MEGALOPTERA								
Corydalis cornutus (L.)		X		X				X
Sialis	X	X						
TRICHOPTERA								
Helicopsyche borealis (Hagen)	X	X	X	X				
Hydroptila				X		X		
Cheumatopsyche		X		X		X		X
Hydropsyche incommoda (Hagen)		X		X		X		X
Macronemum								X
Chimarra		X		X		X		X
Neophylax				X				
Polycentropus	X	X		X		X		X
TRICHOPTERA[2]								
Athripsodes transversus (Hagen)							X	X
Leptocella	X	X						
Mystacides sepulchralis (Walker)	X	X						
Oecetis inconspicua (Walker)	X	X						
Triaenodes marginata (Sibley)	X	X						
Cheumatopsyche analis (Hagen)							X	X
Cheumatopsyche aphanta (Ross)	X	X						
Cheumatopsyche burksi (Ross)							X	X
Cheumatopsyche oxa (Ross)	X	X						
Cheumatopsyche	X	X					X	X
Chimarra aterrima Hagen	X	X						
Chimarra feria (Ross)	X	X						
Chimarra obscura (Hagen)	X	X						
Chimarra	X	X						
LEPIDOPTERA								
Elophila	X	X		X				
COLEOPTERA								
Berosus (A)[3]								X
Helophorus (A)		X						
Dryops (A)			X					
Lutrochus (A)				X				
Macronychus glabratus (Say) (A)				X				
Microcylloepus pusillus (LeConte) (A)		X						
Optioservus ampliatus (Fall) (A)		X						
Optioservus		X						
Stenelmis crenata (Say) (A)				X				
Stenelmis		X						X
Ectopria	X	X	X					
Psephenus herricki (DeKay)	X	X	X					

	Janes Creek				Big Creek			
	Sta. I		Sta. II		Sta. I		Sta. II	
Taxa	P[1]	R	P	R	P	R	P	R
DIPTERA								
Atherix		X		X				
Palpomyia			X			X	X	
Chaoborus punctipennis (Say)					X		X	
Ablabesmyia			X				X	
Pentaneura							X	X
Procladius							X	
Tanypus							X	
Chironomus (*Cryptochironomus*) = (*Harnischia*)						X		
Chironomus (*Cryptochironomus*)			X				X	
Chironomus (*Dicrotendipes*)			X					
Chironomus (*Tribelos*)			X					
Micropsectra			X					
Tanytarsus			X			X		
Empididae				X		X		
Simulium		X		X		X		X
Tabanus		X		X		X		

[1] P = pool, R = riffle.

[2] Adults collected by black light at station I, Janes Creek, 6 September 1969, and station II, Big Creek, 23 September 1969.

[3] (A) = adults.

Table III. Species Diversity Indices, Janes Creek, 12 July-18 October 1969

	Station I			Station II		
	Pool	Riffle	Combined	Pool	Riffle	Combined
July	1.981	3.114	3.528	2.051	3.094	3.447
Aug.	2.935	2.980	3.272	3.200	3.371	4.057
Sept.	3.370	3.428	3.892	3.462	4.114	4.454
Oct.	3.049	3.450	3.784	3.028	3.032	3.856

Table IV. Species Diversity Indices, Big Creek, 12 July-18 October 1969

	Station I			Station II		
	Pool	Riffle	Combined	Pool	Riffle	Combined
July	1.610	1.404	1.822	1.807	1.991	2.615
Aug.	1.119	1.444	1.917	0.628	1.425	2.051
Sept.	1.310	2.462	2.833	1.640	2.356	2.549
Oct.	1.411	2.412	2.905	1.729	2.600	2.794

feeders. Oligochaetes constituted 71% of the total pool fauna by number and, with Trichoptera and Diptera, accounted for 90% of the total aquatic macroinvertebrate community.

There was a decrease in diversity of microhabitats in Big Creek. Rooted aquatic plants were absent, and the dual pressures of dredging and siltation have provided a uniform habitat suitable for a relatively limited number of aquatic macroinvertebrate taxa. The degree of environmental stress is reflected in the diversity index values (Table IV). Values between 1 and 3 indicate moderate pollution, whereas values above 3 indicate clean water areas (Wilhm and Dorris, 1968). Those species present in Big Creek may take advantage of decreased competition and predation to establish a community relatively higher in number per unit area.

The greater diversity of organisms in riffle areas of both streams, particularly Janes Creek, may be due to the greater variety of niches (Kendeigh, 1961). Increased diversity downstream, seen in Janes Creek, is a well documented phenomenon (Robison and Harp, 1971; Sublette, 1956; Van Kirk, 1962) and may be correlated with a greater variety of available niches and moderating environmental conditions (Kendeigh, 1961). This phenomenon was not obvious in Big Creek, probably because of channelization and therefore greater uniformity of habitats present.

Table V. Comparison of Number of Taxa Present in Major Aquatic Macroinvertebrate Groups, Janes and Big Creeks, 12 July-18 October 1969

Group	Number	
	Janes Creek	Big Creek
Mollusca	11	2
Plecoptera	4	0
Ephemeroptera	17	12
Trichoptera	12	7
Coleoptera	11	2
Diptera	11	12

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Antiques - Objects of Lateral Cycling?

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ABSTRACT

After a brief discussion of the various ways the use-life of an object can be prolonged, an additional method is illustrated, that of **adjacent cycling**. Antiques are used as examples. The role of antiques as status symbols is suggested to be the reason for their prolonged use-life. The archaeological implications of adjacent cycling also are discussed.

INTRODUCTION

In recent years there has been an increase in the attention given to the movement of material goods through contemporary American society. Many items no longer useful for the purpose for which they originally were manufactured are retained in this society, though an item which exceeds its usefulness is expected to be discarded. Schiffer (1971, 1975) discussed lateral cycling, recycling and conservatory processes, all of which operate to prolong the use-life of an object. Three aspects of the durable material element become variables in each situation of sustained use: user, form and the use itself. In lateral cycling the use and form of the object remain constant and the user varies. During recycling the form, use and user vary. Conservatory processes preserve the form of the object and generally the use remains constant. Use is temporarily suspended and the object can be viewed as being in storage.

None of these methods account for objects that sustain their original form but change user and use. This distinctive method of prolonging the use-life of objects first was recognized in a survey of antique stores undertaken by the writer while studying lateral cycling. Though furniture and clocks clearly are included in Schiffer's definition of lateral cycling, the whisky bottles, wagon wheels, commode sets and telephone line insulators on the shelves of an antique store are not adaptable to that definition. One becomes a collector's item for its monetary value, one is placed along a driveway, one is displayed on a shelf and the last becomes a paperweight.

Schiffer's (1971, p. 160) linear flow model for the use-life of a durable item can absorb this distinctive method of prolonged use. The idea of *adjacent cycling* is proposed. This type of cycling is adjacent to lateral cycling in that both go back to the beginning of the use process, but not as far back as the manufacturing process. The two differ in that use is a variable in adjacent cycling. It is conceivable that a durable item could be laterally cycled, recycled and adjacently cycled many times before being discarded.

STATUS IMPLICATIONS

Adjacent cycling is responsive to the characteristics of lateral cycling such as movement among caste, class and social units, and maintenance, storage and transport appear as the only intervening processes. In addition a mental attitude is involved that may not be unique to the types of cycling, but definitely differs from the attitude surrounding the recycled or laterally cycled item. A decision is made to use the item in a different way than that originally intended.

Many times the antique is bought as an agent of conspicuous consumption. Schiffer (1973, p. 310) observed:

> In a complexly stratified, highly mobile society, quantity and diversity of household material objects vary directly with status....But at each successively higher level, new items are added until at the top, where the highest statuses are reached, material objects are found that have limited distributions.

This is a major function of antiques. Rare items, items of limited distribution or expensive items make obvious the delineation of wealth, thus class; of "taste," thus class. There are persons who want to preserve the past, but there are also those who are involved in the subtleties of class distinction, and thus create new uses for these objects.

ARCHAEOLOGICAL IMPLICATIONS

The fact that adjacently cycled objects usually are transported in the process of changing use, and the fact that the use does change while the form remains the same, present some interesting questions in the archaeological setting. Can it be ascertained that an artifact began and ended its use-life where it is found in archaeological context? What evidence remains of former use? A mano that has been adjacently cycled into a wall stone is easily recognized as such and one would not expect to read that the presence of a mano there inferred that grinding was done *in* the wall! However, a situation so easily recognizable is not the usual situation confronting the archaeologist. The question that must be considered is, "What are the other possible uses for that item in that form?" Eventually, the interpreter must consider why a society would need to reuse any element in its technological inventory. Many traditional explanations for the form and use of lithic objects could well be reconsidered on this basis.

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A Preliminary Checklist of the Fishes of the Illinois River, Arkansas

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ABSTRACT

A survey of the fishes of the mainstream of the Illinois River in northwestern Arkansas produced 51 species representing 11 families. Four of these species, **Ictiobus bubalus,** smallmouth buffalo; **Moxostoma carinatum,** river redhorse; **Lepomis gulosus,** warmouth; and **Percina phoxocephala,** slenderhead darter, have not been recorded previously from the Arkansas part of the Illinois. Eleven additional species have been reported previously that were not collected during this survey, for a total of 62 species known in the Illinois River.

INTRODUCTION

Recently the Illinois River has become the focus of attention because of the development of a Northwest Arkansas Regional Water Quality Management Plan (Mitchell, 1974) calling for the addition of secondarily treated effluent from both Washington and Benton Counties into the mainstream of the Illinois. The Oklahoma part of the Illinois River is being studied for possible inclusion in the National Scenic Rivers System and is now a component of the Oklahoma Scenic Rivers System. The addition of large amounts of sewage effluent to the river may cause environmental degradation and loss of aesthetic values to both the Arkansas and Oklahoma portions. This checklist serves as a preliminary survey of the fishes of the Illinois River so that possible effects of future sewage effluents can be assessed objectively.

The first reported collections of fishes from the Illinois River were made by S. E. Meek during 1891 at Prairie Grove and Ladd's Mill, Arkansas. Because Ladd's Mill itself was on Clear Creek at Savoy, about one-half mile upstream from the confluence of Clear Creek and the Illinois, it is difficult to determine whether Meek was collecting in Clear Creek or the Illinois. Nevertheless, Meek (1894) reported 31 species in a list and 32 species in a table. Black (1940) recorded 32 species from the mainstream of the Illinois. Buchanan (1973) summarized all previous distribution records for the fishes of Arkansas, presented distribution maps for all species and denoted 58 species as present in the mainstream of the Illinois River.

MATERIALS AND METHODS

The Illinois River is in a rather mountainous area of western Arkansas and eastern Oklahoma and is a principal tributary of the Arkansas River downstream from the Grand River. The Illinois River originates in the Boston Mountains and flows through this physiographic region for about 10 mi. The rest of the Illinois in Arkansas flows through the Springfield Plateau physiographic region. The bottom is predominantly coarse chert gravel with exposed bedrock in places. The river probably derives a significant part of its flow from the large number of springs in the drainage area.

Fishes were collected from 12 sites on the mainstream of the Arkansas part of the Illinois River. Eight collecting trips were made from February through October 1974. A variety of habitats was sampled at each site, including pools, fast runs and riffles.

Most specimens were collected by electroshocking and seining, and a few were collected by hook-and-line and gill nets. Most specimens were identified in the field and returned to the river. Individuals of uncertain classification were preserved in 10% formalin and identified in the laboratory.

CHECKLIST

Fifty-one fish species representing 11 families were collected. Eleven additional species have been reported previously that were not collected during this survey, for a total of 62 species known to be present in the Illinois River. The common and scientific names are those listed by Bailey et al. (1970).

Family **Petromyzontidae** (lampreys)

* 1. *Ichthyomyzon castaneus* Girard . . . . . chestnut lamprey

Family **Lepisosteidae** (gars)

2. *Lepisosteus osseus* (Linnaeus) . . . . longnose gar

Family **Clupeidae** (herrings)

3. *Dorosoma cepedianum* (Lesueur) . . . . gizzard shad

Family **Cyprinidae** (minnows and carps)

4. *Campostoma anomalum* (Rafinesque) . . . . . stoneroller
* 5. *Carassius auratus* (Linnaeus) . . . . goldfish
6. *Cyprinus carpio* Linnaeus . . . . carp
7. *Dionda nubila* (Forbes) . . . . Ozark minnow
* 8. *Hybopsis amblops* (Rafinesque) . . . . bigeye chub
9. *Hybopsis x-punctata* Hubbs and Crowe . . . gravel chub
10. *Nocomis asper* Lachner and Jenkins . . . . . redspot chub
11. *Notemigonus crysoleucas* (Mitchill) . . . . . golden shiner
*12. *Notropis atherinoides* Rafinesque . . . . . emerald shiner
13. *Notropis boops* Gilbert . . . . bigeye shiner
*14. *Notropis camurus* (Jordan and Meek) . bluntface shiner
15. *Notropis chrysocephalus* (Rafinesque) . . . striped shiner
16. *Notropis pilsbryi* Fowler . . . . duskystripe shiner
17. *Notropis rubellus* (Agassiz) . . . . rosyface shiner
*18. *Notropis spilopterus* (Cope) . . . . spotfin shiner
19. *Notropis umbratilis* (Girard) . . . . redfin shiner
20. *Phoxinus erythrogaster* (Rafinesque) . . . . southern redbelly dace
21. *Pimephales notatus* (Rafinesque) . . . bluntnose minnow
*22. *Pimephales promelas* Rafinesque . . . . . fathead minnow
*23. *Semotilus atromaculatus* (Mitchill) . . . . creek chub

Family **Catostomidae** (suckers)

*24. *Catostomus commersoni* (Lacepede) ..... white sucker
25. *Hypentelium nigricans* (Lesueur) . northern hog sucker
**26. *Ictiobus bubalus* (Rafinesque) .... smallmouth buffalo
27. *Minytrema melanops* (Rafinesque) ..... spotted sucker
**28. *Moxostoma carinatum* (Cope) ..... river redhorse
29. *Moxostoma duquesnei* (Lesueur) ...... black redhorse
30. *Moxostoma erythrurum* (Rafinesque) . golden redhorse
31. *Moxostoma macrolepidotum* (Lesueur) ..... shorthead redhorse

Family **Ictaluridae** (freshwater catfishes)

32. *Ictalurus melas* (Rafinesque) .... black bullhead
33. *Ictalurus natalis* (Lesueur) .... yellow bullhead
34. *Ictalurus punctatus* (Rafinesque)...... channel catfish
35. *Noturus exilis* Nelson .... slender madtom
36. *Pylodictis olivaris* (Rafinesque) .... flathead catfish

Family **Cyprinodontidae** (killifishes)

*37. *Fundulus catenatus* (Storer) .... northern studfish
38. *Fundulus olivaceus* (Storer) .. blackspotted topminnow

Family **Poeciliidae** (livebearers)

39. *Gambusia affinis* (Baird and Girard) .... mosquitofish

Family **Atherinidae** (silversides)

40. *Labidesthes sicculus* (Cope) .... brook silverside

Family **Centrarchidae** (sunfishes)

41. *Ambloplites rupestris* (Rafinesque) .... rock bass
42. *Lepomis cyanellus* Rafinesque .... green sunfish
**43. *Lepomis gulosus* (Cuvier) .... warmouth
44. *Lepomis humilis* (Girard) ...... orangespotted sunfish
45. *Lepomis macrochirus* Rafinesque .... bluegill
46. *Lepomis megalotis* (Rafinesque) ...... longear sunfish
47. *Lepomis microlophus* (Gunther) .... redear sunfish
48. *Micropterus dolomieui* Lacepede .... smallmouth bass
49. *Micropterus punctulatus* (Rafinesque).... spotted bass
50. *Micropterus salmoides* (Lacepede) ... largemouth bass
51. *Pomoxis annularis* Rafinesque .... white crappie

Family **Percidae** (perches)

52. *Etheostoma blennioides* Rafinesque .. greenside darter
53. *Etheostoma flabellare* Rafinesque ...... fantail darter
*54. *Etheostoma microperca* Jordan and Gilbert ...... least darter
55. *Etheostoma punctulatum* (Agassiz) .... stippled darter
56. *Etheostoma spectabile* (Agassiz) .. orangethroat darter
57. *Etheostoma stigmaeum* (Jordan) ...... speckled darter
58. *Etheostoma whipplei* (Girard) .... redfin darter
59. *Etheostoma zonale* (Cope) .... banded darter
60. *Percina caprodes* (Rafinesque) .... logperch
**61. *Percina phoxocephala* (Nelson) .... slenderhead darter

Family **Cottidae** (sculpins)

62. *Cottus carolinae* (Gill) .... banded sculpin

*Not collected during this study.
**New records for the Arkansas part of the Illinois River.

DISCUSSION

The number of species now known from the Arkansas part of the Illinois River (62) is comparable with the number obtained from other studies on Arkansas rivers, e.g. 65 species from the Mulberry River (Olmsted et al., 1972), 62 species from the Cossatot River (Cloutman and Olmsted, 1974) and 95 species from the Strawberry River (Robison and Beadles, 1974).

Many of the 11 species previously recorded from the Illinois River, but not collected during this study, can be considered rare or possibly endangered in Arkansas. *Notropis camurus, N. spilopterus* and *Etheostoma microperca* are considered rare (Buchanan, 1974; Robison, 1974). *Catostomus commersoni* may have declined in abundance, and is rare in Arkansas because of its restricted habitat (Buchanan, 1974). Robison et al. (1974) state that *Hybopsis amblops* never is collected in great numbers in Oklahoma and should be regarded as rare. Because this fish is regarded as rare in the Oklahoma part of the Illinois River, it is probably uncommon in the Arkansas part as well. Buchanan (1974) states that *Ichthyomyzon castaneus* may have declined in abundance in Arkansas and possibly is endangered. *Notropis atherinoides* has not been collected from the Illinois River since before 1960 (Buchanan, 1973). The single record of the goldfish, *Carrasius auratus*, from the Illinois (Buchanan, 1973) may have resulted from the release of bait fish or aquarium inhabitants. This exotic species is probably rare throughout the river. Miller and Robison (1973) note that *Pimephales promelas* is most common in small streams in Oklahoma, and many records of this species may have resulted from bait fish release. The writers have collected two of the 11 rare species, *Semotilus atromaculatus* and *Fundulus catenatus*, from tributaries of the Illinois River, but not from the mainstream. Miller and Robison (1973) state that *S. atromaculatus* prefers smaller creeks, at least in Oklahoma. The writers found *F. catenatus* to be abundant in tributaries of the Illinois, but not in the mainstream.

New records for four species, *Ictiobus bubalus, Moxostoma carinatum, Lepomis gulosus* and *Percina phoxocephala*, were established as a result of this study. The collection of *P. phoxocephala* from two sites in Benton County represents the second valid record of this species in Arkansas. The only other valid record is from Blue Mountain Lake in Logan County (Thomas Buchanan, pers. comm.).

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Somatic Pairing in *Drosophila virilis* Mitosis

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ABSTRACT

In neuroblast cells homologous chromosomes tend to pair during prophase of mitosis. Heterochromatic elements of homologous chromosomes are widely separated in very early prophase, at which time the euchromatin is poorly stained. Pairing is intimate for euchromatic portions of chromosomes in early and middle prophase with chiasmata frequently present. Homologous chromosomes most commonly lie side-by-side in late prophase and metaphase. Statistical data are presented to show the frequency of intimate pairing in prophase and side-by-side pairing in metaphase.

INTRODUCTION

Somatic pairing of the chromosomes in Diptera first was reported by Stevens (1908) who described this process in Drosophila. Further studies of somatic pairing in *Drosophila melanogaster* and other Diptera have been made by Metz (1916), Kaufman (1934), Cooper (1948, 1948) and Grell and Day (1970). Studies indicate that synapsis of homologous chromosomes during mitosis is a common phenomenon with chiasmata formation occurring during some stages of pairing but without the occurrence of crossing over. Descriptions of somatic pairing have come primarily from observations of neuroblast cells prepared by sectioning or squashing.

This study was undertaken to determine the frequency of somatic pairing in *Drosophila virilis* where pairing was described by Metz (1916), and to determine the sequence of events in somatic pairing in mitotic prophase.

MATERIALS AND METHODS

Drosophila virilis was used for the study. The stock used was obtained from the University of Texas (Stock No. 1801.1). The flies were maintained in the laboratory on standard Drosophila growth medium.

Neuroblast cells in mitosis were prepared according to a technique modified from that of Guest and Hsu (1973). The brains of 20-30 third instar larvae were dissected out in physiological saline, treated briefly with distilled water, then fixed in one part glacial acetic acid in three parts absolute methanol. The brains were dissociated into single cells in 60% glacial acetic acid and dropped from a Drummond pipette onto a slide preheated to 40C. The preparations were air dried. The slides were stained in 2% Giemsa prepared in 0.15 M phosphate buffer. Slides were stained for 10 minutes, rinsed in distilled water, air dried and mounted in Eukitt.

RESULTS AND DISCUSSION

In Drosophila the heterochromatin appears distinct in prophase in contrast to the euchromatin which stains very lightly. Usually, the heterochromatin will stain intensely in interphase and very early prophase, at which time the euchromatin cannot be seen. This is particularly true when nuclei are stained with Giemsa.

For this study, if the whole chromosome could be seen with the euchromatin extended but distinct, the nucleus was considered to be in early prophase (Fig. 1). Middle prophase was that stage where euchromatin had condensed to some degree as seen in Figure 2, whereas in late prophase the euchromatin was condensed but it was still possible to distinguish between the euchromatin and heterochromatin (Fig. 3). In metaphase the chromosomes stained uniformly (Fig. 4). In every early prophase it was difficult to determine whether or not the euchromatin was paired. Usually the heterochromatic portions of the chromosomes would be distinct and widely separated, the euchromatin appearing as a mass of poorly defined strands. These very early prophases were not counted.

Figure 1. Early prophase showing pairing of euchromatin of homologous chromosomes.

Figure 2. Middle prophase showing pairing of euchromatin of homologous chromosomes with chiasmata in two of the pairs.

Nuclei in air dried preparations are well spread and flattened, and the chromosome structure is observed more readily than in conventional squash preparations. Thus, large numbers of nuclei in various stages of mitosis were available for study.

In early prophase 17 of the 22 nuclei examined showed intimate pairing and one nucleus was observed showing chromosomes with side-by-side pairing. Approximately 82% of early prophase chromosomes showed evidence of pairing of homologues.

In middle prophase 46 of 61 nuclei showed chromosomes with intimate pairing, nine of the 61 showing side-by-side pairing. By late prophase the picture had changed significantly, however, with only two of the 59 nuclei examined showing intimate pairing and 25 of the 59 nuclei showing side-by-side pairing. In metaphase 42 of 85 nuclei examined showed side-by-side pairing and none exhibited intimate pairing. These results are summarized in Table I.

There is no statistical difference between the percentages showing intimate pairing in early and middle prophase. Nor is the difference between the percentages of side-by-side pairing in metaphase and total pairing in late prophase significant. It should be pointed out, however, that in the technique for preparing the cells for study there is an opportunity for distortion as the cells are flattened by air drying. The difference between late prophase and metaphase may be due to this treatment.

Figure 3. Late prophase showing separation of homologous chromosomes with several homologues lying side-by-side.

Figure 4. Metaphase showing random arrangement of chromosomes.

The observations on pairing in mitosis can be interpreted as follows. Intimate pairing of euchromatin of homologous chromosomes is initiated in early prophase or perhaps as early as the preceding interphase. Kaufman (1934) showed illustrations of early prophase showing intimate contact between homologues, and indicated that this complete pairing is found frequently. No cases of complete pairing were observed in this study. Though it was not possible to observe the euchromatin in the very early prophases, the euchromatin appears very elongated and pairing is certainly possible. By early prophase the euchromatin is paired intimately in most cases, with the heterochromatin widely separated. Not all chromosomes in a nucleus show intimate pairing and in many instances the X chromosomes will remain unpaired as Kaufman (1934) noted. The X and the Y are associated randomly; they may lie near each other but are never paired.

The intimate association of the euchromatin of homologous chromosomes continues through middle prophase with chiasmata present in many cases. By late prophase, however, the chromosomes separate and tend to lie side-by-side. Usually the homologues are not in physical contact with one another. Both Kaufman (1934) and Cooper (194) called attention to this side-by-side pairing in late prophase and metaphase, as did Grell and Day (1970). By metaphase all of the homologous chromosomes have separated and about one half of the nuclei show the side-by-side pairing.

Both Kaufman and Cooper studied somatic pairing in Drosophila, but did not attempt to determine the frequency of occurrence. Grell and Day (1970), using oogonial cells of *Drosophila melanogaster*, determined the frequency of pairing for both onohomologous and homologous chromosomes at metaphase. In *Drosophila virilis*, as shown in Table I, it was found that approximately 77% of the early prophases studied showed intimate pairing and about 75% of middle prophases showed homologous chromosomes in this condition. In sharp contrast, in late prophase only 3.4% were intimately paired but

Table I. Nuclei in Mitosis Showing Pairing

	Early Prophase	Middle Prophase	Late Prophase	Metaphase
Total counted	22	61	59	85
Intimate pairing	17	46	2	0
Intimate pairing (%)	77.3	75.4	3.4	0
Side-by-side pairing	1	9	25	42
Side-by-side pairing (%)	4.5	14.8	42.4	48.9
Total pairing	18	55	27	48.9
Total pairing (%)	81.8	90.2	45.8	48.9

approximately 42% showed side-by-side pairing. In metaphase about 49% were in the side-by-side pairing. Grell and Day (1970) reported 71.6% pairing of homologous chromosomes in metaphase in contrast to the results reported here.

The behavior of chromosomes in prophase and metaphase indicates that somatic pairing of homologous chromosomes is a common phenomonon in *D. virilis* as it is in *D. melanogaster*. This association involves euchromatin only, with the heterochromatin unpaired. Cooper (1959), Yunis and Yasmineh (1971) and Hsu (1974) outlined some of the suggested functions of heterochromatin. Yunis and Yasmineh (1971) presented evidence that heterochromatin in general forms aggregates between both homologous and non-homologous chromosomes in both mitotic and meiotic mammalian cells. However, the evidence in *D. virilis* indicates that the heterochromatic segments of homologous chromosomes do not synpase even in very early prophases. One function of heterochromatin in Drosophila, where somatic pairing commonly occurs, may be to facilitate the separation of homologous chromosomes and insure proper disjunction in mitosis and meiosis.

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Age and Growth of Bluegill, *Lepomis Macrochirus* Rafinesque, from Lake Fort Smith, Arkansas

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ABSTRACT

A total of 337 bluegill from Lake Fort Smith were used for this study. Annuli were formed between late February and early June, the younger fish forming annuli earlier than older fish. Total length-scale radius and length-weight relationships were determined. Growth of bluegill was compared with that reported in other studies. Growth curves were analyzed by the Von Bertalanffy growth formula and the parameters were evaluated in terms of physical and biological factors.

INTRODUCTION

The bluegill is widely distributed in the Great Lakes regions to the St. Lawrence drainage, throughout the Mississippi Valley and from Mexico to Virginia (Blair et al., 1968). In Arkansas, it is common in lakes, rivers, streams and ponds where it is an important sport and forage fish. Olmsted and Kilambi (1971) reported that during the late summer and fall *Lepomis* spp., particularly bluegill, carried the heaviest burden of predation by white bass *Morone chrysops* (Rafinesque) in Beaver Reservoir. Applegate et al. (1966) found that the longear sunfish *Lepomis megalotis* (Rafinesque), green sunfish *Lepomis cyanellus* Rafinesque, and bluegill constituted 10% of the food for black basses *Micropterus* spp. in Bull Shoals Reservoir. In Lake Fort Smith, bluegill was the major forage fish for largemouth bass *Micropterus salmoides* (Lacepede) and spotted bass *Micropterus punctulatus* (Rafinesque) (Hoffman et al., 1974). Published information concerning age and growth of the bluegill is considerable. Most of the studies were conducted in northern waters, except those in Oklahoma and Tennessee, and there were only limited studies in the southern tier of these states. A previous age and growth study of bluegill from Lake Fort Smith was performed by Trenary (1958).

Knowledge of the age and growth of fishes in a particular body of water is essential to fishery management. The growth stanzas of fishes reflect inherent growth patterns as well as environmental influences on growth. The objectives of the present study were to determine the time of annulus formation and the growth rates of males and females, and to estimate maximum attainable size and age by the Von Bertalanffy growth formula.

DESCRIPTION OF STUDY AREA

Lake Fort Smith is an artificial impoundment about 1.6 km north of Mountainburg, Arkansas, and it serves as a water supply reservoir for the city of Fort Smith. Its watershed of about 168.35 km^2 is covered primarily with oak-hickory forest. The lake is surrounded by a steep slope on its eastern shore, and by a slightly less steep western slope. It was impounded in 1936 and attained a flood pool surface area of 212.83 ha, a mean depth of 6.99 m and a maximum depth of 21.94 m (Hoffman, 1951). Nelson (1951) reported additional morphometric data in that the lake was turbid from early fall to midsummer, creating conditions for considerable siltation and change in morphometric character since 1952. Lake Shepherd Springs, about 1.6 km upstream, has not acted as a settling basin for many of these sediments.

MATERIALS AND METHODS

A total of 337 bluegill (166 males and 171 females) was collected by a 230-v electroshocker, gill nets and rod and line from October 1970 to September 1971 and by rotenone sampling on 8 July 1971. Specimens were placed on ice and transported to the laboratory where total lengths to the nearest millimeter and weights to the nearest 0.1 g were taken. Scale samples were taken posterior to the tip of the depressed pectoral fin below the lateral line on the left side. Fish were assigned sex on the basis of gonad inspection. Individuals identified as male or female included both immature and mature fish.

Five to 10 scales from each fish were pressed on cellulose acetate strips by means of a Carver laboratory press. A numerical age designation was adopted, and a plus sign was used to refer to growth beyond the annual mark. Scale impressions were projected (43x) on an Eberach scale projection apparatus. Scale measurements were made along a line from the center of the focus anterolaterally to the ventral edge. The distance to each annulus and to the outer edge was recorded to the nearest millimeter. To investigate the validity of the assumption that the annulus was forming during a specific short period of time each year, measurements were made of the marginal scale increments throughout the year. The distance from the last formed annulus to the anterolateral scale edge was recorded for each fish, and measurements were grouped by month.

Date of capture, total length, weight, sex, age, distance to each annulus if present and scale radius for each fish were recorded on data sheets and IBM cards. The analyses of the data were accomplished by use of a Friden electronic desk calculator and an IBM 360-50 computer. All statistical tests for significance are reported at the 0.05 level of probability, unless otherwise stated.

RESULTS AND DISCUSSION

Age Determination and Time of Annulus Formation. The number of scale annuli indicated that ages ranged from zero (young-of-the-year) to 9+ years. Accessory checks were noted close to the focus on some late-spawned bluegill. A few

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spawning checks were noted after the third annulus on some fish. Clumping of annuli and resorption of the anterior field may have obliterated previous annuli. Thus, bluegill aged 9+ possibly could have been older.

The time of annuli formation was determined on the basis of monthly average marginal scale increments for the age groups 1+, 4+ and 6+ (Fig. 1). Annuli formed from late February to

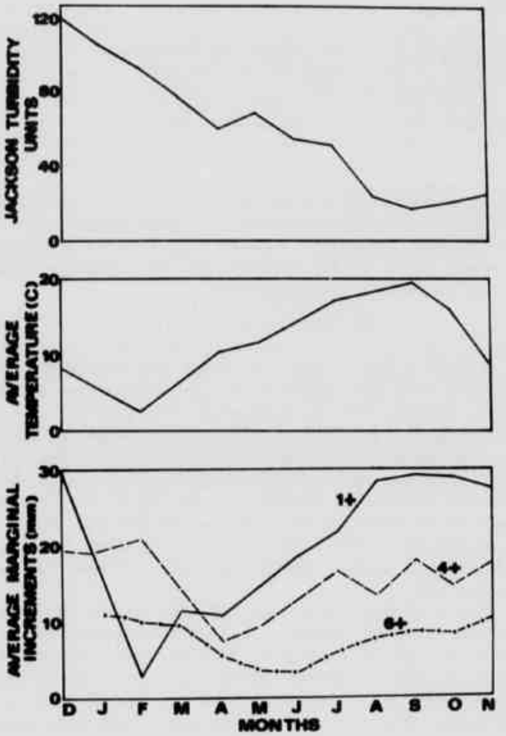

Figure 1. Monthly average marginal scale increments for selected age groups, and average temperature and turbidity of Lake Fort Smith.

early June. The older fish formed the annuli later than the younger bluegill. The average temperature and turbidity (JTU) data of Lake Fort Smith for 1971-72 (Hoffman et al., 1974) are shown in Figure 1. It appears that low temperature and high turbidity were responsible for the formation of annuli in one-year-old bluegill. Although exposed to similar environmental factors, the older bluegill formed annuli at a later time. Because all the 3+ and older fish were sexually mature, spawning and physiological stress may be responsible for annulus formation in the older bluegill.

Total Length-Scale Radius Relationship. The total length-scale radius relationship was derived by a stepwise polynomial technique from the general model:

$$L = \theta_0 + \theta_1 S + \theta_2 S + \ldots + \theta_n S^n$$

(Graybill, 1961) where L is the total length in millimeters, S is the scale radius (43x) in millimeters and θ_0 to θ_n are constants. The relationships for the male and female bluegill were calculated separately.

Covariance analysis showed that the difference between the males and females was not significant ($F_{4,329} = 0.67$) and therefore the data for the sexes were combined. The resulting total length-scale radius relationship was:

$$L = 19.319 + 1.227S - 0.002S^2$$

Length-Weight Relationship. The length-weight relationship was calculated by the formula

$$\log W = \log a + b \log L$$

where

W = weight in grams

L = total length in millimeters

a and b = constants.

Because there were no differences between sexes either in slopes ($F_{1,333} = 1.17$) or in the intercepts ($F_{1,334} = 6.0$), the data was combined and the resulting relationship was:

$$\log W = 3.21 \log L - 5.2207$$

The average calculated and observed weights at each year of life are given in Table I.

Table 1. Average calculated and observed weights in grams at the end and during each year of life, respectively.

		Age-Group								
		1+	2+	3+	4+	5+	6+	7+	8+	9+
MALES	Calculated Weight	2.3	10.7	24.9	41.9	62.8	82.1	105.7	128.2	--
	Observed Weight	6.8	14.9	30.1	46.9	67.0	96.0	128.6	148.5	--
FEMALES	Calculated Weight	2.2	10.5	24.0	42.4	60.8	82.1	103.0	132.1	162.3
	Observed Weight	5.6	15.7	26.7	46.0	64.7	95.5	130.1	153.8	187.9

Table 2. Average calculated growth rate of male bluegill.

	Total Length at each annulus (mm)							
Age-Group	1	2	3	4	5	6	7	8
1	42.1							
2	46.7	81.7						
3	46.4	80.7	109.5					
4	48.5	81.6	107.6	129.6				
5	57.8	89.9	114.0	132.2	145.2			
6	66.3	99.2	121.3	140.1	153.2	162.9		
7	69.9	101.7	125.3	145.6	160.4	171.1	179.1	
8	62.1	94.1	122.0	146.9	163.6	176.6	185.4	191.9
Weighted mean	54.8	88.4	115.2	137.4	153.6	167.0	180.7	191.9
Number of fish	166	163	134	97	74	55	23	6

Growth in Length. By use of the total length-scale radius relationship, the length attained at each annulus was calculated (Tables II, III). The average lengths at the end of one and two years were weighted means based on back calculations for immature and mature bluegill.

Table 3. Average calculated growth rate of female bluegill.

Age-Group	Total length at each annulus (mm) 1	2	3	4	5	6	7	8	9
1	42.6								
2	49.1	85.9							
3	42.9	76.5	105.0						
4	49.2	82.8	109.2	131.0					
5	59.7	90.4	112.9	130.0	143.7				
6	63.6	97.8	121.4	139.0	152.5	162.2			
7	65.7	97.7	120.9	140.2	155.1	166.7	174.3		
8	65.8	99.7	127.7	146.9	160.4	171.5	180.8	185.7	
9	71.8	109.8	140.2	163.4	179.9	192.5	198.9	203.6	206.5
Weighted mean	54.3	88.0	113.9	135.9	152.1	167.0	179.2	193.7	206.5
Number of fish	171	169	146	112	77	51	27	9	4

Growth patterns for male and female bluegill were analyzed by the Von Bertalanffy equation:

$$L_t = L_{\infty}(1 - e^{-K(t-t_0)})$$

where

L_t = length at age t

L_{∞} = asymptotic length

K = coefficient of catabolism

t_o = age at which the length is zero.

Initially the data were analyzed by Walford's transformations (Beverton and Holt, 1957). Covariance analysis showed that both sexes can be represented by a single line (F 2, 11 = 1.02) indicating that males and females attain the same asymptotic length with similar coefficients of catabolism. The combined data for sexes were analyzed further (Richer, 1958) and the growth curve can be represented by the equation:

$$L_t = 253\ (1-e^{-0.18(t+0.42)})$$

The asymptotic weight, W_{∞}, computed by use of the length-weight relationship, was 311.4 g. The age (t_i) at which 95% (P) of asymptotic length could be attained was estimated by the equation:

$$t_i = t_o - \{ \frac{\ln(1 - P)}{K} \}$$

and this age was 16.7 years. The weight at t_i was calculated to be 263 g. Bluegill as old as 13 years have been reported, and the largest bluegill reported weighed 2156g (Snow et al., 1960). Therefore, the projected values of t_i, L_{∞} and W_{∞} for Lake Fort Smith bluegill seem reasonable.

The growth data for bluegill from Lake Fort Smith from an earlier study (Trenary, 1958) were fitted by the Von Bertalanffy growth formula as

$$L_t = 303\ (1-e^{-0.21(t + 0.04)})$$

and the projected age at which 95% of asymptotic length could be attained was 14 years.

Comparison of growth parameters of Trenary's data and of the present study by Walford transformation showed that the slopes were not significantly different (F 1, 8 = 0.12) but the differences in the intercepts were significant (F 1, 9 = 16.92) at the 0.01 level. It is concluded that the bluegill of this study would attain significantly smaller asymptotic length (253 mm) than those of Trenary's study (303 mm).

Of the two growth parameters L_{∞} (W_{∞}) and the coefficient of catabolism, K, the latter was regarded as independent of the level of feeding but varied with certain environmental factors such as temperature, whereas W_{∞} was influenced by food consumption (Beverton and Holt, 1957). Felin (1951) stated that the rate of deceleration of growth is the more stable of the two growth characteristics and that, with relatively constant environments, slope is a physiological character of genetic meaning.

The mean temperatures of Lake Fort Smith at 1 m depth between 1959-1960 (Rorie, 1961) and 1972 (Hoffman et al., 1974) for the period February through September were not significantly different (F 1, 14 = 0.08), and the overall mean temperature was 19.5C. The similarity of coefficients of catabolism for bluegill of Trenary's study and for those of this investigation is due to constant environmental temperature.

According to Hoffman et al. (1974), the composition and standing crop of Lake Fort Smith plankton have not changed since 1938. However, no information on insects was available. It was assumed that availability of food for bluegill remains the same as in the earlier years. The population sizes of adult bluegill and largemouth bass from rotenone samples during 1957-1958 and 1971 were reported by Cole (1959) and Hoffman et al. (1974), respectively. The adult bluegill population sizes were 18,030 in June 1957, 16,710 in June 1958 and 17,782 in July 1971. In July 1971, the population size of juvenile and intermediate-size bluegill was estimated to be 1,235,105 on the basis of the rotenone sample. The population sizes of largemouth bass in June 1957, June 1958 and July 1971 were 9,921, 9,085 and 5,589, respectively. These figures indicate a drastic reduction in the largemouth bass population for which the bluegill forms a major forage in Lake Fort Smith. The decrease in predation would result in greater numbers of juvenile and intermediate-size bluegill that compete with adult bluegill for food. During May and June the juvenile bluegill of Lake Fort Smith fed on insects, which were the main food item for the adults (Henderson, 1972). This competition and the recruitment of young fish to adult size would result in intense competition for food and thus in a smaller amount of available food. These factors probably resulted in slower growth (Table IV) and smaller L_{∞}, in contrast with those of the previous study (Trenary, 1958).

Table 4. Average total length of Lake Fort Smith bluegill and other waters.

Locality	Calculated length in mm at each age 1	2	3	4	5
Lake Fort Smith (Present study)	55	88	115	137	153
Lake Fort Smith (Trenary 1958)	61	103	135	177	194
Bull Shoals Reservoir (Applegate et al. 1966)	48	84	102	123	150
Oklahoma (Jenkins et al. 1955)	81	124	151	172	182
Homewood Lake (Ill.) (Carlander and Smith 1953)	71	114	135	142	147
Alma Lake (Ohio) (Carlander and Smith 1953)	41	91	140	178	203

Growth of Lake Fort Smith bluegill through the first five years of life was compared with growth in other bodies of water and to that reported in an earlier study of Lake Fort Smith (Table IV). The bluegill growth of the present study was slower than that reported in Trenary's study. The factors contributing to this change have been discussed. The growth of Bull Shoals Reservoir bluegill was similar to that found in the present study. It was also evident that Lake Fort Smith bluegill growth was slower than that in Oklahoma and Ohio (Alma Lake), but similar to that in Homewood Lake, Illinois. Eschmeyer (1940) stated fisheries workers generally assume that fish growth is progressively more rapid with decrease in latitude. This phenomenon is attributed to difference in length of growing season (Gerking, 1966). The present study indicates that bulegill do not necessarily grow faster at lower latitudes or grow at the same rate in the same lake at different times. The condition of the lake and available food more aptly dictate the growth rate.

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A Model for Estimating the Probability of Crop Production for *Ginkgo Biloba* L.

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ABSTRACT

Mature female Maidenhair trees (**Ginkgo biloba** L.) have been observed to produce seed dispersal units in some years and none in other years. A temperature and/or photoperiod flowering threshold is suggested. Daily temperatures and daylengths at five **Ginkgo** sites in continental U.S. for January-April 1964-1974 were evaluated. A computer program was designed to estimate daily photothermal equivalent (PTE = temperature and photoperiod), and the magnitude and duration of the PTE in relation to a series of photothermal constants. Use of the data from production and nonproduction years provided a mathematical model for prediction of dispersal unit production. The model was tested with environmental data for additional sites recorded in the botanical literature.

INTRODUCTION

The prediction of plant responses to environmental factors long has been studied by investigators using many types of analytical procedures. As computers have become a common tool for research data analysis, more sophisticated biomathematical procedures have been devised. The objective, however, remains the same: a quantitative assessment of contributing factors and an equation considering such factors which will be reliable in predicting future plant responses.

Crop production model research for agricultural commodities such as grains and fruits has produced analytical procedures for determination of not only quantitative probabilities, but also qualitative predictions of crop production (Brown, 1953; Wielgolaski, 1973). It has been pointed out that greater emphasis should be placed on the relation of daily weather measurement to plant responses such as fruit production rather than average values over extended periods (Caprio, 1966). Because of the important role of climatological factors in the flower development period, equating daily spring weather measurements with fall crop production was chosen to be examined. The purpose of the investigation was (1) to determine which climatological factor or combination of factors best expresses variations associated with crop production in *Ginkgo biloba*; (2) to formulate an easily employed, reliable mathematical model for crop predictions in subsequent years.

MATERIALS AND METHODS

At four sites where mature female *Ginkgo* trees have been observed to produce seed dispersal units[1], available records of the occurrence of a fall crop were obtained. A fifth site was obtained from the botanical literature (West et al., 1970). The crop and weather data of these five widely dispersed sites were used in all computations for variable selection and model building (Table I).

A computer program was written to estimate the 1 January to 30 April daily photoperiod at each site for the years observed (U.S. Naval Observatory, 1971-74). Climatological data were compiled from the weather recording station nearest each site (U.S. Dept. Commerce, 1964-74). By use of the daily maximum and minimum temperatures, average temperature was calculated for 1 January to 30 April for each site. Maximum, minimum and mean temperature data for crop and non-crop production years at the St. Louis, Missouri, site were grouped into 10° intervals. Interval values from low to high temperatures for both groups were accumulated and the chi square of accumulated interval totals of both groups was calculated. The intervals then were accumulated from high to low temperatures and the chi square calculated in the same manner. Values above the 10.0% level of significance for 1° of freedom were noted. By this method, minimum temperature values of 25, 30 and 35F (-4, -1 and 2C) were selected as criteria for best temperature variations of crop and non-crop years. The importance of including a photoperiod threshold requirement in model building has been pointed out (Baier, 1973). Although a photoperiod requirement has not been established for *Ginkgo*, it has been observed that initial leaf formation of young greenhouse-grown trees is during early February in Fayetteville, Arkansas. If a photoperiod flowering requirement exists, it was assumed to be between 620 and 675 min to represent the daily photoperiods for 6 to 28 February at Fayetteville. A series of six photoperiod constants (620, 630, 640, 650, 660, 675 min were used in relation to the three temperature constants for determination of photothermal threshold values (PTT=photoperiod constant and temperature constant). A computer program was written to determine the photothermal equivalent (PTE = photoperiod and temperature) for each daily maximum, minimum and mean temperature for each site-year. The three PTE values were compared with each set of PTT values. Magnitude and duration of PTE-PTT data provided the values of the

[1] The writer favors the term "dispersal unit" (Evenari, 1965), because what constitutes the morphological seed of *Ginkgo* is ill-defined and because the physiological and anatomical maturity of the "seed" cannot be judged from outward appearance of the dispersal unit.

Table I. Locations and Years of *Ginkgo* Seed Dispersal Unit Observation

Site	Crop Production Years	Non-Crop Years
Cambridge, MA	1973, 1974	—
Plainfield, NJ	1968	—
St. Louis, MO	1965, 1966, 1969, 1972	1964, 1970, 1974
Memphis, TN	1968, 1973	1974
Little Rock, AR	1973	1974

temperature-oriented variables to be analyzed by the logistic model of Walker and Duncan (1967).

RESULTS

The greatest separation of crop and non-crop production probabilities for the site-years investigated occurred when a combination of 10 predictor variables were correlated. The predictor variables were the actual number of days during February and March that various relationships occurred between (1) the PTT constant for 640 min and 25F and (2) the daily minimum PTE (Table II). A PTE> PTT day is defined as one in which both daily photoperiod and daily minimum temperature were equal to or greater than the constant values of 640 min photoperiod and 25F temperature.

The probability of crop production and individual variable regression coefficients were determind by the following multivariate logistic model:

$$P = \frac{1}{1 + e^{-(B_o + B_1 x_1 \ldots B_p x_p)}}$$

where P is the probability of seed dispersal units being produced, B_o is a calculated constant, x_i is the actual number of days derived for the ith predictor variable, B_i is its associated regression coefficient and e is the base of the natural logarithm.

Table II. Predictor Variables and Their Regression Coefficients Determined by PTE Using February-March Minimum Temperatures and PTT of 640 Min and 25 F

Predictor Variable (X)	Regression Coefficients	
Constant	32.494406	(B_0)
Total number of days PTE> PTT in February	3.959442	(B_1)
Total number of sign changes for daily PTE-PTT values in February	-3.075101	(B_2)
Greatest number consecutive days PTE> PTT in February	-4.652010	(B_3)
Least number consecutive days PTE> PTT in February	-1.162381	(B_4)
Greatest number consecutive days PTE <PTT in February	0.792214	(B_5)
Total number of days PTE> PTT in March	-1.072725	(B_6)
Total number of sign changes for daily PTE-PTT values in March	-0.532523	(B_7)
Greatest number consecutive days PTE> PTT in March	-0.179378	(B_8)
Least number consecutive days PTE> PTT in March	0.327010	(B_9)
Greatest number consecutive days PTE <PTT in March	-1.424315	(B_{10})

All site-years in which a crop was observed had calculated crop production probability greater than 0.9826. Those site-years when no crop was observed had calculated crop production probability less than 0.0156 (Table III). The model was tested with the climatological data for three additional site-years not used in developing the prediction equation. By use of the model, all three sites had calculated probability that a crop would be produced (Table IV). A fall *Ginkgo* crop at all three sites was reported (Lee, 1955; Pollock, 1957; pers. comm.). A prediction of 1975 crop production for the five test sites was determined (Table IV). However, verification of fall crop production could not be made at the time the paper was submitted for publication.

As additional *Ginkgo* sites and years of observation are recorded, the requirements which determine whether or not a crop will be produced should become more clearly defined. Continual updating of the equation will give greater reliability to each regression coefficient, and thus greater reliability of predictions for yearly crop production.

Note Added in Proof:

A fall observation for 1975 crop production was made at each test site listed in Table IV. All sites produced a crop contrary to the model predictions based on previous years' information.

Table III. Estimation of Probability of *Ginkgo* Seed Dispersal Units as a Function of Selected Predictor Variables.

Site/Year		Status*	Crop Production Probability
Memphis, TN	1974	0	0.0033
St. Louis, MO	1974	0	0.0055
St. Louis, MO	1970	0	0.0094
St. Louis, MO	1964	0	0.0156**
Little Rock, AR	1974	0	0.0061
Memphis, TN	1968	1	0.9972
Memphis, TN	1973	1	0.9926
Little Rock, AR	1973	1	0.9990
Cambridge, MA	1973	1	0.9916
Cambridge, MA	1974	1	0.9996
St. Louis, MO	1972	1	0.9920
St. Louis, MO	1969	1	0.9876
St. Louis, MO	1966	1	0.9835
St. Louis, MO	1965	1	0.9826**
Plainfield, NJ	1968	1	0.9968

*Fruit not produced = 0. Fruit produced = 1.
**Limit values.

This outcome does not invalidate the model, but indicates the need for additional data which will define more precisely the limits for crop production. The 1975 data will be used in updating the equation for future predictions of crop production.

Table IV. Location and Prediction of *Ginkgo* Crop Production

Site	Year	Crop Production Probability
Charlottesville, VA	1957	0.9728
Urbana, IL*	1950	0.8527
Philadelphia, PA*	1973	0.6090
Cambridge, MA**	1975	0.0000
Plainfield, NJ**	1975	0.0000
St. Louis, MO**	1975	0.0090
Memphis, TN**	1975	0.0000
Little Rock, AR**	1975	0.0000

*Site of recorded crop production to test model.

**Calculated probability for fall crop production.

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Mississippian Communities in the St. Francis Basin: A Central Place Model

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ABSTRACT

The development of Mississippian settlement models for northeast Arkansas is reviewed. It is argued that a five-tier central place hierarchy best accounts for the variability currently known to exist among Mississippian communities in the St. Francis basin.

INTRODUCTION

Why human settlements are located where they are and what the relationships between sites and physiographic areas are have long been of interest to archeologists (Chang, 1968; Fitting, 1969; Gummerman, 1971; Plog, 1968; Price, 1974; Willey, 1953). Geographic models, general systems theory and the use of an ecological orientation in the interpretation of settlement patterns have contributed most significantly to the current general methodology of settlement archeology.

The development of a settlement model for a chiefdom level of sociopolitical integration during late Mississippian times in northeast Arkansas is not without precedent. Most notably, Morse (1973, p. 73-76) has proposed a model for the Nodena phase, outlining three clusters of potentially related sites in the region east of the Tyronza River and west of the Mississippi River. The "sub-districts" are broken down into three types of component habitation sites. Farmsteads or hamlets are included under "Type I" sites. These range from single to multiple houses and are generally no larger than ¼ acre in extent. "Type II" sites usually occupy from 2 to 7 acres and have no evidence of public works (i.e., mounds). "Type III" sites can be as large as 15 acres, and have at least one pyramidal mound and an associated village.

THE SETTLEMENT MODEL: A CENTRAL PLACE HIERARCHY

Morse's general scheme is very similar to what is suspected in the St. Francis basin; however, a few modifications and additions appear to be in order. In the first place, if one believes that contemporaneous settlements of differing sizes and functions are interacting, then one must view these settlements analytically in terms of how each is functionally related to another. In this regard, the central place theory developed by Christaller (1966), which is based on the regular lattice model of settlement distribution, is an important interpretive framework from which to work. Christaller offered the central place model as a general deductive theory to explain the "size, number and distribution of towns" on the basis of the belief that "there is some ordering principle governing the distribution" (Berry and Pred, 1961, p. 15). Central places are ranked according to the number of goods and services they can provide. Size of the settlement and number of goods and services potentially provided are related directly in this regard. By definition, then, hamlets are of a lower order than are towns. According to the model, settlements can be organized hierarchically in several various geometrical arrangements of central places. This organization is based on Christaller's marketing principle whereby the hierarchy and location of sites (nesting pattern) theoretically result in the maximum number of central places necessary to supply goods and services to the consumer in accordance with the principle of movement-minimization (Garner, 1967, p. 308). With this, one can further view the settlement patterns of the St. Francis basin during the late Mississippian period as a total system or systems of sociocultural interaction.

Sanders and Price (1968, p. 116) outlined several potential settlement patterns which could be characteristic of a chiefdom social structure, including the following generalized model.

> Ceremonial centers with a civic precinct and very small residential groups made up of the chiefly lineage, plus perhaps a small group of service personnel. The other lineages would be scattered over the countryside in nuclear family, extended family or lineage settlements. These settlements would support the chiefly lineage by food tribute and themselves consist of full-time farmers or farmers-part-time-craftsmen with specializations based upon local resources.

A second proposed model would have the entire chiefdom residing at a single central place. The third model suggests that a majority of the chiefdom population would live at the highest order center and the rest of the population would be distributed in smaller settlements. Generally, the second and third patterns occur only under circumstances where factors such as warfare or the uneven distribution of crucial resources (i.e., land or water) are present (Sanders and Price, 1968, p. 116).

The first chiefdom settlement pattern presented by Sanders and Price appears best to fit the archeological and historical documentation at hand. If one agrees that the nature of activity loci is hierarchical, and if the size of the loci and the number of potential activities offered are directly related, then one should be able to rank known settlements and predict possible additional settlement orders. At present, the settlement model for the Parkin phase would include at least a five-order hierarchy (Table I). Just as the chiefdom is a ranked society based on status differentiation centered on a single status position, that of the chief, so too are the patterns of settlement

Table I. Hierarchical Arrangement of Settlements in the Parkin Phase

First order	Specialized ceremonial centers
Second order	Combined village ceremonial centers (not including small house mounds)
Third order	Large (7-15 acres) villages
Fourth order	Intermediate (1-7 acres) villages
Fifth order	Hamlets or farmsteads

associated with it. Here the hierarcically defined "status" differentiation is based on specialization or the relative importance and varied quantity of goods and services provided by a specific order of central place. The focal point of the hierarchy is the first order settlement or specialized ceremonial center. The redistribution of surplus local resources (e.g., food surpluses or exceptional raw materials) is an important aspect of the chiefdom and it is at these first order sites that this redistributive process takes place (Service, 1962). These large first order settlements may include "not only the resident chief, but also a greater or lesser number of administrative assistants..., service personnel, and even full-time craftsmen" (Sanders and Price, 1968, p. 44). Good examples of first order central places in the St. Francis basin are the Parkin site (3CS29) and the Togo or Neeley's Ferry site (3CS24). From the limited excavation at Parkin, it appears that the site did not serve as a long-occupied village, but rather as a major center for a large number of people while being occupied by only a very few. Both the "village" and ceremonial mounds are artificial constructions resulting from massive public work projects, a common characteristic of the chiefdom (Klinger, in press).

Large villages with associated mounds or mound groups are characteristic of second order settlements. At least six sites are known which show these general characteristics, including the Richard Bridge Place (3CT22), Vernon Paul (3CS25), the Turnbow Place (3CS61), the Williamson site (3CS26), the Cummings site (3PO5) and the Big Eddy site (3SF9). It is difficult to say what specific activities may have taken place at these settlements. However, on the assumption that house mounds are associated with high ranking individuals and thus relatively important activities, these sites are grouped as second order central places.

Some of the most striking examples of Phillips et al.'s (1951, p. 329) "St. Francis-type" sites are indicative of third order settlements according to the present hierarchical arrangement. The Barton Ranch site (3CT18), the Fortune Mound (3CS71), the Rose Mound (3CS27) and the Castile site (3SF12) are the most outstanding examples. All are large rectangular elevated villages (village mounds) with no ceremonial structures in apparent association. These sites represent the major population centers of the chiefdom. Stratigraphic tests at the Rose Mound (Phillips et al., 1951, p. 284-292) indicate that intensive occupation of these centers contributed to the 2 m or so buildup of the village mounds. Although the Parkin site is very similar in size and village mound height, the village mound itself appears to be the result of artificial building zones and not long-term occupation. Possibly, then, other similar sites such as Barton Ranch, Fortune and Castile may represent stages of construction toward the first order centers. Stated another way, these may be the result of the demand for additional first order redistribution centers because of increased population, but were not finished (i.e., large temple mounds were not built) before the sites were abandoned.

Intermediate, nonelevated, villages often located on natural ridges or levees are representative of fourth order settlements. Very few of these sites have been reported; however, the Manly site (3SF25) serves as a good example. These settlements are essentialy the same as third order centers only they are smaller and had considerably fewer residences. The fifth order of settlement is composed of small hamlets or farmsteads probably containing fewer than five houses at any one time. These are the sites that are closest to the cultivated fields and the individuals residing at them were essentially tenants or caretakers of the fields. Other activity loci such as quarry sites, butchering stations or overnight campsites would be included in this order. Unfortunately, no fifth order sites have been recognized to date in the St. Francis basin.

So far as is known, the De Soto journals of the 1541 expedition contain first hand descriptions of the St. Francis area during approximately the time period the settlements discussed were occupied. There are unquestionably a number of problems involved in using data such as contained in the journals; however, a general overall picture of the cultural organization does emerge. The settlement system outlined is, in most respects, consistent with the De Soto descriptions.

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An Occurrence of the Puma, *Felis concolor*, from Svendsen Cave, Marion County, Arkansas

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ABSTRACT

A partial skeleton including fragmental skull and mandibles of the puma, **Felis concolor**, was recovered from Svendsen Cave, Marion County, Arkansas. The remains are thought to be of Late Pleistocene (Wisconsin) or Sub-recent age. Fossil records of the puma are rare and only one other Pleistocene or Sub-recent site in Arkansas, Conard Fissure, has yielded remains which could be assigned to this large felid.

INTRODUCTION

Remains of the puma, *Felis concolor*, were discovered in Svendsen Cave, Marion County, Arkansas, in January 1974 by John Svendsen, Yellville, Arkansas, and Ola Eriksson, Lund, Sweden. The remains were reported to the Arkansas Archeological Survey and collecting was carried out by the discoverers and members of the Departments of Anthropology and Geology and the University Museum, University of Arkansas, Fayetteville.

The skeletal elements were encased in a travertine ledge, which greatly hindered collecting. Recovery of the skeletal elements required that large pieces of travertine be broken off and removed to the University of Arkansas where the bone materials were freed from the matrix with 10% acetic acid. After removal from the matrix by acidizing, the remains were treated with Gelva-15 to prevent damage due to crumbling.

The skeleton was lying in a semiarticulated position in a small ledge approximately 5 ft above the present passage floor. The stream in the cave is in an active stage of fill removal and is probably responsible for the absence of the rest of the skeleton.

LOCATION

Svendsen Cave is 3.5 mi southeast of Yellville, Marion County, Arkansas (Fig. 1). The cave is developed in dolomitic limestone mapped as the Everton Formation (Ordovician) and contains approximately 3000 ft of mapped passage. The remains were 500 ft from the present entrance in the main passage which is a low strenuous crawl including a siphon and two climbs, the highest about 18 ft (Fig. 1). It is probable that the cat entered the cave from an entrance now unknown and may have been washed to the depositional site.

AGE

No exact date can be assigned to the Svendsen puma although antiquity is suggested by the mode of occurrence and lack of metastable materials in the skeletal remains.

At the depositional site, the bone-bearing travertine is being solutioned and the sediments in the passage are being removed by the stream. Thus a climatic regime of less than the present level of precipitation, which allowed formation of a travertine ledge over part of the skeleton, is indicated for the cave area during the deposition of the puma.

Skeletal measurements (Table I) taken on the Svendsen

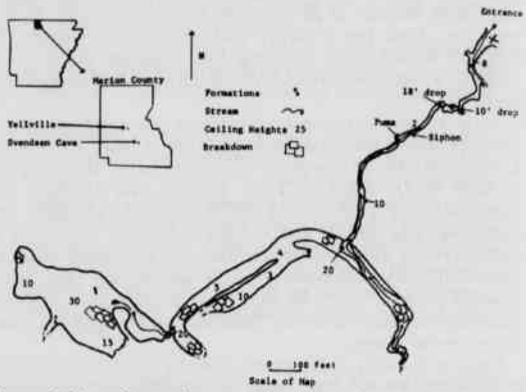

Figure 1. Location and map of Svendsen Cave showing site of puma remains. Mapped by Ervin, Svendsen and Eriksson.

Table I. Measurements (mm) of Dentition, Mandible and Humerus of *Felis concolor*

	Svendsen Cave	Recent Range
Dentition		
LP^4 crown length	22.3	18.9-27.2*
LP^4 crown anterior width	12.0	9.3-13.9*
LP^4 crown posterior width	8.6	
LP^4 length paracone	9.1	8.4- 9.8**
LP^4_4 length metastyle	8.5	8.4-10.3**
LP crown length	16.3	
LP^4 crown width	8.6	
LM^1 crown length	18.1	14.3-21.0*
LM^1_1 crown width	8.9	
Mandible		
Depth anterior to LP_4	28.5	
Depth posterior to LM_1	29.2	
Maximum thickness at LM_1	12.9	
Distance LP_4-LM_1	34.2	
Humerus		
Humerus length	237.4	
Width at distal end	52.5	
Maximum diameter at mid-shaft	24.6	

*Young and Goldman (1946).

**Kurten (1965).

puma are well within the measurement parameters of recent subspecies of the modern puma, *Felis concolor*, and if the Middle Pleistocene (Kansan-Sangamon) puma were on the whole larger as indicated by Kurten (1965), a Late Pleistocene (Wisconsin) or Sub-recent (Altithermal) age of the remains would be most reasonable.

The fact that no odor was released from the remains during a "bone burn test" (Quinn, 1957) indicated an absence of metastable materials and therefore antiquity. Because the results of the test depend not only on age, but also on preservation conditions, care must be used in making final judgments on the bone materials and their age on the basis of this method.

The only associated faunal deposits with the Svendsen cat were fragmentary bat remains. A minimum of four individuals, based on left mandible fragments, identified as the small bat *Pipistrellus* sp. were recovered from the matrix surrounding the puma. Both geographic and time ranges of the genus *Pipistrellus* are extensive and offer no help as climatic or age indicators.

SYSTEMATIC PALEONTOLOGY

Order Carnivora Bowdich 1821
Family Felidae Gray 1821
Felis concolor Linnaeus 1771

Materials recovered: Partial skull with LP^4 -LM^1 (UA #74-20-1); partial left mandible with P_4-M_1 (UA #74-20-2); left humerus (UA #74-20-3); scapula, ribs and vertebrae (UA #74-20-4). The partial skull, left mandible and humerus are illustrated in Figure 2. All materials are reposited at the University of Arkansas Museum, Fayetteville, Arkansas. Measurements of the important skeletal elements taken with vernier calipers are plotted in Table I.

DISCUSSION

Althought the puma has existed in Arkansas from at least the Middle Pleistocene (Kansan) to the present, its presence has been reported in only one other Pleistocene or Sub-recent site, Conard Fissure.

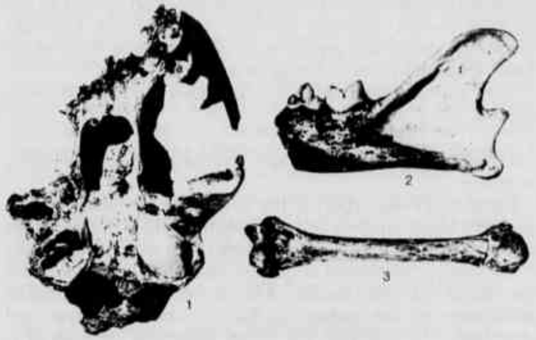

Figure 2. (1) Ventral view of partial skull of *Felis concolor* (UA 74-20) showing LP^4 and LM^1, x0.87. (2) Lateral view of partial left mandible of *F. concolor* (UA 74-20) showing LP_4 and LM_1, x0.87. (3) Dorsal view of left humerus of *F. concolor* (UA 74-20), x0.38.

Brown (1908) reported puma-like cat remains, some of which he named a new species, *Felis longicrus*, and others he referred to the modern puma, *F. cougar* now recognized as *F. concolor cougar*, from Conard Fissure, Newton County, Arkansas. A Kansan age has been assigned, on the basis of micromammal biostratigraphy, by Graham (1975) to Conard Fissure. Simpson (1941) showed that the remains assigned to *F. cougar* by Brown (1908) from Conard Fissure should be reassigned on basis of size and morphology to *F. longicrus*. Simpson (1941) also synonymized *F. longicrus* Brown as a junior synonym of *Felis inexpectata* Cope (1899) and showed that many of the Pleistocene puma-like felids are within the variation range of the modern puma, *F. concolor*. Kurten (1965) recognized *F. inexpectata* as a subspecies of *F. concolor* encompassing the Middle Pleistocene pumas which appear to be generally larger but otherwise identical to the Late Pleistocene and present populations. Following Kurten (1965), the Conard Fissure puma materials should be recognized as *F. concolor inexpectata*.

ACKNOWLEDGEMENTS

The writer is indebted to Dr. F.J. Svendsen and his son, John, for their help, courtesy and permission to collect the skeletal materials. Other people deserving credit for their part in collecting and/or identification of the puma are Steve Ervin, Ola Eriksson, Carol Spears, J.H. Quinn, Ray and Linda Medlock, John David McFarland III, Wayne Melton, Jim Svendsen and Walter L. Manger. The Department of Geology provided lab facilities and the University of Arkansas Museum provided supplies to support this project.

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New Distributional Records of Fishes from the Lower Ouachita River System in Arkansas

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ABSTRACT

Fishes collected from the lower Ouachita River system in Arkansas during 1971-1974 are reported. As a result of these collections six species were added to the Ouachita River system ichthyofauna of Arkansas including an undescribed species of **Notropis, Hybopsis aestivalis** (Girard), **Ictiobus bubalus** (Rafinesque), **Fundulus chrysotus** (Gunther), **Lepomis symmetricus** (Forbes) and **Etheostoma fusiforme barratti** (Holbrook). New distributional records for **Ichthyomyzon gagei** (Hubbs and Trautman), **Notropis maculatus** (Hay), **N. lutrensis** (Baird and Girard), **Erimyzon sucetta** (Lacepede), **Fundulus notti** (Agassiz) and **Lepomis marginatus** (Holbrook) within the system also are presented.

INTRODUCTION

During recent extensive field collecting in the faunistically neglected lower Ouachita River system in Arkansas, new distributional records were attained for several species not previously documented from this region and additional documentation was made for others in the system for which only one or two records were extant. This work expands and clarifies knowledge of the distribution of certain Arkansas fishes in this poorly known fish distributional region.

Within Arkansas, the upper Ouachita River system has been studied much more thoroughly than the lower reaches (Fruge, 1971; Reynolds, 1971; pers. obser.), although much work remains to be done in both areas. Buchanan (1973) included locality records from the lower Ouachita River system extracted primarily from collections housed at Northeast Louisiana University and Southern State College, in addition to a few previous literature records. Herein, the lower Ouachita River system is the area drained by the river south of Camden where the main channel has entered its lowland course. Included are its main tributaries, the Saline River and Bayou Bartholomew, in addition to all smaller streams draining directly into the main river. New distributional records thus refer only to the Arkansas portion of the Ouachita River system.

METHODS AND MATERIALS

All material is housed in the Southern State College Vertebrate Collection. Except for the Grand Marais Lake collection, all collections were made with 10- and 20-ft seines of ¼ inch mesh. Unless otherwise noted all collections were made by the writer and Southern State College students. Use of scientific and common names follows that of Bailey et al. (1970).

ACKNOWLEDGEMENTS

Appreciation is expressed to Dr. David Etnier, University of Tennessee, and his Regional Faunas class who assisted in collecting several of the new records herein and also to Dr. Bill Davis, Louisiana Tech University, who examined the *Hybopsis aestivalis* specimen. Larry Calhoun, Larry Weaver and Stephen Pelt contributed significantly to this publication with their constant enthusiasm and hard work in the field.

RESULTS AND DISCUSSION

During the period 1971-1974 fishes were collected from the incompletely studied lower Ouachita River system in Arkansas. The new distributional records from this three-year period of sampling are reported. As a result of these collections six species were added to the known Ouachita River system ichthyofauna including an undescribed species of *Notropis, Hybopsis aestivalis* (Girard), *Ictiobus bubalus* (Rafinesque), *Fundulus chrysotus* (Gunther), *Lepomis symmetricus* (Forbes) and *Etheostoma fusiforme barratti* (Holbrook). In addition new distributional records for *Ichthyomyzon gagei* (Hubbs and Trautman), *Notropis maculatus* (Hay), *N. lutrensis* (Baird and Girard), *Erimyzon sucetta* (Lacepede), *Fundulus notti* (Agassiz) and *Lepomis marginatus* (Holbrook) were established from throughout the lower Ouachita drainage.

The new distributional data on fishes in the Ouachita River system illustrate the relatively poor knowledge of this important Coastal Plain area in Arkansas. That seven of the new records came from a single site is illustrative of the potential this area holds for ichthyologists. Ongoing ichthyofaunal surveys in this area by several graduate students at Northeast Louisiana University should add greatly to knowledge of the fishes of the lower Ouachita River drainage in Arkansas.

New distributional data are provided for the following species.

Ichthyomyzon gagei Hubbs and Trautman. Southern brook lamprey.

Robison (1974a) reported the first three specimens of the southern brook lamprey collected south of the Arkansas River in the state in 1972, two of which were taken from the Ouachita River system. Additional collection yielded 36 specimens, and the status of this species was revised from uncommon occurrence in the system to fairly common, though not abundant. The following are recent collection localities of *I. gagei* in the Ouachita River system with numbers of individuals in parentheses: (1) Thomas Creek, 11.5 mi S of Malvern on Country Club Road. Secs. 21 and 22, T5S, R16W. Hot Springs Co. 9 June 1973; (15) Keisler Creek, 11.4 mi S of Malvern on Country Club Road. Secs. 15 and 16, T5S, R16W. Hot Springs Co. 9 June 1973; (1) Clear Creek, 12.5 mi S. of Malvern on Country Club Road, Sec. 23, T5S, R16W. Hot Springs Co. 9 June 1973; (13) South Fork of Saline River, ½ mi N of U.S. Hwy 70 near Nance. Sec. 18, T2S, R16W. Saline Co. 8 April 1974; (6) Ten Mile Creek at U.S. Hwy 70 bridge. Sec. 19, T2S, R16W. Saline Co. 8 April 1974.

Hybopsis aestivalis (Girard). Speckled chub.

A single specimen (25.2 mm standard length) of *H. aestivalis* was collected on 16 August 1974 in the Boeuf River (tributary of Bayou Bartholomew) at the U.S. Hwy 82 bridge (Sec. 13, T16S, R3W), 4 mi W of Lake Village, Chicot Co. It was the first reported speckled chub from the Ouachita River system in Arkansas. The specimen was a young breeding male with developed breeding tubercles on the dorsal surface of the pectoral fins. Because of the paucity of records, meristic data are presented: anal rays 8, pectorals 16, pelvics 8. The lateral line had 37 scales with 6 scales above and 5 below the lateral line. Predorsal scale rows numbered 15. The belly was scaled and two barbels, one on each side, were present. The *H. aestivalis* taxonomic problem is a complex one. According to Dr. Bill Davis (pers. comm.) who currently is studying the species throughout its range, this specimen probably should be relegated to the subspecies, *H. a. hyostomus* (Gilbert). Lack of previous records in the Ouachita River system may be due to the lack of small gravel and sand substrates throughout much of the system, excluding the Coastal Plain area where relatively little collecting has been done to date.

Notropis lutrensis (Baird and Girard). Red shiner.

Surprisingly, until now the only record of the red shiner from the entire southeastern part of Arkansas was of two adults collected in 1938 from Caney Creek (tributary of Bayou Bartholomew), 1 mi N of Star City, Lincoln Co. (Black, 1940). Nine large collections in the Coastal Plain in June 1974 established *N. lutrensis* as the dominant cyprinid in most streams east of the Saline River including Bayou Macon, Boeuf River and Bayou Bartholomew. In many instances, *N. lutrensis* proved to be the dominant species in these sluggish, silt-laden streams.

Because *N. lutrensis* is primarily a Great Plains cyprinid species which extends eastward down the Arkansas River, Black (1940) explained its presence as probably an introduction from a flood connection of Bayou Bartholomew and the Arkansas River. In its extreme headwaters Bayou Bartholomew comes within 8 mi of the Arkansas River. However, Black (1940) was attempting to explain the presence of only two specimens. Further collecting undoubtedly would have shown *N. lutrensis* to be much more abundant. As Bayou Bartholomew once was a channel of the Arkansas River, *N. lutrensis* probably has long been an inhabitant. Entry into Bayou Bartholomew and surrounding areas also undoubtedly has taken place several times as flood connections occurred regularly between the Mississippi River (where *N. lutrensis* is common) and these drainages before levee construction.

Although Douglas (1974) did not show *N. lutrensis* in any of the aforementioned drainages in Louisiana, recent collections of this species at Monroe, Louisiana, in the main Ouachita River (N. H. Douglas, pers. comm.) suggest that it should be expected in the lower Ouachita River proper in Arkansas.

Notropis maculatus (Hay). Taillight shiner.

The taillight shiner was regarded as rare in Arkansas by Robison (1974b), Black's (1940) record of two young specimens from the Saline River being the only documentation of this species in the Ouachita River system. Reynolds' (1971) subsequent survey of the fishes of the Saline River did not reveal *N. maculatus*. While conducting a fish population sample of Grand Marais Lake, an oxbow of the Ouachita River near Huttig, Union Co., on 5 August 1974, the writer and John Cloud of the Arkansas Game and Fish Commission took five specimens of *N. maculatus* in breeding color by use of rotenone. *N. maculatus* also has been collected several times from a backwater area (Sec. 2, T16S, R14W) of the Ouachita River along U.S. Hwy 167, 12 mi SW of Hampton, Calhoun Co.

Notropis sp.

Discovery of this new undescribed species of *Notropis* from the lower Ouachita River drainage has further intensified the collecting effort directed at southward flowing streams draining into the Ouachita River proper. This very distinctive new *Notropis* is being described by Dr. Reeve M. Bailey, University of Michigan, and the writer.

To date 75 individuals have been collected from Locust Bayou (=Creek) near the town of Locust Bayou in Calhoun Co. As the description of this unreported cyprinid is in progress, no additional comments will be made at present.

Erimyzon sucetta (Lacepede). Lake chubsucker.

Only one record of the lake chubsucker was recorded previously from the Ouachita River system from Lapile Creek, 4 mi E of Strong, Union Co. (Black, 1940). Three additional records are documented herein. The first is of three young of the year specimens from the backwaters (Sec. 2, T16S, R14W) of the Ouachita River along U.S. Hwy 167, 12 mi SW of Hampton, Calhoun Co., collected on 23 May 1974; the second is of two specimens from a small, shallow, weed-choked pool (Sec. 36, T13S, R9W) along State Hwy 8, approximately 5 mi S of the junction of State Hwys 8 and 4, Bradley Co., on 23 May 1974. This site is part of the Saline River drainage. A third series of three specimens was taken from Big Cornie Creek, 5 mi E of Magnolia at U.S. Hwy 82, Columbia Co. (Sec. 17 and 20, T17S, R19W) on 20 November 1971. Dr. Etnier and class assisted in the first two collections.

Reynolds (1971) reported *Erimyzon oblongus* (Mitchell) but no *E. sucetta* in his survey of the fishes of the Saline River. The writer also has taken *E. oblongus* in the main Saline River. Though several of the specimens were small juveniles, identification was not difficult because of the characteristic darkened caudal spot and uniform dark lateral band. Juvenile specimens also tended to have a slight reddish wash to the caudal fin. Subsequent collecting at the Ouachita backwater and Saline River site has yielded additional specimens.

Ictiobus bubalus (Rafinesque). Smallmouth buffalo.

Inexplicably the common smallmouth buffalo had not been documented from the Ouachita River system although local fishermen confirm its presence throughout the system. Buchanan (1973) did not indicate *I. bubalus* in the system, nor did Reynolds (1971) indicate its presence from the Saline River, nor did Fruge (1971) record it in his survey of the Caddo River fishes.

Eighteen specimens of the smallmouth buffalo were collected during a fish population sample on Grand Marais Lake near Huttig, Union Co., on 5 August 1974 under the auspices of John Cloud of the Game and Fish Commission. Lateral-line scales in 14 individuals ranged from 36 to 39 with a mean of 37.7. *I. bubalus* proved to be the dominant catostomid collected in the oxbow lake locality and only four specimens of *I. cyprinellus* (Valenciennes) were taken.

Lepomis marginatus (Holbrook). Dollar sunfish.

A single record for *L. marginatus* in the Ouachita system was given by Black (1940). Buchanan (1973) showed only one record after 1960. The post-1960 record is of two adult specimens collected by the writer from Big Cornie Creek at U.S. Hwy 82 bridge (Sec. 17 and 20, T17S, R19W) on 21

November 1971. New records for the dollar sunfish from collections made in lower Big Cornie Creek (Sec. 3, T18S, R19W) in Columbia Co., the Ouachita River backwater locality previously mentioned in Calhoun Co. and the Saline River drainage roadside pool in Bradley Co. established *L. marginatus* as an uncommon inhabitant of the lower Ouachita system. Confusion with the very similar *L. megalotis* (Rafinesque) might explain the lack of previous records, although paucity of collections is probably the prime reason.

Lepomis symmetricus Forbes. Bantam sunfish.

The bantam sunfish is uncommon in Arkansas and had been collected only once in the Ouachita River system by the writer from Big Cornie Creek at U.S. Hwy 82 in Columbia Co. The second collection of four *L. symmetricus* was taken on 23 May 1974 by the writer, D. A. Etnier and the U. T. Regional Faunas class from a roadside pool of the Saline River drainage (Sec. 36, T13S, R9W) in Bradley Co. The fish had spawned recently as depressions in the mud and leaf litter substrate were filled with numerous eggs. A third collection of three individuals was made on 16 August 1974 from the Ouachita River backwater area along U.S. Hwy 167 (Sec. 2, T16S, R14W), 12 mi S of Hampton, Calhoun Co.

Fundulus chrysotus (Gunther). Golden topminnow.

The five collections of the golden topminnow reported herein taken from the lower Ouachita River system are the first recorded from the entire system. The first two specimens of *F. chrysotus* collected from the system were taken from Big Cornie Creek, Columbia, Co., near the Arkansas-Louisiana state line in 1971. Additional collections include a single specimen from Holmes Creek, a tributary of Smackover Creek, in Smackover, Union Co., on 12 August 1973; three specimens from a backwater pool of the Ouachita River, 12 mi SW of Hampton, Calhoun Co., on 23 May 1974 along U.S. Hwy 167; four specimens from a roadside ditch on State Hwy 8, 5 mi S of junction of State Hwys 8 and 4 on the same date; and two specimens from Two Bayou Creek, 12 mi W of Hampton at State Hwy 4 bridge on 6 October 1974. Additional specimens have been collected on subsequent trips.

Fundulus notti (Agassiz). Starhead topminnow.

Only two records were known from the Ouachita River system, both from the upper part. Specimens reported herein from the lower Ouachita River system include two specimens of *F. notti* from the backwater area of the Ouachita River along U.S. Hwy 167 on 23 May 1974; and three specimens from a weed-choked roadside ditch (Saline River drainage) on State Hwy 8, 5 mi S of the junction of State Hwys 8 and 4 on 23 May 1974. Both sites were visited again on 16 August 1974 when four specimens were taken from the Ouachita site and 76 specimens were collected from the Saline River drainage site. In addition seven specimens were collected on 6 October 1974 from Locust Bayou at the State Hwy 4 bridge, Calhoun Co.

Populations of *F. notti* in the Ouachita River drainage are similar to the more northern populations of *F. notti dispar* as recognized by Brown (1958) and probably will be elevated to specific status after a more thorough study on the *F. notti* complex is completed (Edward Wiley, pers. comm.).

Etheostoma fusiforme barratti (Holbrook). Scaleyhead darter.

Robison (1974b) listed the scaleyhead darter as rare in Arkansas with only two localities known in the state. *E. fusiforme* never previously had been taken from the Ouachita River system. The first specimens, one adult and four juveniles, were collected from a backwater area of the main Ouachita River along U.S. Hwy 167, 12 mi S of Hampton, Calhoun Co. on 23 May 1974 by the writer, D.A. Etnier and the U. T. Regional Faunas class. The habitat was approximately 6-8 inches deep with a mud and sand bottom covered with dead and decaying leaves, fallen limbs and sticks. The site was visited four times subsequently and 21 additional specimens were taken.

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Arkansas Butterflies and Skippers

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ABSTRACT

Since 1955 the writer has been compiling information on Arkansas butterflies and skippers. A list of species is presented from data obtained from personal collecting, extensive contacts with contemporary collectors, and a concerted literature search. A total of 151 species are listed on a chart which also shows from which of five designated areas in the state each species has been reported.

In 1893 The Rev. John Davis, after a "somewhat diligent canvass of the suburbs of Little Rock," reported collecting 30 species of butterflies (Davis, 1894). There have been few other published reports on Arkansas butterflies—none of a comprehensive nature for the state as a whole. A regional list for Northeast Arkansas by Masters (1967) and, earlier, lists of Hesperiidae (1945) and Theclinae (1951) by H. A. Freeman and a short list by Rowley (1892) constitute the known published lists. The writer has been collecting in Arkansas, mainly in the northwest, since 1955 and has kept records not only of personal findings but also of those of contemporary collectors contacted and those found in a diligent search of the literature. The current list contains names of 151 species and is short by an estimated 8-10 species that are likely to be found eventually.

Topographically the two main features of Arkansas are the forest highlands of the northwest "half" triangle of the state and the flatlands of the southeast "half" triangle of the state. The forest highlands are bisected by the Arkansas River which runs west to east between the Ozark Highlands on the north and the Ouachita Mountains on the south. Elevation of the highlands ranges upward from 140 m (450 ft) in the Arkansas River Valley to peaks of about 850 m (2800 ft). The flatlands are separated conveniently into the Gulf Coastal Plains on the south and southwest, and the Mississippi Alluvial Plains and Terraces of the eastern "third" of the state along the Mississippi River. Elevation of these areas is mostly from 65 to 90 m (200-300 ft) above sea level. Thus, Arkansas can be divided into five areas which coincide in a general way with the major physiographic, soil and vegetation regions of the state (Dale, 1963; see map, Fig. 1). The northern forests, the Ozarks, are mainly the upland oak-hickory type with some pine. The southern forests, in part the Ouachitas but also the Gulf Coastal Plains, are composed largely of oak-pine or pine woods. The Mississippi Alluvial Plains and Terraces region is mainly cultivated with rice, cotton, soybeans and other crops which have largely supplanted the native vegetation of pine, oak-pine and bottomland oak-gum-cypress woods. The northwest, west and southeast sections of the state are dotted with once-designated prairies, some of which still retain the prairie features of vegetation, hardpan soil and absence of trees (Armstrong and Moore, 1957; Ruby, 1953; and Wackerman, 1929). Thus, the state has a wide variety of habitats and they are reflected in a varied spectrum of insects. The main body of the lepidoptera fauna is characteristically that of the so-called Appalachian subregion, but in Arkansas is considerably overlaid with essentially southern and southwestern species.

Resident collectors in the state have been relatively very few, and therefore much of the state still has not been well collected. The most intensive collecting has been in the northeast, northwest, southwest, and central parts of the state; only the southeast is relatively unaccounted for. Even there, however, the scattered records can be augmented by accurate extrapolative inferences based on other known Arkansas records and those of adjacent Mississippi (Mather and Mather, 1958, 1959) and Louisiana (Lambremont, 1954; Lambremont and Ross, 1965; Ross and Lambremont, 1963). Because records are from widely separated and strategically located areas, the present list is a fairly comprehensive one for the whole state.

On the accompanying list (Table I), the species of butterflies and skippers of Arkansas are presented and numbered in order according to dos Passos' synonymic list (dos Passos, 1964, 1965) and its revisions of the Melitaeinae (dos Passos, 1969) and the Lycaenidae (dos Passos, 1970). Other modifications have been incorporated for certain name changes and recognition of specific status of some heretofore designated

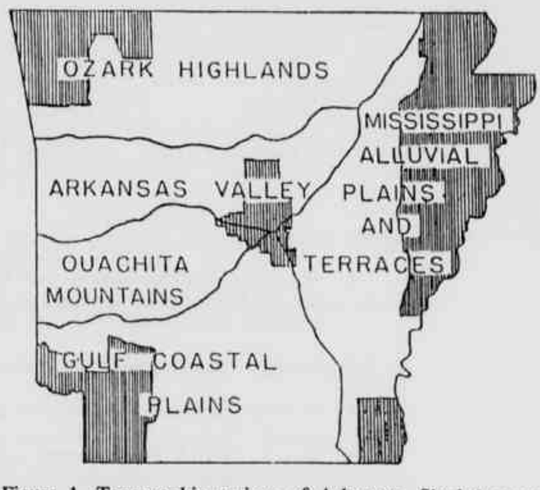

Figure 1. Topographic regions of Arkansas. Shaded areas correspond to counties from which butterfly and skipper records are shown in Table I. (From Dale, 1963, whose permission to use is gratefully acknowledged.)

This article is taken from a report by the writer which has been accepted for publication in the Mid-Continent Lepidoptera Series (Paulissen, 1975). It was thought desirable to give the material statewide circulation by publishing it in the *Proceedings*.

Table I. List of Butterfly and Skipper Species Found in Designated Areas of Arkansas. Numbers correspond to dos Passos' synonymic list (1964) including revisions (1965, 1969, 1970). Certain verified subspecific designations have been included.

Species	NW	NE	CEN	SW	SE	EX
MEGATHYMIDAE						
13 *Megathymus yuccae* (Boisduval & Le Conte)						1
HESPERIIDAE						
Hesperiinae						
24 *Panoquina ocola* (Edwards)	x	x	x	x	e	
27 *Calpodes ethlius* (Stoll)		x	x		e	
29 *Lerodea eufala* (Edwards)	x	x	x	x	e	
34 *Amblyscirtes linda* H. A. Freeman	x	x	x			
37 *Amblyscirtes samoset* (Scudder)	x		x			
40 *Amblyscirtes aesculapius* (Fabricius)	x				e	
43 *Amblyscirtes nysa* Edwards	x					2
45 *Amblyscirtes vialis* (Edwards)	x	x	x	x	e	
46 *Amblyscirtes belli* H. A. Freeman	x	x	x	x	e	
47 *Amblyscirtes alternata* (Grote & Robinson)				x	e	
50 *Atrytonopsis hianna* (Scudder)	x			x	e	
62 *Euphyes alabamae* (Lindsey)			x	x	e	
63 *Euphyes dukesi* (Lindsey)			x	x	e	
67 *Euphyes vestris metacomet* (Harris)	x	x	x	x	e	
73 *Poanes hobomok* (Harris)	x		x			
74 *Poanes zabulon* (Boisduval & Le Conte)	x	x	x			
77 *Poanes yehl* (Skinner)	x			x	e	
78 *Poanes viator* (Edwards)						3
83 *Problema byssus* (Edwards)	x					
86 *Atrytone delaware delaware* (Edwards)	x	x	x			
87 *Atalopedes campestris* (Boisduval)	x	x	x	x	e	
88 *Pompeius verna sequoyah* (H. A. Freeman)		x	x	x	e	
89 *Wallengrenia otho* (Smith)	x	x	x	x	e	
89 *Wallengrenia egeremet* (Scudder)	x		x		e	
90 *Polites coras* (Cramer)	x	x				
95 *Polites themistocles* (Latreille)	x	x	x	x	e	
96 *Polites origines origines* (Fabricius)	x		x	x	e	
99 *Polites vibex* (Geyer)			x	x	e	
101 *Hesperia metea licinus* (Edwards)	x		x	x	e	
115 *Hesperia meskei* (Edwards)		x	x			
117 *Hesperia leonardus* Harris	x		x			
122 *Hylephila phyleus* (Drury)	x	x	x	x	e	
125 *Copaeodes aurantiaca* (Hewitson)			x			
126 *Copaeodes minima* (Edwards)			x	x	e	
130 *Ancyloxypha numitor* (Fabricius)	x	x	x	x	e	
134 *Lerema accius* (Smith)	x	x	x	x	e	
137 *Nastra lherminier* (Latreille)	x	x	x	x	e	
Pyrginae						
148 *Pholisora catullus* (Fabricius)	x	x	x	x	c	
161 *Pyrgus communis* (Grote)	x	x	x	x	e	
162 *Pyrgus oileus* (Linnaeus)			x		e	
163 *Erynnis icelus* (Scudder & Burgess)	x					
164 *Erynnis brizo* (Boisduval & Le Conte)	x	x	x	x	e	
165 *Erynnis persius* (Scudder)		x				
167 *Erynnis baptisiae* (Forbes)	x		x			
168 *Erynnis zarucco* (Lucas)		x				
168 *Erynnis funeralis* (Scudder & Burgess)	x		x	x		
169 *Erynnis martialis* (Scudder)	x		x	x	e	
173 *Erynnis horatius* (Scudder & Burgess)	x	x	x	x	e	
174 *Erynnis juvenalis* (Fabricius)	x	x	x	x	e	
181 *Achlyodes thraso* (Hübner)	x					
188 *Staphylus hayhursti* (Edwards)	x	x	x	x	e	
193 *Cogia outis* (Skinner)	x					4
200 *Thorybes bathyllus* (Smith)	x	x	x	x	e	
201 *Thorybes pylades* (Scudder)	x	x	x	x	e	
204 *Thorybes confusis* Bell	x	x	x	x		
207 *Achalarus lyciades* (Geyer)	x	x	x	x	e	
211 *Autochton cellus* (Boisduval & Le Conte)	x	x				
217 *Urbanus proteus* (Linnaeus)			x			
236 *Epargyreus clarus* (Cramer)	x	x	x	x	e	
PAPILIONIDAE						
Papilioninae						
246 *Battus philenor* (Linnaeus)	x	x	x	x	x	
247 *Battus polydamas* (Linnaeus)		x				5
248 *Papilio polyxenes* Fabricius	x	x	x	x	e	
24 *Papilio joanae* J. R. Heitzman	x					
256 *Papilio cresphontes* Cramer	x	x	x	x	e	
262 *Papilio glaucus* Linnaeus	x	x	x	x	e	
267 *Papilio troilus* Linnaeus	x	x	x	x	x	
268 *Papilio palamedes* Drury			x		e	
269 *Eurytides marcellus* (Cramer)	x	x	x	x	x	
PIERIDAE						
Pierinae						
274 *Appias drusilla* (Cramer)	x					
277 *Pieris protodice* Boisduval & Le Conte	x	x	x	x	x	
280 *Pieris rapae* (Linnaeus)	x	x	x	x	x	
281 *Ascia monuste* (Linnaeus)			x			
Coliadinae						
286 *Colias eurytheme* Boisduval	x	x	x	x	x	
287 *Colias philodice* Godart	x	x	x	x	x	
299 *Colias cesonia* (Stoll)	x	x	x	x	x	
302 *Phoebis sennae eubule* (Linnaeus)	x	x	x	x	x	
303 *Phoebis philea* (Johansson)		x				
305 *Phoebis agarithe* (Boisduval)	x		x			
310 *Eurema daira* (Godart)			x		e	
312 *Eurema mexicana* (Boisduval)	x		x			
315 *Eurema lisa* Boisduval & Le Conte	x	x	x	x	x	
319 *Eurema nicippe* (Cramer)	x	x	x	x	x	
320 *Nathalis iole* Boisduval	x	x	x	x	x	
Euchloeinae						
323 *Anthocaris midea* Hübner	x	x	x	x	e	
329 *Euchloe olympia* (Edwards)	x		x			
RIODINIDAE						
Riodininae						
343 *Calephelis muticum* (McAlpine)	x					

1. *M. yuccae*. Until recently, the only known specimen from Arkansas was one captured by Mr. D. Paxon in his backyard in Ft. Smith in April 1940 (pers. comm.). A second specimen was collected in Nevada County in 1973 by Ed Gage (1974).

2. *A. nysa*. The only record is in Field (1938, p. 265) for Carroll County.

3. *P. viator*. Ed Gage (1974) reported taking specimen in Lafayette County in 1973.

4. *C. outis*. Taken by H.A. Freeman in Sharp County, north central Arkansas (*in litt.*) and by J.R. Heitzman at Eureka Springs, Carroll County, in northwest Arkansas (*in litt.*).

	NW	NE	CEN	SW	SE	EX
LYCAENIDAE						
Theclinae						
355 *Harkenclenus titus* (Fabricius)	x	x	x			
361 *Satyrium liparops* (Le Conte)	x		x	x		
362 *Saturium kingi* (Klots & Clench)						6
363 *Satyrium calanus* (Hübner)	x	x	x	x		
364 *Saturium caryaevorus* (McDunnough)	x					
365 *Saturium edwardsii* (Saunders)	x	x	x			
379 *Calycopis cecrops* (Fabricius)	x	x	x	x	e	
383 *Callophrys irus* (Godart)			x	x		
384 *Callophrys henrici* (Grote & Robinson)	x	x	x	x	e	
388 *Callophrus niphon* (Hübner)	x	x	x	x	e	
394 *Callophrus gryneus* (Hübner)	x	x	x		e	
408 *Atlides halesus* (Cramer)	x		x	x	e	
412 *Euristrymon ontario* (Edwards)	x		x	x		
414 *Panthiades m-album* (Boisduval & Le Conte)	x		x	x	e	
417 *Strymon melinus* Hübner	x	x	x	x	x	
Gerydinae						
429 *Fenesica tarquinius* (Fabricius)	x		x		e	
Lycaeninae						
433 *Lycaena thoe* Guérin-Méneville		x				
443 *Lycaena phlaeas* (Linnaeus)	x	x	x			
Plebejinae						
446 *Brephidium exilis* (Boisduval)	x		x			
448 *Leptotes cassius* (Cramer)				x		
449 *Leptotes marina* (Reakirt)	x		x			
453 *Hemiargus isola* (Reakirt)	x	x	x	x	e	
469 *Everes comuntas* (Godart)	x	x	x	x	x	
479 *Glaucopsyche lygdamus* (Doubleday)	x			x		
481 *Celastrina argiolus* (Linnaeus)	x	x	x	x	x	
LIBYTHEIDAE						
Libytheinae						
482 *Libytheana bachmanii* (Kirtland)	x	x	x	x	e	
NYMPHALIDAE						
Charaxinae						
484 *Anaea andria* Scudder	x	x	x	x	e	
Apaturinae						
492 *Asterocampa celtis* (Boisduval & Le Conte)	x	x	x	x	e	
494 *Asterocampa clyton* (Boisduval & Le Conte)	x	x	x	x	e	
Eurytelinae						
502 *Mestra amymone* (Ménétriés)				x		7
Limenitidinae						
517 *Limenitis astyanax* (Fabricius)	x	x	x	x	e	
518 *Limenitis archippus* (Cramer)	x	x	x	x	x	
Vanessinae						
527 *Vanessa atalanta* (Linnaeus)	x	x	x	x	x	
528 *Cynthia virginiensis* (Drury)	x	x	x	x	x	
529 *Cynthia cardui* (Linnaeus)	x	x	x	x	x	
531 *Junonia coenia* (Hübner)	x	x	x	x	x	
Nymphalinae						
535 *Numphalis milberti* (Godart)						8
536 *Numphalis antiopa* (Linnaeus)	x	x	x	x	e	
537 *Polugonia interrogationis* (Fabricius)	x	x	x	x	x	
538 *Polugonia comma* (Harris)	x	x	x		e	
546 *Polugonia progne* (Cramer)	x	x	x			
Melitaeinae						
548 *Chlosyne nycteis* (Doubleday)	x	x	x	x	e	
549 *Chlosyne gorgone* (Hübner)	x	x	x	x	e	
563 *Phuciodes texana* (Edwards)	x					
566 *Phyciodes tharos* (Drury)	x	x	x	x	x	
568 *Phyciodes phaon* (Edwards)	x	x	x	x	e	
592 *Euphydryas phaeton ozarkae* Masters	x					
Argynninae						
611 *Speyeria idalia* (Drury)	x		x			
621 *Speyeria diana* (Cramer)	x		x	x	e	
622 *Speyeria cybele* (Fabricius)	x		x			
624 *Euptoieta claudia* (Cramer)	x	x	x	x	x	
Heliconiinae						
626 *Heliconius charitonius* (Linnaeus)	x					
628 *Dryas julia* (Fabricius)			x			
630 *Agraulis vanillae* (Linnaeus)	x	x	x	x	e	
DANAIDAE						
Danainae						
631 *Danaus plexippus* (Linnaeus)	x	x	x	x	x	
633 *Danaus gilippus strigosus* (Bates)			x			9
SATYRIDAE						
Lethinae						
636 *Lethe portlandia missarkae* J. R. Heitzman & dos Passos	x					
636 *Lethe anthedon* (Clark)	x		x			
637 *Lethe creola* (Skinner)	x		x			
Satyrinae						
639 *Euptychia gemma* (Hübner)	x	x	x	x	e	
643 *Euptuchia areolata* (Smith)				x	e	
645 *Euptuchia hermes sosybius* (Fabricius)	x	x	x	x	e	
646 *Euptuchia cymela* (Cramer)	x	x	x	x	x	
656 *Cercyonis pegala* (Fabricius)	x		x	x		

x = present or reported
e = expected

5. *B. polydamas*. Reported for north central Arkansas (Masters, 1976) and for Hot Springs, Garland County, central Arkansas, by Renie Mallory (*in litt.*).

6. *S. kingi.* Malcolm Douglas (*in litt.*) reported collecting specimen near Sheridan, Grant County, in 1974.

7. *M. amymone*. Five specimens were taken south of Texarkana, Miller County, in southwest Arkansas by Masters (1970).

8. *N. milberti.* Reported from near Harrison, Arkansas, before the 1930's (Masters, *in litt.*).

9. *D. gilippus*. Besides being reported for central Arkansas by H.A. Freeman (*in litt.*), it also was taken at Ft. Smith by D. Paxon during the drouthyearsof the 1930's (pers. comm.). In 1972 Randy Lewis collected specimens near the Arkansas River south of Alma.

"subspecies." Name changes include *Eurytides* in place of *Graphium* (Munroe, 1960), *Calephelis* for *Lephelisca* (McAlpine, 1971) and *Cynthia* for *Vanessa* (Field, 1971). Specific status is recognized for *Euphyes alabamae* (Shapiro, 1970), *Erynnis funeralis* (Burns, 1964) and *Lethe anthedon* (Heitzman and dos Passos, 1974). The table also shows which species are found in each of the five separate areas of the state. The northwest area comprises Benton, Carroll and Washington Counties; the records are derived mainly from those of the writer with a significant contribution from those of the Heitzmans. The northeast comprises Clay, Craighead, Crittenden, Cross, Greene, Lee, Mississippi, Phillips, Poinsett and St. Francis Counties; the records mostly were supplied by J.H. Masters (1967, *in litt.*) but also include those from the late Otis Hite and Dr. Maxine (Hite) Manley (*in litt.*). The central section comprises Faulkner and Pulaski Counties; records are mostly from H.A. Freeman (1945, 1951, *in litt.*) but also include those from Dr. John Redman (*in litt.*). The southwest section comprises Hempstead, Lafayette, Little Rock and Miller Counties; records are derived almost entirely from those of Fay Karpuleon (*in litt.*). These areas are shaded on the map (Fig. 1). The southeast area listings are derived from actual but scattered records and extrapolations from Arkansas, Mississippi and Louisiana records. These inferred records are designated by "e" on the chart. A sixth column denotes individual and unusual species collected elsewhere in the state. The totals for each area, 122 for the northwest, 88 for the northeast, 119 for the central, 91 for the southwest and estimated 91 for the southeast, reflect the fairly extensive and concentrated coverage of these separate areas.

One other area of the state has been well collected and deserves notice—the Batesville area in Independence County where Dr. Veryl Board reports collecting more than 60 species. This area would be within the northeast quadrant if the state were simply divided into quarters; actually it does not belong with the area designated Mississippi Alluvial Plains and Terraces but rather with the Ozark Highlands region. Therefore it was not included in the report for the northeast area. Some species collected by Board are absent from reports for the northeastern counties.

Species which are anticipated to be found in the state eventually include *Atrytone arogos, Kricogonia lyside, Calephelis virginiensis, Calycopis beon, Phaeostrymon alcestis* and *Lycaena xanthoides.* Besides these, because of the proximity to Texas which at times is invaded by tropical and subtropical species from Mexico, strays from these areas would be expected, especially during widespread or prolonged hurricane activity. In the hurricane year 1968, for example, *Ascia monuste* and *Dryas julia* were reported from Little Rock, and in 1971 *Phoebis agarithe* and *Appias drusilla* were found in northwest Arkansas.

ACKNOWLEDGEMENTS

As with all lists of this kind, many people and their contributions make it possible. Those to whom the most debt is owed are Dr. Veryl Board, H.A. Freeman, J.R. Heitzman, Fay Karpuleon, J.H. Masters, Bryant Mather and Dr. John Redman. The writer also is indebted to the following for their help, records and interest: Richard Brown, Malcolm Douglas, Ruth Eason, John Fuller, Ed Gage, A.W. Haddox, William Howe, Otis Hite, Maxine (Hite) Manley, Randy Lewis, Renie Mallory, D. Paxon, Kilian Roever, E. Phil Rouse, Charles Selman, Gerald Straley and Gerald Wallis. Last, but most important, the writer is very grateful for the constant help and companionship of his sons in the field and his wife's forbearance, without either of which this study would have fallen far short.

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Pole Stars of Other Planets

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ABSTRACT

The north celestial pole of the Earth and the other planets is discussed. Right ascension and declination information on the location of the poles on the celestial sphere is summarized. The name of the brightest visible star near each pole is given and the special case of Uranus is discussed.

While Earth moves slowly in its orbit around the sun, it spins on an axis pointing constantly almost exactly to the star at the end of the Little Dipper called Polaris, or the North Star. As viewed from the rotating Earth, all of the stars except Polaris move across the sky, making trails on time exposure photographs.

If we were to move about in the solar system we would see the same sky patterns because the distances traveled would be really very small in comparison with the distances between the stars; but if we should travel to another planet, an interesting question would be, "What is the pole star of this planet, or is there a star on or near its celestial pole?" Table I summarizes the coordinates of the poles of the planets (Sturms, 1971).

In fact it is safe to say that the pole and the pole star, if the particular planet has a bright pole star, for all the planets should be somewhere on the star patterns not very far from the ecliptic pole or fairly close to the precessional path of Earth's spin axis; for all except Uranus. We will return to this interesting point later. Figure 1 shows the circle along which the celestial pole of Earth will move and also has points numbered to show the approximate location of the celestial poles of the other planets except Uranus. It will be noted that the pole of Saturn is nearer to Polaris than the pole of any other planet.

If we could move to Venus or Jupiter, the point directly above the equivalent pole (2 and 5) would be near the ecliptic pole (Fig. 1) because their orbits lie close to the ecliptic plane defined by the Earth's orbit and their spin axes are very nearly perpendicular to their respective orbits. Point 2 in Figure 1 for the planet Venus is actually the south celestial pole of the planet because of its retrograde rotation.

The planet Mars is tilted so that its north pole (4) points to a part of the sky not far from the bright star Deneb, the head of the Northern Cross, the tail of Cygnus the Swan. Cepheus is on one side of the Martian celestial pole and Cygnus is on the other. Indications are that, because of precession, the polar axis will point even more closely to the bright star Deneb in a few hundred years.

If we Earth people could wait around for a long time (about 10,000 years) the bright star Vega in Lyra would be near our North Pole, producing a beautiful north star for Earth inhabitants. Cygnus and Aquila and Hercules and the Head of Draco would then move as circumpolar objects around Vega.

All the polar axes of the planets point to the same general region of the sky, except the polar axis of Uranus. This planet "lies down" and spins with its axis very close to the plane of its orbit. In fact, the north pole of Uranus points to the head of Orion so that the stars of Orion, Taurus, Auriga, Gemini and Canis Minor would be prominent circumpolar objects (Fig. 2).

Based in part on materials developed by the author for a University of Arkansas Planetarium script, March 1975.

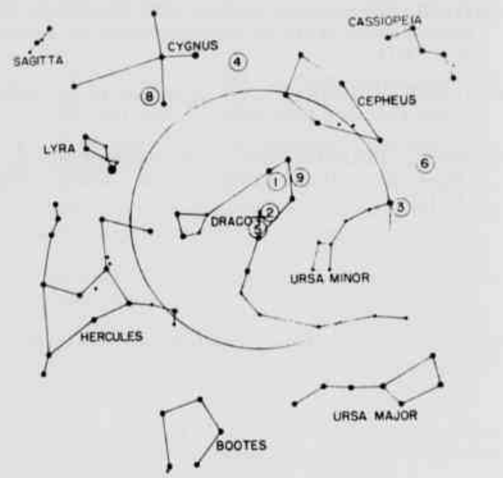

Figure 1. Numbers identify approximate locations of celestial poles of planets. Ecliptic pole is identified by + near the center of illustration.

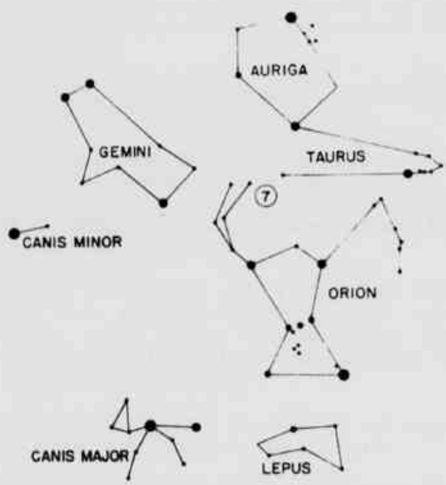

Figure 2. North circumpolar region for planet Uranus. Number identifies approximate location of celestial pole of Uranus.

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Table I. North Celestial Poles of the Planets (see Sturms, 1971)

1. MERCURY 18.7 hrs 61.4°.
   About 3° from the 4th magnitude star omicron-Draconis, in the direction of Polaris.
2. VENUS 18.5 hrs 69.0°.
   Near phi-Draconis. Actually the south celestial pole as Venus rotates retrograde.
3. EARTH
   Pole now within 1° of Polaris and will be at its nearest point, slightly less than ½°, about the year 2100.
4. MARS 21.2 hrs 53°.
   Will be near Deneb in the future.
5. JUPITER 17.9 hrs 64.6°.
   Near the ecliptic pole, a few degrees from zeta-Draconis. South celestial pole of Venus is also near the ecliptic pole as both Jupiter and Venus spin with their axes nearly perpendicular to their obital planes.
6. SATURN 2.6 hrs 83.3°.
7. URANUS 5.1 hrs 14.9°.
   Axis "lies down," nearly in the orbital plane; points to region of Orion's head just south of the ecliptic.
8. NEPTUNE 19.7 hrs 41.5°.
   Within about 3° of 2nd magnitude star delta-Cygni.
9. PLUTO 19 hrs 63.9°.
   Within a few degrees of delta-Draconis.
10. SUN 19.07 hrs 63.8°.

Some New or Otherwise Noteworthy Plants of the Arkansas Flora

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ABSTRACT

During the last several years interesting additions have been made to the holdings of the University of Arkansas Herbarium at Fayetteville. A list of 24 species of vascular plants, new or rare in Arkansas, is presented. Many of these were collected by the second author during research for his Master's degree. Several were collected by Marie P. Locke, Pine Bluff, Arkansas.

During the last several years, representative specimens of a number of new or rare species collected in Arkansas have been deposited in the Herbarium at the University of Arkansas, Fayetteville. Many of these have not been reported from the state in earlier catalogs of the state flora (Branner and Coville, 1891; Buchholz and Palmer, 1926; Demaree, 1943), and it seems worthwhile to call them to the attention of other botanists of the area.

In the following list, dicots are listed first followed by monocots; the families, genera and species are listed alphabetically. Voucher specimens are on file in the U. of A. Herbarium at Fayetteville.

DICOTS

Amaranthaceae

Amaranthus palmeri S. Wats.
Baxter Co.; by a small creek running through Mt. Home, ¼ mi S of Holiday Inn on Hwy 62. B. L. Lipscomb 190; Sept. 22, 1974. This is a western species, rare in Missouri (cf. Steyermark, 1963).

Capparidaceae

Polanisia dodecandra (L.) DC. subsp. *dodecandra* var. *dodecandra*
Marion Co.; by Rush Creek, at Rush, S of Yellville about 18 mi. B. L. Lipscomb 191; Sept. 28, 1974. This is the variety with smaller flowers [var. *trachysperma* (T. & G.) Iltis has larger flowers]. Steyermark (1963) includes Arkansas in its range, but on the basis of the Herbarium at Fayetteville the variety is previously known in the state only from Washington County.

Compositae

Bidens vulgata Green
Baxter Co.; by small creek across Hurst Road, 5 mi from jct with Hwy 62, vicinity of Cotter. B. L. Lipscomb 199; Oct. 26, 1974. A species similar to *B. frondosa* L., but with more numerous outer phyllaries and large achenes; listed by Smith (1973) as to be expected in Arkansas.

Prenanthes serpentaria Pursh
Grant Co.; Red Cockaded Woodpecker Sanctuary, SE of Sheridan. M. P. Locke 1179; Sept. 18, 1973. Also found in **Jefferson Co.;** near Hazel and Monticello Streets, Pine Bluff. M. P. Locke 1194; Sept. 24, 1973. This is an eastern U.S. species (cf. Radford et al., 1968), similar to *P. crepidinea* Michx. but with smaller heads and coarsely lobed leaves.

Cruciferae

Alliaria petiolata (Bieb.) Cavara & Grande (incl. *A. officinalis* Andrz. ex DC.)
Benton Co.; rare in loam at edge of field, 2.1 mi NW of jc Ark. 102 and 59, then 1.3 mi N. J. Test XIII-1-14; March 30, 1972. This species is not listed by Steyermark (1963), but is present in NE Kansas (Barkley, 1968) and parts of the eastern U.S. and Canada (Gleason, 1963).

Alyssum alyssoides L.
Marion Co.; first collected by D. M. Moore in small park about 1 mi NW of Yellville, April 6, 1973; later collected in fruit and identified by D. M. Moore and E. B. Smith, May 30, 1973. Fernald (1950) listed this species from eastern Canada, northeastern U.S. and California; Steyermark (1963) did not list it. It is the smallest of our yellow-flowered species of Cruciferae and has dense stellate pubescence.

Thlaspi perfoliatum L.
Benton Co.; common in back yard, 1416 W. Cypress, Rogers. G. Bradford 1; March 7, 1970. Also in **Washington Co.;** rich bottomland S of bridge over West Fork of White River, S of Greenland. R. Thompson 36; March 28, 1972. This largely northeastern U.S. species (cf. Radford et al., 1968; Steyermark, 1963) recently has been reported in Oklahoma (Magrath and Weedon, 1974).

Hypericaceae

Hypericum gymnanthum Engelm. & Gray
Fulton Co.; near very large pond, 1 mi W of Viola. B.L. Lipscomb 201; Sept. 29, 1974. Steyermark (1963) included Arkansas in the range of this species, but this is the first Arkansas record of it in the Herbarium at Fayetteville. Gary Tucker (pers. comm.) reports that the SMU Herbarium has a collection from **Dallas Co.** (Demaree 52552).

Labiatae

Mentha cardiaca Gerarde
Baxter Co.; along White River next to city park in Cotter. B.L. Lipscomb 193; Sept. 8, 1974. This is another north-eastern U.S. species, rare in Missouri (Steyermark, 1963).

Leguminosae

Vicia grandiflora Scop.
White Co.; dry hillside, 2 mi W of Beebe. S.A. Wolfram

49; April 17, 1971. This southeastern U.S. species (cf. Radford et al., 1968; Steyermark, 1963) has a large pale yellow corolla. Gary Tucker (pers. comm.) reports that the Herbarium at Russellville includes material from **Pope Co.** (E. Dahlem, s. n.).

Malvaceae

Anoda cristata (L.) Schlect.
Woodruff Co.; weed near Augusta; sent in for identification by Ford L. Baldwin, Extension Agronomist, Sept. 6, 1974. Also present in **Mississippi Co..;** weed in soybean field; sent in for identification by B.L. Fagala, Extension Agent, Sept. 17, 1974. Various ranges are given for this species (cf. Correll and Johnston, 1970; Radford et al., 1968; Steyermark, 1963), none including Arkansas.

Polygonaceae

Polygonum cuspidatum Sieb. & Zucc.
Jefferson Co.; roadside, near intersection of Good Faith Road and St. Louis & SW Railroad, Pine Bluff. Marie P. Locke 1594; Sept. 15, 1974. Escaped from cultivation.

Primulaceae

Lyssimachia nummularia L.
Baxter Co.; sprawling over rocks in small creek 3½ mi N of Gassville on Hwy 126. B.L. Lipscomb 194; Sept. 16, 1974. Steyermark (1963) does not include Arkansas in the range of this northern species.

Rubiaceae

Galium uniflorum Michx.
Jefferson Co.; Pine Bluff Arsenal, Pine Bluff. Marie P. Locke 1177; Sept. 5, 1973. This is a Coastal Plain species (cf. Fernald, 1950; Radford et al., 1968), previously reported for Arkansas only from **Stone Co.** (Browne, 1974). Gary Tucker (pers. comm.) reports he collected it in **Woodruff Co.**

Scrophulariaceae

Mazus japonicus (Thunb.) Ktze.
Woodruff Co.; weed in yard of Mrs. W.B. Vinzant, Augusta. Mr. and Mrs. Arnold Huenefeld 72-16; May 15, 1972. Also in **Jefferson Co.;** weed near intersection of Baraque and Idaho Streets in Pine Bluff. Marie P. Locke 1584; Aug. 18, 1974. This lawn weed may not be as rare as previous collections indicate; the writer found it on the campus of Southern State College in Magnolia; **Columbia Co.;** E.B. Smith 1848; April 11, 1975. Steyermark (1963) includes Arkansas in its range.

Mimulus ringens L. var. *ringens*
Fulton Co.; near very large pond, 1 mi W of Viola. B.L. Lipscomb 195; Aug. 17, 1974. Steyermark (1963) included Arkansas in the range of this species, but there was no material of it at the Herbarium at Fayetteville.

Veronica comosa Richter
Baxter Co.; at fresh water spring in city park of Cotter. B. L. Lipscomb 197; Aug. 14, 1974. The range of this species shown by Steyermark (1963) indicates it would be in Arkansas, but there was no material of it from the state at the Herbarium at Fayetteville.

Solanaceae

Solanum sarachoides Sendtner
Baxter Co.; near small pond supplied by fresh water spring, 4 mi W of Mt. Home and about 0.5 mi N. B.L. Lipscomb 196; Oct. 13, 1974. Rare in Missouri (Steyermark, 1963).

Umbelliferae

Hydrocotyle umbellata L.
Fulton Co.; at edge of Mammoth Spring, Mammoth Spring. B.L. Lipscomb 198; Aug. 17, 1974. This species is not listed by Steyermark (1963); it has the flowers in a single umbel, in contrast with the several verticils of the more common *H. verticillata* Thunb. Gary Tucker (pers. comm.) reports that the Herbarium at Russellville has material of this species from **Newton Co.**

MONOCOTS

Alismaceae

Sagittaria engelmannia J.G. Smith subsp. *brevirostra* (Mack. & Bush) Bogin
Baxter Co.; at edge of large pond, 1 mi W of Cemetery Road, Mt. Home. B.L. Lipscomb 189; Sept. 7, 1974. Steyermark (1963) included Arkansas in the range of this subspecies, but there was no Arkansas material of it at the Herbarium at Fayetteville. Gary Tucker (pers. comm.) reports that the Herbarium at Russellville contains one sheet of this species from **Pope Co.** (D. Carr 19).

Cyperaceae

Eleocharis macrostachya Britt.
Baxter Co.; by large pond 4.7 mi SW of Mt. Home on Hwy 62. B.L. Lipscomb 192; Sept. 8, 1974. There was one other specimen of this species from Arkansas (**Newton Co.;** lake shore at Ponca; coll. by Krekeler s. n.; August 1943), but because of its apparent rarity it is included on this list.

Gramineae

Paspalum praecox Walt.
Chicot Co.; by Lake Chicot, Lake Village. Marie P. Locke 1397; Oct. 1, 1973 (det. by R. Freckman, U. of Wisconsin). This Coastal Plain species (cf. Correll and Johnston, 1970; Radford et al., 1968) has not been reported previously for Arkansas.

Pennisetum alopecuroides (L.) Spreng.
Drew Co.; escaped from cultivation; sent in for identification by Kenneth L. Smith, Extension Agronomist, August 1974. Cultivated under the name of "Pennisetum japonicum."

Lemnaceae

Wolffia papulifera Thompson
Boone Co.; in several ponds along Hwy 62, 3 mi E of

Harmon (also in ponds along Hwy 62 just into **Marion Co.**). B.L. Lipscomb 188; Sept. 12, 1974. This species also was seen in **Baxter Co.** Steyermark (1963) included Arkansas in the range of this species, but there was no material of it in the Herbarium at Fayetteville. Gary Tucker (pers. comm.) reports that the Herbarium at Russellville includes material of it from **Perry** (D. Little, s. n.) and **Newton** (G. Tucker 14303) **Counties.**

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Castanea pumila var *ozarkensis* (Ashe) Tucker, comb. nov.

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ABSTRACT

Castanea ozarkensis Ashe, the Ozark chinquapin of the vascular plant family Fagaceae, is distributed widely throughout the Interior Highlands of Arkansas and the adjacent states of Missouri and Oklahoma. Examination of material from throughout the range of C. ozarkensis indicates demonstrable morphological intergradation with C. pumila (L.) Miller sensu lato, the chinquapin of wide distribution in much of the eastern United States. It is proposed that C. ozarkensis be reduced to C. pumila var. ozarkensis (Ashe) Tucker, comb. nov.

Castanea ozarkensis Ashe, the Ozark chinquapin, was described by W. W. Ashe (1923). The range of the species has been interpreted in several different ways. Fernald (1950) included Louisiana and Mississippi in its range, whereas Vines (1960) attributed it to "northeastern Louisiana" but did not mention Mississippi. Elias (1971) agreed with Fernald and gave the range as Mississippi, Louisiana, Arkansas, Oklahoma and Missouri. Steyermark (1963) stated, however, that specimens examined from Louisiana and Mississippi were *C. pumila* (L.) Miller. The writer has examined several of the specimens also examined by Steyermark and agrees with his determination; *ozarkensis* has been confused in those states with the entity recognized by many as *C. pumila* var. *ashei* Sudw. As indicated in Figure 1, the Ozark chinquapin is almost wholly restricted to the Interior Highlands of Oklahoma, Arkansas and southern Missouri.

Ashe (1923) designated no type specimen in his original description of *C. ozarkensis*. Neither did he indicate a type locality, although he indicated the range of the species as "common north of the Arkansas River from Center Ridge, Arkansas, northward to southwestern Missouri and westward to the valley of the White River." Several of Ashe's collections were examined at NCU in 1966 and again in 1975, but no specimen designated as a type was seen among them. Ashe (1923) described a second Ozarkian species of chinquapin, *C. arkansana*, and attributed it to Benton, Carroll, Franklin, Madison and Washington Counties; no type specimen was designated for *arkansana*, although the type locality was given as "near War Eagle Creek, Madison County." The indefatigable Ashe (1924) later decided that *arkansana* was not worthy of recognition at the species level and reduced it to *C. ozarkensis* var. *arkansana* (Ashe) Ashe. Ashe indicated that *arkansana* was characterized by glabrous sun leaves (glaucescent on the lower surface), whereas *ozarkensis* in the sun was characterized by leaves with yellowish pubescence on the lower surface. He indicated that *arkansana* totally replaced *ozarkensis* in northwest Arkansas. This is not so, however, as both the glabrous and pubescent-leaved forms have been observed throughout the northwestern section of the state; intergradation of pubescence between the two forms is complete. Little (1953) reduced *arkansana* to synonymy with *ozarkensis*, and the writer agrees with his disposition of it.

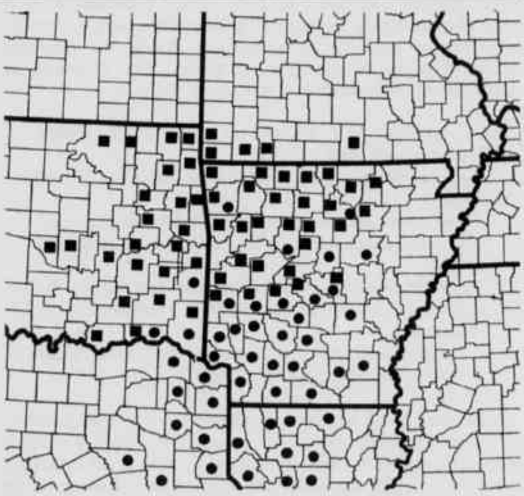

Figure 1. Distribution of *Castanea pumila* var. *ozarkensis* and *C. pumila* var. *pumila* in Arkansas and surrounding states (Oklahoma records based on Williams, 1972; records of other states based on specimens examined). Squares = *C. pumila* var. *ozarkensis*. Circles = *C. pumila* var. *pumila*.

Numerous authors have noted the close relationship between *ozarkensis* and *pumila* (L.) Miller *sensu lato*. The *pumila* complex as it exists in most of the eastern United States is an extremely difficult group in much need of modern experimental study. Numerous taxa have been described (Ashe alone proposed 15 new names in *Castanea*) and some no doubt are worthy of recognition; several of the described taxa, however, are poorly marked and typified by extreme intergradation with others and probably are not worthy of nomenclatural distinction. Moore (1941) and Demaree (1943) both accepted *C. pumila* var. *ashei* Sudw. and *C. pumila* var. *margaretta* Ashe as members of the Arkansas flora. Arkansas specimens referable to *C. pumila* var. *pumila* were examined in this study, although that name has not appeared on the state checklists. These three entities intergrade so freely, however, that the writer is unable to distinguish them consistently and is unconvinced of the efficacy of their recognition (as in Correll and Johnston, 1970). The writer prefers to treat the Coastal Plain populations in Arkansas as a complex of intergrading taxa with synonymy as follows:

C. pumila (L.) Miller var. *pumila*

Incl. *C. alnifolia* Nutt.; *C. alnifolia* var. *floridana* Sarg.; *C. ashei* Sudw.; *C. floridana* (Sarg.) Ashe; *C. margaretta* Ashe; *C. pumila* var. *ashei* Sudw.; *C. pumila* var. *margaretta* Ashe.

Recent field studies and examination of herbarium materials indicate the necessity of reducing *C. ozarkensis* Ashe to a variety of *C. pumila* (L.) Miller. As mentioned, the Ozark chinquapin is almost wholly restricted to the Interior Highlands region, whereas the second entity is primarily restricted to the Coastal Plain. Specimens from the regions of sympatry at relatively low elevations in Stone, Independence, White, Pope, Saline and Jefferson Counties are problematic; intergradation in both vegetative and reproductive characters occurs at these localities.

In the mountainous counties *ozarkensis* is typically distinct and easily recognized on the basis of its large, coarsely toothed leaves (Fig. 2) and large involucres with numerous closely set spines. The spines of *ozarkensis* are 1 cm or more long at maturity, whereas those of *pumila* are less than 1 cm long; Elias (1971) erroneously described the spines of the involucres of *pumila* as "much longer than in *C. ozarkensis*." The branchlets of *ozarkensis* are typically glabrous at maturity. Typically the leaves of the Ozark chinquapin are rather heavily beset with indumentum on the lower surface; some forms of the species, however, have glabrous or nearly glabrous leaf surfaces (sterile specimens of the glabrous forms have been confused with *C. dentata* by some workers).

In the counties near and along the fall-line between mountains and Coastal Plain, *ozarkensis* intergrades with *pumila*, a chinquapin having smaller involucres, smaller leaves with slight serrations (Fig. 2) and markedly pubescent branchlets. Specimens (all at UARK) from Jefferson (Locke 791), Saline (Aingworth s.n., Moore 480507 and Tucker 10096) and Pope (Moore 55-566) Counties are particularly notable intermediates between *pumila* and *ozarkensis*. Tucker 10096, taken from a tree of about 8 m having a single trunk, has coarsely serrate leaves up to 17 cm long (as in *ozarkensis*) and distinctly pubescent branchlets (as in *pumila*). Involucres on the specimens from the tree, collected on 15 July 1972, are approximately 2.5 cm in diameter (at full maturity would be larger, as in *ozarkensis*) and have moderately remote spine clusters (as in *pumila*). The other specimens cited are similarly intermediate; all are marked by the large leaves, some coarsely toothed and others less so, and markedly pubescent branchlets.

The following key will distinguish most specimens of *ozarkensis* from other Arkansas members of the *pumila* complex.

1. Leaves relatively small, 6-16 cm long, teeth shallow and bristle-tipped or sometimes barely visible; mature fruiting involucres less than 2.5 cm in diameter (including spines) . . . 1. *C. pumila* var. *pumila*

2. Leaves relatively large, 10-25 cm long, with coarsely serrate teeth; mature fruiting involucres more than 2.5 cm in diameter (including spines). . . . . 2. *C. pumila* var. *ozarkensis*

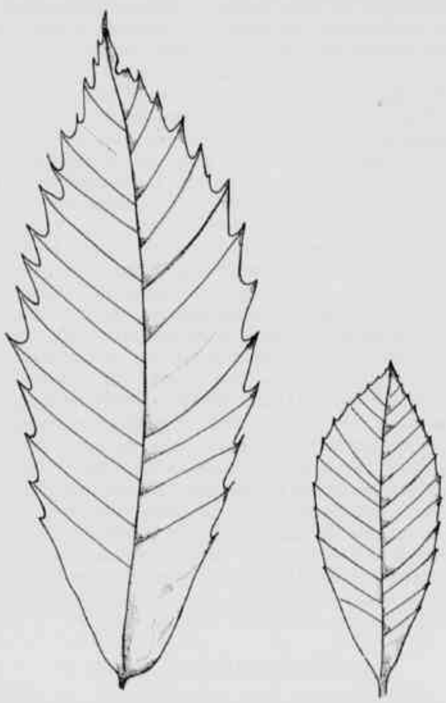

Figure 2. Leaves of *C. pumila* var. *ozarkensis* and *C. pumila* var. *pumila*. Left: *C. pumila* var. *ozarkensis* (the larger leaf). Right: *C. pumila* var. *pumila* (the smaller leaf). Both leaves ½ actual size.

In view of the complexities of the *pumila* complex, the writer is somewhat reluctant to offer yet another nomenclatural combination. The material examined in this study, however, is convincing that *ozarkensis* is not the well-defined endemic species visualized by many authors but is instead an intergrading geographic segregate of the more widely distributed *pumila*.

Several woody plant groups are under investigation in conjunction with the Vascular Flora of the Southeastern United States project. The writer proposes a new combination in the hope of stimulating someone to subject the group to intensive experimental work in an attempt to clarify the taxonomic relationships of the taxa in the genus. The proposed new combination, with pertinent synonymy, follows.

C. pumila (L.) Miller var. *ozarkensis* (Ashe) Tucker, comb. nov.

C. ozarkensis Ashe. Bull. Torr. Bot. Club 50:360. 1923.

Type: none designated in original description.

C. arkansana Ashe. Bull. Torr. Bot. Club 50:361. 1923.

Type: none designated in original description, but type locality near War Eagle Creek, Madison County, Arkansas.

C. ozarkensis var. *arkansana* (Ashe) Ashe. Elisha Mitchell Sci. Soc. J. 40:45. 1924.

Ashe designated neither type specimens nor type locality in his original description of *C. ozarkensis*. From among the specimens studied by Ashe before publication of his description in November 1923, the writer has selected the following to serve as a lectotype: W. W. Ashe s.n., herbarium accession number 64311 (NCU). The lectotype specimen is one of a suite of several specimens collected by Ashe in Searcy County, Arkansas, on 17 September 1923; Ashe did not assign collection numbers to the Searcy County specimens.

ACKNOWLEDGEMENTS

Appreciation is extended to the curators of the following herbaria for courtesies in the examination and loan of herbarium materials: A, GH, MO, NCU, SMU and UARK. Dr. Edwin B. Smith's careful review of the manuscript also is appreciated. The National Science Foundation provided partial support of this research with Grant GB-41276.

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The Calico Rock Sandstone Member of the Everton Formation (Ordovician), Northern Arkansas

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ABSTRACT

Surface and subsurface stratigraphic studies in northeastern Arkansas show the Calico Rock Sandstone (Middle Ordovician) to be a lobate sand body up to 200 ft thick. The environment of deposition is considered from a study of grain characteristics, ripple marks, subjacent and superjacent units and unpublished isopachous maps. The data indicate the Calico Rock Sandstone formed in a transgressing Everton sea as a barrier island and nearshore sand complex. The quartz sand was derived from a northern source and was distributed by southwestward flowing longshore currents.

INTRODUCTION

The Calico Rock Sandstone is a St. Peter-like sandstone member of the Everton Formation (Fig. 1) which is up to 200 ft thick. It is exposed extensively in Izard and adjacent counties in northeastern Arkansas, and is present in several wells in the subsurface on the south. Westernmost exposures of the Calico Rock Sandstone are on the Buffalo River in southeast Marion County. Eastward from Marion County the sandstone is present along the tributaries of the White River and from there it extends northward to Viola, Fulton County, Arkansas. Inasmuch as the Calico Rock Sandstone is of high porosity and permeability, petroleum geologists may find this sandstone to be a potential reservoir for oil and gas in the subsurface of Arkansas.

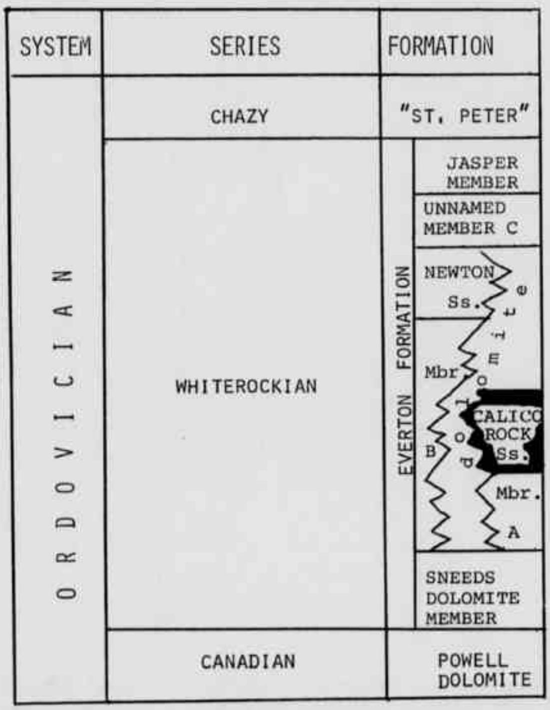

Figure 1. Age and stratigraphic position of Calico Rock Sandstone in Everton Formation of northern Arkansas.

The detrital fraction of the Calico Rock contains more than 95% quartz. Where the sandstone is silica cemented, it is composed of frosted to transparent, angular to subrounded quartz grains which commonly have secondary crystal overgrowths. The quartz grains are of fine to medium size and are well sorted (Fig. 2). Because of the overall paucity of cement, however, the beds of sandstone are friable and characterized by porosity in the range of 30-40% (Giles, 1930). Where beds of the Calico Rock Sandstone are calcareous, the well-sorted, medium-size grains of quartz are frosted and rounded to well rounded. Very calcareous beds may contain admixtures of oolites and calcilutite intraclasts.

The sand grains show extraordinary roundness which possibly was acquired by eolian action. That such sand passed through a desert eolian stage at one time before incorporation in the marine environment has been suggested by Dake (1921) and more recently by Kuenen (1959, p. 23). Additional corroborating evidence for an eolian transition comes from the bimodal texture of some of the Calico Rock sand (Fig. 2, nos. 1, 2; histograms of Giles, 1930, p. 122-125). According to Folk (1968), bimodality is attributed to the action of wind in desert areas. Undoubtedly the sand is marine, but the preserved size distribution was created in an eolian environment. Further, the absence of shale and significant clay fraction in the sandstone of the Calico Rock may be related to eolian winnowing as suggested by Pettijohn et al. (1972, p. 225).

The Calico Rock Sandstone is laminated, cross bedded, and ripple marked. Numerous ripple mark fields in the outcrop belt on the Salem Plateau allow paleogeographic reconstruction.

DEPOSITIONAL ENVIRONMENT

The environment of deposition for the Calico Rock Sandstone was deduced from an examination of (1) internal characteristics such as grain size and sedimentary structures, (2) the rock types and depositional environments of the overlying and underlying rock units and (3) the overall geometry and thickness relations of the Calico Rock sand body (from unpublished maps).

The aforementioned data suggest that most of the Calico Rock Sandstone probably accumulated in a barrier island-strandplain system. Minor amounts of sand were deposited on the shallow marine shelf. Sand from the Calico Rock barrier was washed and blown seaward into the shelf environment or even into the lagoonal environment depending on wind direction. The dune sand of the Calico Rock barrier complex, however, is not preserved. Characteristic high-angle dune cross bedding has not been observed in outcrops of the Calico Rock Sandstone. Evidently, the slow but inevitable sea level rise accompanying the Everton transgression reworked and modified some barrier island characteristics.

Internal Characteristics. Statistical data for the grain size of the Calico Rock Sandstone from several localities in the outcrop belt were taken from Giles (1930) and used to make a contour plot of zones of coarseness (Fig. 3). Two linear zones of coarse sand are illustrated and probaby correspond to the high-energy shoreface environment of the barrier. Areas where the finer fraction is indicated may signify an inter-barrier environment. The trends suggest longshore transport of sand from the north and northeast.

Ripple marks are abundant on the upper surface of most layers of the Calico Rock Sandstone (Fig. 4). Ripple mark fields, some in excess of 90,000 sq yd, are extensive in Izard County, Arkansas. Symmetrical ripple marks are the most common type, hence the orientation of their crests should be parallel with the shore and consequently useful in paleogeographic reconstruction. Six ripple mark fields were studied in the outcrop belt (Table I). Rose diagram plots for stations 1, 2 and 3 (Fig. 5) show trends similar to those of zones of coarse-grained sand illustrated in Figure 3. Stations 4, 5 and 6, however, deviate from this pattern. This is understandable as Kukal (1971, p. 221) found that 10% of ripples form at a right angle to the shoreline and about 27% are diagonal to it; 63% of ripples form parallel with the shoreline. The paleogeographic significance of ripples, therefore, is important but deviations can be expected.

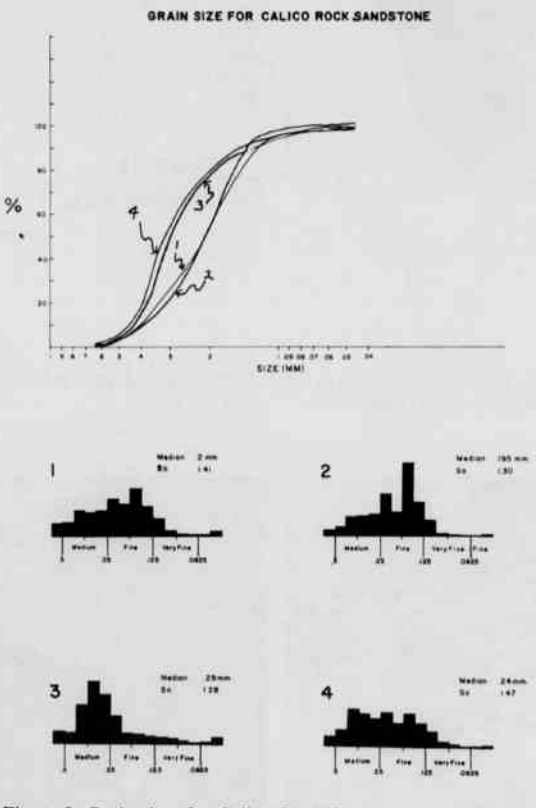

Figure 2. Grain sizes for Calico Rock Sandstone illustrated by cummulative curves and histograms. Trask's sorting coefficient indicated by So. Sample 1 from Sugarloaf Mt., Stone County; Sample 2 from Calico Rock, Izard County; Samples 3 and 4 from ripple mark fields 1 and 6, respectively (see Fig. 5).

Vertical Sequence. The Calico Rock Sandstone conformably to unconformably overlies interbedded limestone and sandstone referred to as Member A by Suhm (1974). The limestone of Member A is calcarenite with symmetrical and asymmetrical (quiet water) oolites, quartz grains and calcilutite intraclasts. Bedded calcilutite is locally stromatolitic with algal heads and oncolites. Thin to medium beds of calcareous to siliceous sandstone are interbedded with the limestone. Scour and fill structures and convolute bedding are seen in places. The sedimentary structures, lithologic character and stromatolites (see Ginsburg, 1960) of Member A represent deposition in an extensive shallow water environment such as a lagoon.

Conformably overlying the Calico Rock Sandstone, in contrast, is a thick sequence of medium and fine-medium crystalline dolomite interbedded in minor amounts with dolomitic sandstone. The crystalline dolomite is assumed to have originated by late secondary dolomitization of limestone. Some lithologic characteristics, as well as the lateral persistence of the strata in this interval, seem to indicate deposition in the shallow subtidal marine environment.

Therefore, because laterally migrating environments are reflected in lithologic transition (Walther, 1894), and because rock units underlying and overlying the Calico Rock Sandstone were found to be lagoonal and offshore, respectively, the Calico Rock Sandstone apparently accumulated in a barrier island environment (see Suhm, 1974, Fig. 15, p. 699).

SOURCE AREA

The source area for the sand of the Calico Rock Sandstone (from data contained herein and unpublished isopachous maps) must have been a delta-river system on the north, perhaps in Missouri. The river system could have traversed the Ozark Dome or the Canadian Shield or both. Dake (1921) suggested that the quartz sand was derived from the shield and that the sand was transported southward across a desert-like area (see introductory comments) and then incorporated into a transgressing sea such as the Everton sea. Also, Cambrian sandstone exposed and eroded at a position peripheral to the shield added sand to points southward (Dapples, 1955; Lamar, 1928; Potter and Pryor, 1961; Theil, 1935). The fact that the sand of the Calico Rock, as well as that of younger sandstone units, coarsens on the north in Missouri and Illinois also seems to indicate a source in that direction (Giles, 1930, p. 42-43).

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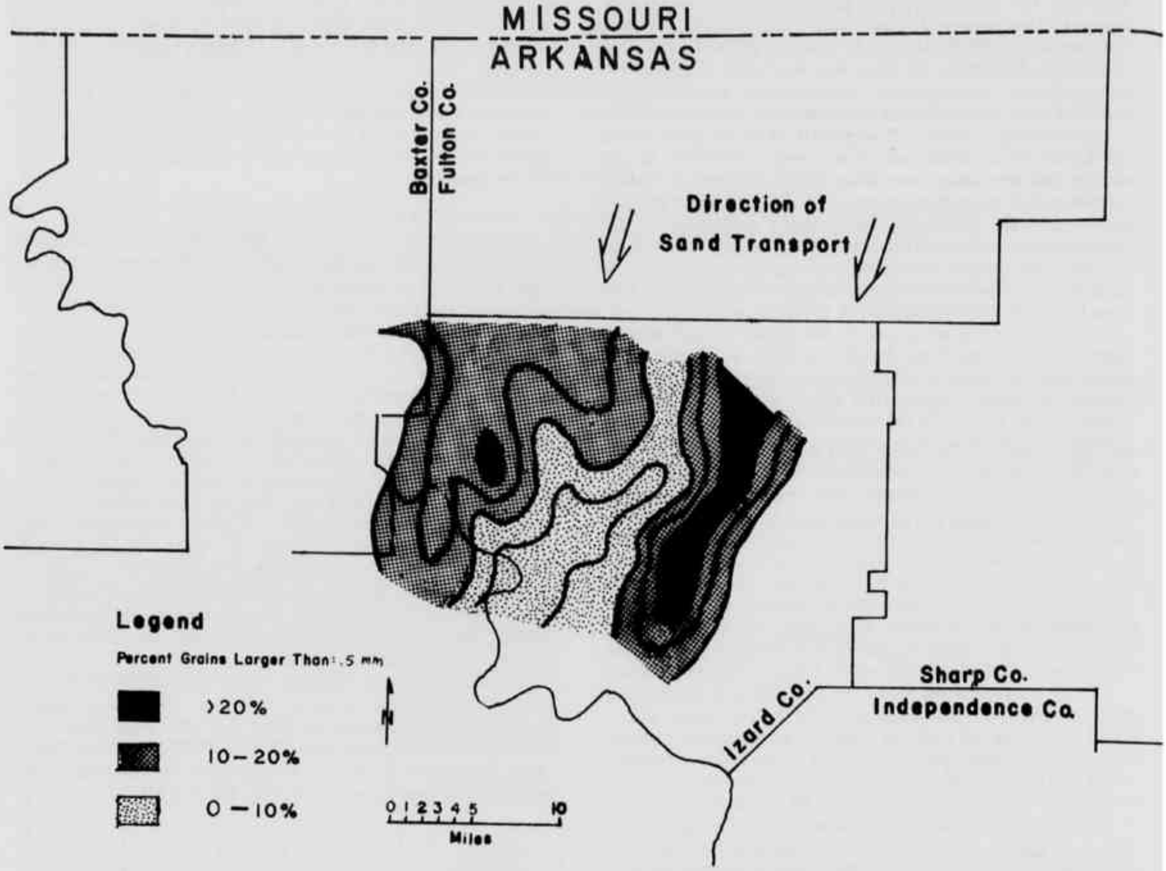

Figure 3. Map showing percentage of grains larger than 0.5 mm from 35 sampling stations in upper half of Calico Rock Sandstone. Trends may represent reworked barrier or beach ridge sand. Size analyses from Giles (1930).

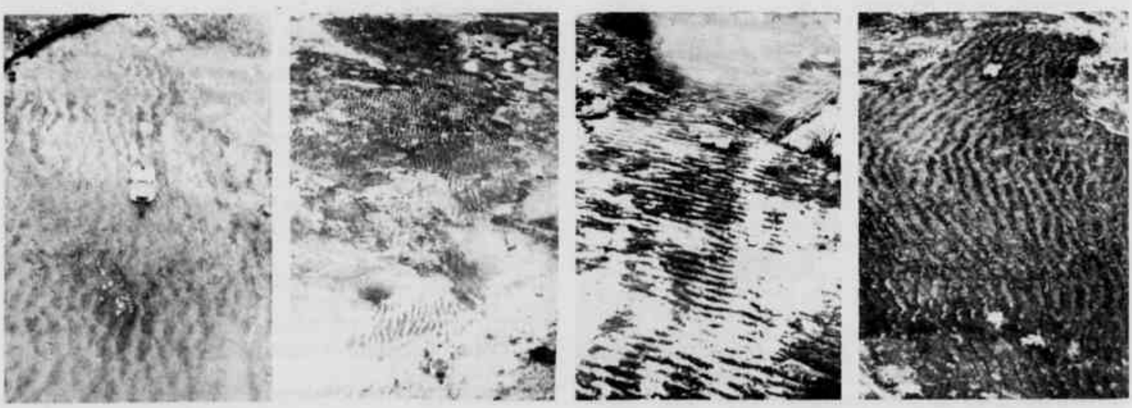

Figure 4. Portions of four different ripple-marked fields in Calico Rock Sandstone Member, Izark County, Arkansas.

Table I. Ripple mark fields in Calico Rock Sandstone.

Locality	Position in Calico Rock Sandstone	No. Measurements	Remarks
1. Approximately ½ mi N of Naked Joe Knob on E side of Ark. State Hwy 5, N½, Sec. 35, T18N, R12W.	Upper half	17	Wave length from 1" to 3", average about 2". Symmetrical. Cross-bedding common.
2. Approximately 5 mi NW of Calico Rock, Ark., on NE side of Ark. State Hwy 5, W½, SE¼, Sec. 4, T17N, R11W.	Upper half	83	Wave length from ½" to 4¼", average about 2¼". Wave height from 3/8" to ½". Most ripples symmetrical. Interference ripples seen. Cross-bedding common.
3. Approximately 1 mi N of Calico Rock, Ark., on N side of Ark. State Hwy 5, NW¼, Sec. 15, T17N, R11W.	Upper half	81	Wave length from ¾" to 5", average about 2". Wave height about ½". Most symmetrical but asymmetrical dip to north. Cross-bedding common.
4. One half mile S of Pineville, Ark., on E side of highway, N½, SE¼, Sec. 1, T17N, R11W.	Upper half	82	Wave length from ¾" to 2", average about 1¼". Most symmetrical but interference and asymmetrical dipping to N or E also seen.
5. One mile W of Forty Four, Ark., on N side of Ark. State Hwy 56, NW¼, Sec. 8, T17N, R10W.	Upper half	65	Wave length from 1" to 5", average about 1¾". Wave height about ½". Symmetrical.
6. Approximately 1 mi W of Band Mill, Ark., on N side of Ark. State Hwy 56, SW¼, Sec. 7, T17N, R9W.	Upper half	59	Wave length average about 1½". Symmetrical. Cross-bedding seen in middle of Calico Rock Sand stone as well as upper part.

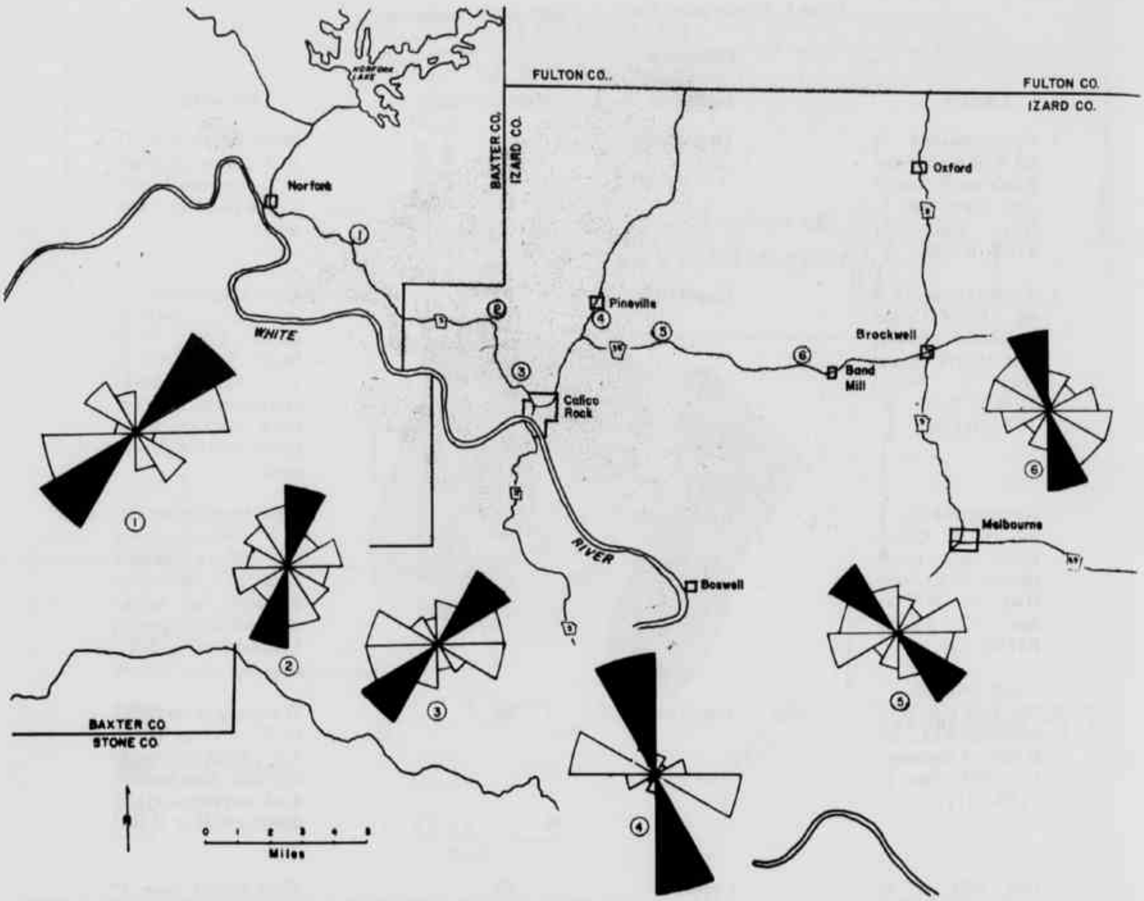

Figure 5. Rose diagrams of ripple mark directions from six ripple-marked fields in Calico Rock Sandstone outcrop belt (shaded). Specific localities of fields and number of measurements for ripple marks are indicated in Table I.

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Anthropology and the Academy of Science: The Need for a New Role

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ABSTRACT

Few anthropology papers were presented at the Annual Meetings of the Arkansas Academy of Science before 1968. Establishment of the Arkansas Archeological Survey in 1967 brought an influx of professional anthropologists to the state and a subsequent increase in the number of anthropology papers published. However, the growth in number of active anthropologists has created a need for more information channels within the state. The time is right for the Anthropology Section of the Academy to become a formal base for interaction and information dissemination among anthropologists.

The Arkansas Academy of Science was formed at a meeting in Little Rock on January 11, 1917. The call for formal organization was made by Mr. Troy W. Lewis, a Little Rock attorney. Though adopting the idea of an annual meeting, the Academy met only once in 1917 and not again until October of 1932 when Mr. Lewis once more attempted to organize the professional scientists throughout the state.

The first regular annual meeting of the revived Academy was in Little Rock during the spring of 1933 (Ham, 1941). From 1933 to the present, the Academy has met annually at the various colleges and universities around the state. The *Proceedings* of the Academy began publication in 1941 as a result of the 25th Annual Meeting (Vol. I). Volume II of the *Proceedings* was published in 1947 and then, beginning in 1950 (33rd Annual Meeting), the *Proceedings* has been published regularly after each annual meeting.

Over the last six decades social sciences in general have not been actively in the mainstream of the Arkansas Academy of Science. Sociology, history, geography, psychology and anthropology all have been conspicuously absent in contrast to other participating sciences such as chemistry, agriculture, biology and geology (compare the *Proceedings* from 1941 to 1974).

During the six years from 1950 to 1955, a total of six papers which come under the heading of general anthropology were presented at the annual meetings of the Academy. These papers were presented during such sections as Sociology (1952-53, 1954), Social Research (1951) and Sociology/Anthropology (1955), which included an additional 27 papers concerning psychological, sociological or historical phenomena. One paper of which the main thesis was archeological was presented during the Sociology section of the 1955 meeting. Of the total number of papers presented during these six years, 11 were submitted for review and subsequently were published in the *Proceedings* of the Academy.

During the next 12 years (from 1956 to 1967) there was an overall lack of participation on the part of social science sections. No papers even remotely concerned with anthropological data or theory were presented to the Academy.

At the 1968 meeting of the Academy an anthropology-oriented revitalization movement began. The Arkansas Archeological Survey had been established during July of the previous year (1967) and the state realized a sudden influx of professional anthropologists. During the 1968 meeting, Survey archeologists presented six papers on the prehistory of various regions in the State of Arkansas. Although none of the papers were submitted to the Academy for publication, they were submitted to and published by the Arkansas Archeological Society (1969). Since the reinitiation of anthropology to the Academy in 1968, there has been a constant (though not overwhelming) interest in the meetings on the part of students and professionals alike. From 1968 to 1975, 52 papers have been presented in the Anthropology or Archeology/Anthropology Sections of the Academy. Of these only 10 concerned general anthropology, whereas 42 were specifically archeological in scope. The publication record of the years 1968 to 1973 (including those papers published by the Arkansas Archeological Society) is commendable (see Volumes XXII-XXVII of the *Proceedings*). Of the 38 papers presented during this period (1968-1973), 17 were submitted for review and were published by the Academy.

Though the growth of the Anthropology Section within the Academy is encouraging, its spirit and the role it plays in the professional community still must be viewed with a critical eye. Approximately 30 professional anthropologists currently reside in the State of Arkansas, in addition to perhaps half as many graduate students. As the number of active anthropologists has grown, so too has the need for open formal and informal information channels. Unless information flow mechanisms expand in proportion to the number of potential participants within the system, few will benefit from the combined knowledge those participants hold.

Stated another way, and perhaps more to the point, the current rate of information flow among professionals in this state is staggeringly minimal. This situation leaves most anthropologists virtually unaware of the sometimes relevant activities carried out by collegues. If the discipline is expected to grow, either in numbers or maturity, this problem must be attacked directly.

The time is right for the Anthropology Section of the Arkansas Academy of Science to be built into a formal base, supported by all the professionals, whose goal is to provide a nonpartisan mechanism through which participants may interact and disseminate information.

Interaction and information dissemination are the two key concepts. The role of the Anthropology Section needs to evolve in a direction which will adequately facilitate them.

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