Journal of the Arkansas Academy of Science

Volume 7 Article 1

1955

Arkansas Academy of Science Proceedings - Volume 7 1955

Academy Editors

ARKANSAS ACADEMY OF SCIENCE

proceedings

ume VII and VIII 1955

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Price: Three Dollars

ARKANSAS ACADEMY OF SCIENCE

Founded 1917

proceedings

Volume VII 1955

CONTENTS -- VOLUME VII

ARKANSAS ACADEMY OF SCIENCE

THIRTY-SEVENTH ANNUAL MEETING

The College of the Ozarks, Clarksville
April 24-25, 1953

FRIDAY, APRIL 24

9:00 a.m. Registration.
11:00 a.m. Meeting Called to Order. Dr. Delbert Swartz Presiding.
12:45 p.m. Luncheon.
2:00 p.m. Sectional Meetings. Biology, Chemistry, Mathematics, Psychology Geology, History, Sociology. Physics.
6:30 p.m. Dinner.
7:30 p.m. Annual Public Lecture. John Tyler Caldwell, President, University of Arkansas.

SATURDAY, APRIL 25

9:00 a.m. Business Meeting. Treasurer's Report. Report of Standing Committees. Election of Officers. Appointment of Committees.
10:00 a.m. Selected Papers from Science Talent Search and Arkansas Junior Academy of Science. Supervised by J. A. Doughty, University of Arkansas.
12:00 p.m. Installation of Officers and Adjournment.
12:15 p.m. Informal Luncheon.
1:30 p.m. Field Trip to Pilot Knob and Fort Douglas. Arranged by Dr. Dwight Moore.

SECTIONAL PROGRAM

BIOLOGY SECTION

Chairman: R. S. Fairchild, University of Arkansas

B-1-1 An Apparatus for the Quantitative and Qualitative Control of Gases in Pure Culture, Delbert Swartz, University of Arkansas.

B-2-2 An Ultra Light Apparatus for the Study of Respitatory Metabolism, Richard V. Ganslen, University of Arkansas.

B-3-3 An Antibiotic Substance Produced by Rhizopus nigricans Ehrenberg, B. J. Williams, University of Arkansas.

B-4-4 Rapid Identification of Urinary Calculi Through the Use of X-ray Analysis, W. J. Smothers and L. H. Siegel, University of Arkansas.

B-5-5 The Biosyntheses of Some Relatively Complex Organic Compounds by Certain Molds, George T. Johnson, University of Arkansas.

B-6-6 Micro-organisms and Sanitation in the Carbonated Beverage Industry, Kenneth Mace, Pepsi Cola Company.

B-7-7 Prussic Acid Poisoning in Common Vetch, E. S. Ruby, J. Beasley, and E. L. Stephenson, University of Arkansas.

B-8-8 Preliminary Observations on the Cave Bats of Arkansas, J. A. Sealander and H. Young, University of Arkansas.

B-9-9 Preliminary Study of Trace Mineral Deficiencies in Arkansas, Paul R. Noland, University of Arkansas.

B-10-10 Carcass Quality of Inbred and Crossbred Uark Poland China Swine, M. C. Heck and E. S. Ruby, University of Arkansas.

B-11-11 A Study of the Contamination of Rural Water Supplies, Clinton B. Rushing, University of Arkansas.

B-12-12 The Effects of Insufficient Nutrients During Seedling Stage on Growth and Yield of Cotton Plants, F. W. Snyder and Robert D. Riggs, University of Arkansas.

B-13-13 The Development of the Bran Layer of the Rice Caryopsis, Ralph Scott, University of Arkansas.

B-14-14 Water Stable Soil Aggregates Formed by Polyelectrolytes, C. L. Garey, University of Arkansas.

B-15-15 Red Clover Hays vs. Korean Lespedeza Hay for Wintering Dairy Heifers, Charles T. Hickman, L. Ratcliff and O. T. Stallcup, University of Arkansas.

B-16-16 Branchiobdellidae of Arkansas, David Causey, University of Arkansas.

B-17-17 A Pictorial Key to Diagnostic Skull Remains of Edible Arkansas Mammals, Robert S. Chase Jr., University of Arkansas.

B-18-18 The Normal Histology of Brown Fat of Certain Arkansas Bats, P. M. Johnston and J. A. Sealander, University of Arkansas.

B-19-19 Sample Numbers for Forage Production Determinations, E. S. Ruby, University of Arkansas.

CHEMISTRY SECTION

Chairman: W. K. Noyce, University of Arkansas

C-1-20 Making Organic Functional Groups Forceful and Vital, Jean Rosser Williams, Arkansas State College.

C-2-21 Consideration of Ion Exchange Equilibria, James L. Pauley, University of Arkansas.

C-3-22 Some Aspects of the Hot Atom Chemistry of Bromine, Thomas C. Hoering, University of Arkansas.

C-4-23 The Vapor Pressure of Saturated Solutions of Some Lithium Salts, Hyman Chessin, University of Arkansas.

C-5-24 Influence of High School Mathematics on Grades in General Chemistry at State College, R. H. Austin, Arkansas State College.

C-6-25 Instrumentology -- A Proposed New Division of Science, Edward S. Amis, University of Arkansas.

GEOLOGY SECTION

Chairman: D. W. Sprouse, Southern State College

G-1-26 The Brentwood Limestone of Madison County, Arkansas, Vance O. Cook, University of Arkansas.

G-2-27 Geology of Devils Den State Park, James E. Case and Francis B. Connelly University of Arkansas.

HISTORY AND POLITICAL SCIENCE SECTION

Chairman: Walter N. Breymann, Southern State College

HP-1-28 Non-recognition of Red China: Reasons and Rationalizations, Keith S. Peterson, Arkansas State Teachers College.

HP-2-29 Organizing the Freedman's Bureau in Mississippi, Clifton L. Ganus Jr., Harding College.

HP-3-30 Existentialist Philosophies and Political Decline, William A. Bultman, Arkansas State Teachers College.

HP-4-31 The Cientificos: Critics of the Diaz Regime, 1892-1903, Walter N. Breymann, Southern State College.

PHYSICS SECTION

Chairman: N. F. Bolling, Arkansas State Teachers College.

P-1-35 Variable Self-Pulsing Blocking Oscillator, J. A. Doughty, University of Arkansas.

P-2-36 Some Optical Properties of Vapor Deposited Films of Arsenic, Antimony, and Bismuth, Z. V. Harvalik, University of Arkansas.

P-3-37 A Simple Ultrasonic Generator, J. A. Doughty, H. Chessin, and D. W. Irby, University of Arkansas

P-4-38 Heat Transmission Through Fabrics as a Function of Thickness, R. J. Heaston, University of Arkansas.

PSYCHOLOGY SECTION

Chairman: H. N. Peters, Veterans Administration Hospital North Little Rock

Ps-1-39 An Investigation of Directional Orientation in Mazes Without Goal-pointing Blinds, Merrell E. Thompson, University of Arkansas.

Ps-2-40 Alpha Rhythm and Farm Perception, O. D. Murphree, Veterans Administration Hospital, North Little Rock.

Ps-3-41 Objective and Projective Measures of Withdrawal Behavior, Edmond F. Erwin, University of Arkansas School of Medicine.

SOCIOLOGY SECTION

Chairman: Norman E. Washburne, Southern State College

S-1-42 The Role of Religion in Crow Indian Culture and Society, Fred W. Voget, University of Arkansas.

S-2-43 The Reactions of Jesus Toward Economic Institutions, George T. Blackman, Ouachita College.

S-3-44 The "Spiritualists": Described and Analyzed, J. Edward Blackwell, Grambling State College.

S-4-45 A Note on the Ecology of Mental Illness in Arkansas Donald D. Stewart, Carl W. Backman, and Gay Swift, University of Arkansas.

S-5-46 A Report on the Urbanization of Counties in Arkansas, Norman F. Washburne, Southern State College.

ARKANSAS ACADEMY OF SCIENCE

SECRETARY'S REPORT
Thirty-seventh Annual Meeting
The College of the Ozarks, Clarksville
April 24-25, 1953

President Delbert Swartz opened the meeting in Science Hall with comments on past activities of the Academy and with emphasis upon those after its reactivation 29 years ago by nine persons who met in the Hotel Lafayette in Little Rock. The business meeting then was called by the President.

The minutes of the last annual meeting were approved as shown in Volume VI of the proceedings. The following committees were appointed:

Nominations---Professors W. C. Munn, D. M. Moore, and T. L. Smith.

Resolutions---Professors Z. V. Harvalik, H. Iltis, and J. W. Sears.

Audit---Professors I. T. Beach, W. W. Nedrow, and C. V. Robinette.

Meeting Place---Professors R. H. Austin, W. C. Munn, and W. J. Smothers.

It was explained that Southern State College was unable to be host for the Academy meeting; therefore, it was necessary that the Executive Committee choose another meeting place. Upon receipt of an invitation from Dr. T. L. Smith of The College of the Ozarks, the committee voted to accept this invitation.

Professor W. W. Nedrow brought to the attention of the Academy the desire of the Deans of the Colleges of Arkansas that State meetings which involved faculty be held jointly rather than at different times and locations. It was pointed out by President Swartz that participation in the Academy is open to all who are interested in science. The history of the change in name of the organization from Arkansas Academy of Science, Arts, and Letters to its present name was reviewed by President Swartz and D. M. Moore. Dr. Norman Payne moved that the Academy consolidate its meetings with other groups but retain the identity of the Arkansas Academy of Science, if the Academy were approached officially by the Deans. The motion passed.

The secretary announced that Professors P. M. Johnston and J. A. Sealander of the University had been selected by the research committee to receive the grant given by the American Association for the Advancement of Science for support of their project, "Studies on the Brown Fat of Arkansas Bats."

Changes in the constitution discussed by the Executive Committee during the past year were presented for discussion by the Academy. Preliminary approval of several changes was obtained, subject to final action at the next meeting.

Z. V. Harvalik moved that the names of prospective new members be read at the luncheon Friday. The motion passed.

After a discussion of the publication cost of the Proceedings, it was moved by Professor N. F. Washburne that advertising be solicited. The motion passed.

The business meeting was adjourned at 12:30 p. m.

At the second business meeting, the changes in the constitution and by-laws as

approved in the previous business meeting were brought up for final vote. The motion, made by Dr. I. T. Beach, passed.

The treasurer's report was presented as a part of the report of the Auditing Committee. On the motion of N. F. Bolling, the treasurer's report was approved.

Z. V. Harvalik, chairman of the Resolutions Committee, presented the following report:

(1) Resolution:
The Arkansas Academy of Science expresses its sincere appreciation to The College of the Ozarks for its excellent cooperation with the Arkansas Academy of Science by serving as host to its thirty-seventh annual meeting.

(a) It is moved that the Arkansas Academy of Science instruct its secretary to send a copy of this resolution to Dr. Vincent, President of The College of the Ozarks, and to Dr. T. L. Smith, Chairman of the Committee of Local Arrangements.

(b) It is moved that this resolution be incorporated into the permanent records of the Arkansas Academy of Science.

(2) Resolution:
(a) The Arkansas Academy of Science thanks Mr. J. A. Doughty and all the teachers who helped in this endeavor for this extremely fine work in stimulating the interest of the youth of this state in scientific activities.

(b) It is moved that the secretary send a copy of this resolution to Mr. Doughty and that he incorporate this resolution into the permanent records of the Arkansas Academy of Science.

(3) Resolution:
The Arkansas Academy of Science expresses thanks to Dr. John Tyler Caldwell, President of the University of Arkansas, for his cooperation in presenting a most inspiring address at the annual banquet of the Arkansas Academy of Science.

(a) It is moved that the secretary send a copy of this resolution to President Caldwell, and that he incorporate this resolution into the permanent records of the Arkansas Academy of Science.

(4) Resolution:
The Academy wishes to thank Mr. Cheadle and his staff, pro tem managing editor, for his splendid work in publishing the Proceedings.

(a) It is moved that the secretary send a copy of this resolution to Mr. Cheadle.

The motions presented by Dr. Harvalik in his report were passed.

Professor W. C. Munn reported the recommendations of the Nominating Committee:

President---Z. V. Harvalik.
President-elect---Ruth Armstrong.
Secretary-treasurer---W. J. Smothers.
Managing Editor---C. R. Cheadle.

Professor N. F. Bolling moved that the recommendations of the Nominating Committee be accepted. The motion passed.

Professor R. H. Austin, Chairman of the Meeting Place Committee, presented the following report:

Invitations have been received from Ouachita College at Arkadelphia, the University of Arkansas at Fayetteville, and Harding College at Searcy for the meeting of the Academy in 1954.

The Committee wishes to extend their appreciation of these invitations and to solicit a renewal of these invitations for the following meeting in 1955.

It is the opinion of the Committee and their report to the Academy that the 1954 meeting should go to the University of Arkansas at Fayetteville since it has now been away for two years. This is not a set rule but has been considered fair in respect to the work and faithfulness of the University people in support of the Academy

Professor Austin's motion was passed and the next annual meeting will be at Fayetteville.

D. M. Moore brought up the possibility of holding two Academy meetings each year, one in the Fall and another in the Spring. Technical papers might be presented at the Fall meeting and field trips planned for the Spring meeting. After discussion, the matter was postponed for action at a later date.

As the official Academy representative to the Academy Conference held in conjunction with the AAAS meeting at St. Louis, Dr. Moore presented a brief report on the discussions of this group. One of the main points was the need to develop a broader membership base and to stimulate interest in State Academies and their programs.

CONSTITUTION AND BY-LAWS AS AMENDED AT CLARKSVILLE, APRIL 25, 1953

Article 1. Name

The name of this organization shall be "The Arkansas Academy of Science."

Article II. Objects

The objects of this organization shall be the promotion and diffusion of knowledge of the fields of Science and the unification of these interests in the State.

Article III. Membership

Section 1. Persons and organizations interested in the objects of this Academy may join on the recommendation of the membership committee and payment of dues.

Section 2. There shall be three classes of membership in the Academy: Members, Associate Members, and Institutional Members.

Section 3. The grade of Associate Member shall be restricted to those who are students in Junior Colleges, Colleges, and Universities. The dues shall be less for Associate Members than for Members.

Article IV. Officers

The officers of the Academy shall be a president, a President-elect, a Secretary-treasurer, an Editor-in-chief, and a Managing Editor who shall perform the duties usually pertaining to their respective offices. These officers of the Academy shall be chosen by ballot by the membership at large in the annual meeting and shall hold office for one year, except the secretary-treasurer, who shall hold office for five years. These officers, the retiring president, the Junior Academy advisor, the program chairman, and other members designated by the president shall constitute the Executive Committee of the organization.

Article V. Meetings

The annual meeting of the Academy shall be held at such times and places as will be designated by the executive committee.

Article VI. Publications

The publications of the Academy shall include the transactions of the Academy and such papers as are deemed suitable by the executive committee.

Article VII. Amendments

The constitution may be altered or amended at any annual meeting by a three-fourth majority of the attending members of at least one year's standing. Final action on any alteration or amendment shall not be taken at the session at which it is presented.

BY-LAWS

1. These by-laws may be altered or amended in the same manner as the constitution.
2. The following committees shall be set up whenever necessary: Program, Membership, Publications, Auditing, Nominations, Local.
3. Whenever the number of papers to be presented in any field becomes sufficiently large an additional section may be created at the discretion of the Program Committee.
4. Persons presenting papers shall leave a copy of the paper with the Secretary of the Academy on the day of presentation and at that time signify willingness or unwillingness to have said paper published by the Academy. In the event of non-publication the paper will be filed in the archives of the Academy as part of the permanent records of the organization.
5. Members who shall allow their dues to remain unpaid for two years, having been annually notified of their arrearage by the Secretary, shall lose their status of membership. Such ex-members may regain their membership by the regular process of election and paying of dues.
6. No bill in excess of $5 may be incurred against the Academy unless approved by the executive committee. No bill against the Academy shall be paid without an order signed by the President and the Secretary.
7. The fiscal year and the membership year shall be designated as beginning with the day of the opening session of the annual spring meeting and ending on the day before such opening session.
8. All officers elected at the annual meeting assume their duties at the end of the last business session of the meeting.
9. A person elected to membership within a year holds paid-up membership for the remainder of that fiscal year.
10. The dues for members of the Academy shall be $3 per year and will entitle the member to receive a copy of the Proceedings. Dues of an institution will be $10 per year. Dues for Associate Members shall be $1 per year but will not entitle the Associate Member to a copy of the Proceedings.

ABSTRACTS OF PAPERS PRESENTED AT THE THIRTY-SEVENTH ANNUAL MEETING

The College of the Ozarks, Clarksville
April 24-25, 1953

BIOLOGY SECTION

Chairman: R. S. Fairchild, University of Arkansas

B-1-1

An Apparatus for the Quantitative and Qualitative Control of Gases in Pure Culture. Delbert Swartz, University of Arkansas.

A system of filters and gas washing bottles has been used successfully to control certain gaseous components of air passed through pure cultures of fungi being used in studies of the production of available nitrogen.

B-5-5

The Biosynthesis of Some Relatively Complex Organic Compounds by Certain Molds. George Thomas Joynson, University of Arkansas.

The imperfect fungi are suited admirably to the study of synthetic reactions in the intact organism because they will grow on simple carbohydrates, such as those with glucose as the sole carbon source. Included in this paper are some case histories containing suggestions of the general pathway involved in relatively complex biosyntheses.

B-9-9

Preliminary Study of Trace Mineral Deficiences in Arkansas. Paul R. Noland, University of Arkansas.

A factorial experiment was designed to study the possible need of the trace minerals, cobalt and copper, in growing and fattening swine. Pigs with an average initial weight of 39 pounds were fed to a final weight of about 100 pounds. The feed consisted of a practical drylot ration containing corn, soybean meal, calcium and phosphorus supplements, B-vitamins, and vitamins A and D. This ration was supplemented with 0.6 mgm. of cobalt per pound of feed, 0.6 mgm. of copper per pound of feed, and a combination of 0.6 mgm. of cobalt and 0.6 mgm. of copper per pound of feed. The average daily gains and the feed required for each 100 pounds of gain for the four treatment groups were: basal, 1.23 and 376 pounds: cobalt, 1.31 and 322 pounds; copper, 1.30 and 377 pounds; and cobalt and copper combined, 1.40 and 303 pounds. The differences between the treated and untreated groups approached significance at the five per cent level of probability.

B-15-15

Red Clover Hay vs. Korean Lespedeza Hay for Wintering Dairy Heifers. Charles T. Hickman, L. Ratcliff, and O. T. Stallcup, University of Arkansas.

Red clover hay was compared to Korean lespedeza hay during a 77-day feeding trial. Two groups, each composed of eight dairy heifers (Holsteins and Jerseys), received identical treatment through the experiment, except for the type of roughage fed ad lib. Each heifer was paired with a heifer from the other group. The couples were approximately the same age, weight, and breed. The heifers receiving the red clover hay consumed an average of 16.2 pounds a day per animal. The group fed Korean lespedeza hay consumed an average of 17.26 pounds a day per animal. The average weights gained per day per animal were 1.20 pounds for those fed red clover hay and 1.23 pounds for those fed Korean lespedeza hay. The heifers fed on red clover hay consumed an average of 13.65 pounds to gain one pound; the heifers fed on Korean lespedeza hay consumed an average of 14.05 pounds to gain one pound.

CHEMISTRY SECTION

Chairman: W. K. Noyce, University of Arkansas

C-1-20

Making Organic Functional Groups Forceful and Vital. Jean Williams, Arkansas State Teachers College.

This paper is an attempt to show how to put life and meaning into seemingly dead diagrams by vitalizing the functional groups. A vivid and forceful picture of magnetic fields and dynamic action taking place under definite scientific laws is given the student, who thinks of force and action in relation to another stronger or weaker force. The structural formula must cease to be merely bonds with atoms arranged in a definite pattern. By discussing processes in this manner, the student is able to memorize formulae from the standpoint of objects in action. The functional groups are the active units, they are the soldiers in the field.

C-2-21

Consideration of Cation Exchange Equilibria. James L. Pauley, University of Arkansas.

It has long been known that the affinity of cation exchange resins for various cations differs in general according to the lyotropic series, such as Cs Rb K Na Li and Ba Sr Ca Mg for aqueous solutions at moderate concentrations. This series is also the order of increasing hydrated ionic radii, such as Li Na K Rb Cs, etc. Many mechanisms have been proposed to explain this selectivity, but no satisfactory mechanism has been developed. This paper offers an explanation of this selectivity based on a consideration of the coulombic forces acting on the system. Consider the resin as a series of negative point charges distributed at random throughout the resin, with the cations held at an average at their closest distance of approach which may be considered to be the sum of the hydrated radii of the "absorbed" cation and the resin anion. The free energy change involved in the exchange of the cations, and thus K_{eq}, may be determined then from the work necessary to remove each of the two types of cations involved from this distance of closest approach to infinity against the coulombic attractive forces acting between the cation and the resin anion. Calculations have been made for several ions for a particular resin for several uni-univalent exchanges and one uni-divalent exchange, and the calculated K_{eq} was found to agree quite well with that obtained experimentally.

C-3-22

Some Aspects of the Hot Atom Chemistry of Bromine. T. C. Hoering, University of Arkansas.

Much information exists on the chemical effects of neutron capture of bromine in organic bromides. Less information is available on inorganic compounds of bromine. Experiments have been performed to determine the chemical effects on bromates of three nuclear processes--(1) neutron capture by Br^{79} to give the lower (18-minute) state of Br^{80}, (2) neutron capture by Br^{79} to give the upper (4.4-hour) state of Br^{80}, (3) isomeric transmission of Br^{80}. The results of process (1) indicate that the retention in neutral solutions of bromates is about two per cent. The retention increased greatly as the pH is lowered, and it increases slightly at high pH. The retention in neutral solutions following processes (2) and (3) is about 35 per cent.

C-4-23

The Vapor Pressure of Saturated Solutions of Some Lithium Salts. Hyman Chessin, University of Arkansas.

The vapor pressure of saturated solutions of several lithium salts was determined at 20°C, 40°C, and 60°C with a differential tensimeter. Such saturated solutions maintain constant humidity conditions in enclosed chambers. These humidity conditions are independent of small temperature fluctuations. Because of their high solubilities, the lithium salts are particularly valuable for the production of low relative humidities.

C-5-24

Influence of High School Mathematics on Grades in General Chemistry at State College. R. H. Austin, Arkansas State College.

Grades in the first semester of general chemistry at Arkansas State College are higher among students who had one year of algebra and one year of plane geometry in high school. A second year of algebra, however, did not appear as beneficial to the chemistry student as a year of plane geometry after the first year of algebra. Solid geometry did not seem to help chemistry grades of the students.

C-6-25

Instrumentology: A New Division of the Physical Sciences. Edward S. Amis, University of Arkansas.

Instrumentology deals with theories of the design, maintenance, and use of instruments in physical sciences, and the interpretation and application of data obtained by instrumental methods of measurement. Instrumentology includes both instruments for control and for measuring. The importance of instrumentology is demonstrated by the fact that in 1952 two billion dollars were spent to purchase equipment for instrumental control and measurement. Equations previously considered insolvable have been solved by means of mechanical calculators and calculators making use of multiple banks of electron tubes and by means of differential analyzers. The atomic energy program has encouraged improvement of instruments used in control, testing, measurement, and calculation.

PHYSICS SECTION

Chairman: N. F. Bolling, Arkansas State Teachers College

P-4-38

Heat Transmission Through Fabrics as a Function of Thickness and Density of Packing. Robert J. Heaston, University of Arkansas.

Thermal conductivity data invariably are given in literature without specifying how, or under what conditions, the data were obtained. A review of the literature also revealed that there were several methods of obtaining thermal conductivity data. From these, the Cenco-Fitch method was chosen for research on the thermal conductivity of thin (0.0085 to 0.328 inches thick), circular samples of different fabrics and quilted batts of fibrous materials. The substances tested included cork, orlon, vinyon HH, wool felt, chamois leather, cotton, and various combinations of fibers. An attempt was made to correlate thermal conductivity as a function of thickness and density at a constant pressure of 1.437 psi. The value of k was found to increase first with an increase in thickness. With further increase of thickness, the value of k levelled off and then decreased with increasing thickness. With an increasing density, the thermal conductivity decreased, but there was also an optimum point where the value of k changed and increased with an increased density. With a high moisture content, the thermal conductivity increased seven or eight times in value.

SOCIOLOGY SECTION

Chairman: Norman E. Washburne, Southern State College

S-1-42

The Role of Religion in Crow Indian Culture and Society. Fred W. Voget, University of Arkansas.

Warfare--the primary institutionalized pattern of Crow culture--idealized the courageous and daring person who raided the enemy. Considered from a socio-psychological viewpoint, the primary role definition emphasized a maximizing of the social self in competition with others. It guaranteed the person a high degree of autonomy in motivation. The source for the autonomy of the social self is found in the primary support pattern--religion--for a Crow based his action on a prophetic intelligence derived from the supernatural. Considered psychologically, Crow religion contributed a basic security to the believer and tended to reduce anxiety in situations beyond the control of the individual. When analyzed in terms of ends, roles, and content, the religious pattern shows significant congruencies with the primary institutionalized pattern.

S-3-44

The Spiritualists: Described and Analyzed for Their Sociological Significance. J. Edward Blackwell, Grambling State College.

Spiritualism can be defined as a system of professed communication with departed spirits or the unseen world, chiefly through individuals who possess special endowments for such communications. Spiritualism includes three distinct categories: modern spiritualism, which includes such mental phenomena as mental telepathy, clairvoyance, premonition, and telekinisis; divine spiritualism, which includes a mixture of the elements of many major religious faiths, systematized into one organization based on "divine intervention" in the lives of the living and the spirits of the dead; and voodooism, a witchcraft that deals with evil spirits that may be combated and appeased by charms, rituals, and incantations.

AN ANTIBIOTIC SUBSTANCE PRODUCED BY RHIZOPUS NIGRICANS EHRENBERG

BILLY JOE WILLIAMS
University of Arkansas

INTRODUCTION

Plugs of medium were removed from cultures of *Rhizopus nigricans* and placed on freshly-seeded agar plate cultures of *Micrococcus aureus*. When these were incubated, a clear zone in which the bacteria failed to grow appeared surrounding the mold medium. Since previous similar tests did not support this result, the above test was repeated and *Micrococcus aureus* again failed to grow. The failure of a bacterium to grow in the presence of the products of another organism hereafter will be called inhibition or antibiotic activity.

PURPOSE

The experimental work which is outlined here was an effort to explain the cause of these preliminary results.

EXPERIMENTAL METHOD

To justify further investigation of these findings it was desirable to know whether cultures of *Rhizopus nigricans* also would inhibit the growth of other pathogenic bacteria. In an effort to answer this question, plugs of medium again were removed from cultures of the mold and placed on freshly-seeded plate cultures of *Bacillus anthracis*, *Salmonella typhosa*, *Salmonella shottmuelleri*, *Shigella sonnei*, and *Corynebacterium bovis*. Plugs of sterile medium identical to those on which the mold was grown were tested in a like manner to serve as controls. When these test plates were incubated, all of the test organisms were inhibited by the medium upon which the mold had grown, whereas the control medium inhibited none.

Rhizopus nigricans was grown on a broth medium containing proteose-peptone and glucose. Filtrates from these cultures were tested by the cup plate method against *Bacillus anthracis*. The organism was inhibited under these test conditions. The pH of the tested broth filtrate was found to be 3.0; consequently, tests were devised to determine whether this acidity caused the observed inhibitions. Sterile broth and distilled water were adjusted to pH 3.0. A portion of the broth filtrate from the mold culture was adjusted to pH 6.6; an aliquot of this was readjusted to pH 3.0; and a portion of the original culture filtrate was left untreated. These then were tested by the cup plate method against *Micrococcus aureus*. Only the untreated filtrate from a culture of *Rhizopus nigricans* inhibited the test organism. Therefore, it was concluded that the observed inhibitions were not caused by acidity alone, but also by some substance or substances produced from a glucose proteose-peptone solution by the metabolic activities of *Rhizopus nigricans*. Extraction and identification of this substance seemed to be the next logical steps.

Before attempts were made to extract the antibiotic substance from the broth filtrates, tests were devised to determine whether this substance could be concentrated by boiling in air and to determine which pH range would offer the maximum potency and stability. To answer these questions, portions of the broth filtrate were boiled for 5, 10, 15, and 20-minute periods and other portions were adjusted to pH values of 2.3, 3.0, 4.3, 6.0, and 8.0. Each of these portions was tested by the cup plate method against *Bacillus anthracis*. All of the boiled portions inhibited the test organism. Those that were boiled the longest time produced the largest inhibition zones. Therefore, it was shown that the antibiotic substance could be concentrated by boiling broth filtrates in air. None of those portions of the broth filtrates with a pH greater than 4.3 inhibited the test organism.

Preliminary to extracting the antibiotic substance from the crude solution, the broth filtrate was boiled to near dryness. A syrupy brown liquid resulted. This was placed in a 100°C oven to complete the drying process. The resulting dark brown gummy residue was extracted several times with acetone. This solvent

was evaporated and the resulting residue was extracted with boiling ether. In turn, this was evaporated and the resulting residue was extracted with ether cooled to 0°C. The cold ether then was evaporated and the residue was extracted with boiling chloroform. The chloroform extract was evaporated by boiling to dryness. When it cooled, the result was a layer of large amber aggregate crystals interspersed among many small clear crystals. All residues were suspended in distilled water and tested by the cup plate method against *Micrococcus aureus*. The residue from the acetone extraction and the crystalline deposit from the chloroform extract each inhibited the test organism.

An aqueous solution of the chloroform extract and a portion of a broth filtrate from a culture of *Rhizopus nigricans* were tested with ferric chloride for the presence of organic acids. A yellow color resulted. Attempts were made to separate the two crystalline forms found in the chloroform extract by washing in various solvents. Separation was not accomplished and, therefore, additional chemical tests to identify the antibiotic substance as a known compound were not performed. The pH of aqueous solutions of the crystalline deposit showing antibiotic activity was 2.7.

DISCUSSION

These tests have demonstrated clearly that an antibiotic substance is produced as a result of the growth of a local isolate of *Rhizopus nigricans* and that many pathogenic bacteria are inhibited in virto by this substance. The identity of this antibiotic is unknown, although some of its properties are known. Tests have established that this substance is stable to a temperature of 100°C for a period of at least 20 minutes, and that its antibiotic properties are diminished at pH values greater than 4.3. Although there is good reason to suspect that the organic acids produced by the mold are responsible for the observed inhibitions, certain well-known inhibitory acids have been eliminated as possible causes. Kojic acid and phenolic acids were eliminated by the results of the ferric chloride test. Because this antibiotic is soluble in chloroform and is concentrated by boiling, whereas lactic acid is neither, this acid is not considered the cause of the observed inhibitions. Likewise, because of the stability of this antibiotic substance to boiling, all volatile acids are eliminated as possible causes. Since the purity of the extracted material has not been determined, it is not certain whether the acidity of this material is due to the antibiotic substance present in these extracts. Without other evidence to the contrary, however, it can be assumed that this acidity is due in part to the antibiotic substance, and although it has not been proved by test that organic acids are responsible for the observed antibiotic activity, one of these or a similar substance is suspected.

CONCLUSION

The following facts are known as a result of this experiment:

1. An antibiotic substance is produced by a locally isolated strain of *Rhizopus nigricans*.
2. These substances prevent the growth in vitro of the following bacteria:
   a. *Bacillus anthracis*
   b. *Micrococcus aureus*
   c. *Salmonella typhosa*
   d. *Salmonella shottmerelleri*
   e. *Shigella sonnei*
   f. *Corynebacterium bovis*
3. This substance can withstand a temperature of 100°C for a period of at least 20 minutes without appreciable loss in antibiotic activity.
4. In solutions adjusted with sodium hydroxide to pH values greater than 4.3, the ability of this substance to inhibit bacterial growth is greatly diminished.

SUMMARY

A crystalline substance believed to be an organic acid was isolated from broth filtrates of cultures of *Rhizopus nigricans*. This substance prevented the growth in vitro of both gram positive and gram negative pathogenic bacteria.

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MICROORGANISMS AND SANITATION IN THE CARBONATED BEVERAGE INDUSTRY

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Microorganisms play important roles in many industries, and often their importance varies directly with the size of the industry. They are vital in the preparation, storage, and sale of carbonated beverages. The size of the industry indicates their importance. The following facts and figures are from the United States Department of Commerce bulletin, *Census of Manufactures 1947*. There were 5,618 syrup and bottling plants in the United States which employed 79,397 people. These plants produced merchandise valued at $837,662,750. The soft drink industry is the largest user of sugar--in 1949 it used 1.4 billion pounds. The industry also uses large amounts of water, approximately 6.25 billion gallons annually.

Since the keeping properties of the product are dependent in large part upon its freedom from spoilage organisms, high bacteriological standards are necessary in the carbonated beverage industry. This is especially important because the final product is not heated.

There are two significant ways in which microorganisms can affect the carbonated beverage industry. Unless proper sanitation measures are employed there is a remote chance of disease organisms as well as spoilage organisms entering the product itself. However, the nature of the product--that is, the presence of large amounts of carbon dioxide with the resulting acidity (pH 2.2 - 3.2) and high sugar content (11 - 14 per cent)--provides such an environment that disease organisms do not survive to reach the consumer even if they were present at the time of bottling. There has been no known instance of a communicable disease outbreak being traced to carbonated beverages. This is an exceptional record when compared to other food products.

Despite this excellent record, microorganisms cause several types of spoilage: formation of sediments, short shelf life, separation of essential oils, foaming at the filling machine which results in low carbonation and low fill, loss of carbonation on opening, fermentation, and off tastes. The true fruit and artificial flavors are especially susceptible to spoilage because of their low carbonation and high pH value. The cola beverages are the least susceptible because of their low pH value (2.4 - 2.7) and higher carbonation (3-4 volumes).

Carbon Dioxide in the concentration found in the beverages is valuable as a preservative. The effects of CO_2 on microorganisms is worthy of note, because it seems to exert a selective effect on bacteria. Some are killed while others are not harmed, and these will even increase in number in its presence. The presence of CO_2 in the beverage is especially detrimental to the growth of some molds. Some species are not able to grow in relatively large amounts of CO_2. Others, however, sometimes appear in beverages with little or no CO_2 or when abnormal amounts of air have been introduced into the bottle in the process of filling.

In order to establish the effects of sugar, acid, and CO_2 on the survival of *E. coli*, W. A. Nolte of the University of Maryland introduced 4,500,000 *E. coli* in each of the following media: (1) tap water, (2) tap water and .085 per cent citric acid, (3) tap water, .085 per cent citric acid, and 10 per cent sucrose, (4) tap water, .085 per cent citric acid, 10 per cent sucrose, and 3.5 volumes of CO2. The results obtained are shown in Figure 1. Another ingredient that sometimes is found in carbonated beverages is sodium benzoate. This preservative is used chiefly in flavor type beverages. The strength generally employed, 1/20 of 1 per cent, is, however, of little value in heavy contaminations.

There are several sources of spoilage in a beverage plant--airborne organisms, water, sugar, machinery, and bottles. The greater amount of spoilage seems to be caused by the air-borne species of microorganisms; of these, yeast is particularly noteworthy. Statistics by the *American Bottlers of Carbonated Beverages* indicate that in the plants inspected, 46 per cent had yeast contamination of empty washed bottles or simple or finished syrup. Forty per cent of these plants

NOTE: Research Paper No. 1113, Journal Series, University of Arkansas.

with yeast contamination had contaminated syrup or syrup handling equipment. Investigation showed that the presence of yeast in the finished product was caused by the following conditions: (1) holding simple syrup for excessive periods of time, (2) excessive periods of storage of improperly agitated finished syrup, (3) infrequent or improper sterilization of syrup handling equipment, (4) using valves and fittings that were not of sanitary construction, (5) dead end syrup lines, and (6) possible air contamination of syrup, bottles, or equipment.

Yeast that falls into finished syrup and survives the high concentration of sugar may grow after it has been diluted in the finished product. To keep at a minimum the air-borne microorganisms, some plants have found it feasible to install ultra-violet ray lamps in their syrup rooms. If properly installed, the lamps can be very effective. In plants that store large amounts of simple or finished syrup, ultra-violet lamps are installed at the top of the tank to reduce the number of organisms coming in contact with the syrup. Any organisms in the syrup itself will not be effected to any extent as ultra-violet has low penetration power in organic media. Even a thin film provides a high degree of protection to organisms contained in them. Syrup that has splashed on the walls, floors, and ceilings of mixing rooms may become sufficiently diluted to allow the growth of molds and yeast. Spores from these sources can be carried by air currents to all parts of the plant, contaminating material coming in contact with the finished product or its ingredients, thereby causing spoilage. Bottles stored over long periods of time--such as through the winter months--frequently are the source of airborne mold spores that contaminate syrup, crowns, and other material, converting them into unsuitable materials for use.

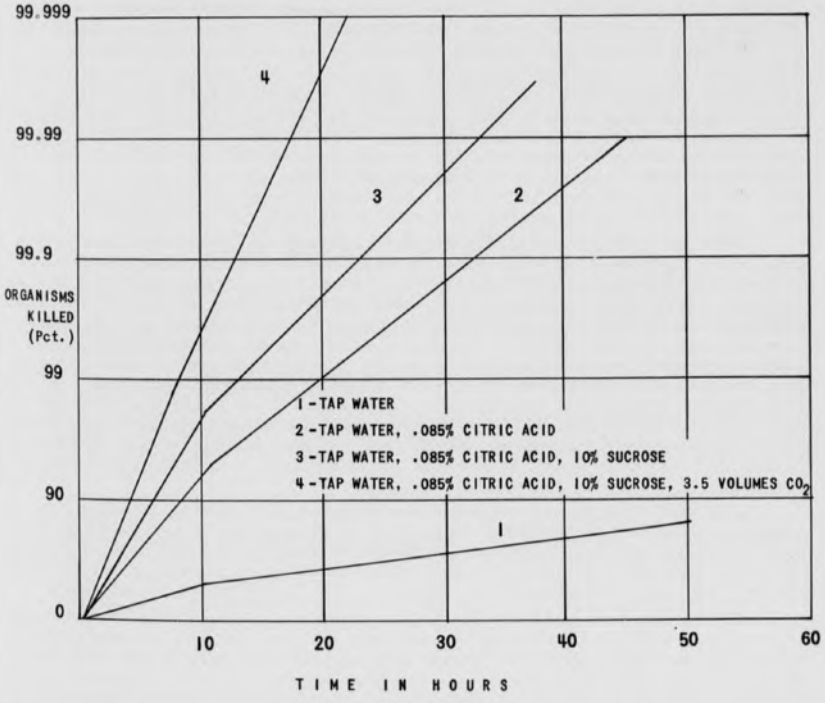

Fig. 1. The Effect of Sugar, Acid, and CO_2 on the Survival of Organisms.

Since water makes up at least 85 per cent of the finished product, a good source of pure water is important. Some spoilage has been traced to contaminated water mains. The bottler's efforts in sanitation can be defeated if water containing spoilage organisms is allowed to pass through his equipment. The solution of this problem has been found in lime coagulation and a super chlorination water treating system along with sand filtration and carbon purification. In this type of system the residual chlorine content after two to four hours retention is kept at from six to eight parts per million at the sand filter. The equipment through which the water passes on its way to the finished product also contributes to spoilage. The main trouble in plants lacking water treating equipment lies in poorly maintained sand filters and carbon purifiers. Certain types of coolers and parts of fillers also have been a serious source of trouble.

The most abundant organic ingredient in carbonated beverages is sugar. Most parent companies in the beverage industry have set up rigid standards for the micro-flora content of sugar. Storing sugar properly is important if it is to be kept sanitary. It should be stored on pallets off the floor and away from walls in enclosed, properly ventilated rooms. Paper bags are better than cloth for keeping sugar free from contamination during storage. Cloth bags absorb moisture, forming a dilute sugar solution around the outside edge, offering a good environment for certain microorganisms.

The problem of preventing sugar from becoming a source of contamination is complicated by a frequent practice in the industry--shaking the bags over the mixing tanks to remove all of the sugar. Tests by the *American Bottlers of Carbonated Beverages* to find out how much contamination results from this practice, show the following results when the bags were properly stored: 1,208 bacteria from each bag, 35 yeast, 82 mold. In the second series of tests the bags were brushed with a fine hair brush. This time the count was 320 bacteria, 1 yeast, 29 mold. The third series of tests was run with the outside layer of paper torn off the bags. The count was reduced to 60 bacteria, no yeast, and 6 mold.

Producing a clean sanitary bottle in which to package the finished product is a major problem facing the manufacturers of carbonated beverages. Unless this is overcome, serious spoilage can result. It is fortunate that the concentration of caustic necessary to produce a clean bottle is more than the concentration necessary to kill microorganisms. The present requirements for washing compounds include exposing the bottle to a three per cent alkali solution, of which not less than 60 per cent is caustic, for at least five minutes at a temperature of not less than 130°F or to an equivalent cleaning and sterilizing compound.

Tests by a well known manufacturer of washing compounds show that vegetative cells and spores of yeast normally encountered in carbonated beverages are killed when exposed to 130°F and as little as .19 per cent caustic for five minutes. At the same temperature it takes only two minutes and .75 per cent caustic to kill *Staphlococcus aureus* (F. D. A. Phenol Coefficient Technique was used in these tests). Tests by the American Bottlers of Carbonated Beverage's laboratories on the resistance of yeast to caustic soda showed these results: In a one per cent caustic solution 5,600 swimming yeast were introduced. At the end of five minutes at 104°F, 230 survived, and at 122°F none survived. At the end of 10 minutes at 104°F, 130 survived. In two per cent caustic 5,600 swimming yeast were introduced. At the end of five minutes at 104°F, 20 survived, and at 122°F none. At the end of 10 minutes at 104°F, there were no survivors.

Water softening agents sometimes are employed with caustic to aid in obtaining a clean bottle. It has been found that in general the action of Alkyl arly sulphonates weakens microorganisms for attack by other germicides such as caustic. Mold, for instance, is killed in half the time if as little as .15 per cent of the wetting agent is used.

Mobile laboratories of the Pepsi-Cola Company have found that the sterilizing action of the caustic solution can be nullified if care is not taken in sanitizing the rinse tank of the bottle washing machine. Spoilage has been traced to this compartment. Dirt particles that have not been removed from some of the bottles drop off in the rinse compartment, carrying with them organisms that have not been reached by the caustic solution. The warm damp walls of this section offer an excellent environment for these organisms to thrive.

The sanitation problem can be reduced by a carefully chosen site. Locations near bakeries, laundries, or breweries should be avoided because of airborne yeast. Excessively dusty or smoky sites or poorly drained areas also should be avoided.

The building itself should be designed properly for sanitary maintenance. For example, the bottling room should be enclosed. Tests have shown that there is more yeast, bacteria, and mold in the air inside beverage plants, particularly the receiving end of the soaker, than in outside air. Therefore, it is advisable to separate the receiving end of the bottle washer from the bottling area. The bottling and syrup rooms also should have walls and floors of hard, glazed material which is water and acid proof. This will enable easier cleaning.

It is often difficult to sell sanitation to plant managers and personnel because the results are not always tangible. However, it has been proved that a plant that practices adequate cleaning will produce a superior product. To help the bottler with spoilage problems in prevention as well as elimination, parent companies have set up laboratories to deal with them. The *American Bottlers of Carbonated Beverages* and some parent companies, including the Pepsi-Cola Company, have established mobile laboratories to aid the bottler in his own plant. These laboratories are able in many instances to spot spoilage-producing conditions before they have progressed for enough to cause loss of merchandise. The personnel on these mobile units are able to advise the bottler on the latest methods in sanitation and aid him in setting up programs that suit his plant's needs. The parent companies realize that uniform high quality throughout the nation is of prime importance and that good sanitation is a leading factor in maintaining that quality.

Some conclusions may be drawn from this study: (1) Sanitation in the beverage industry must be thorough, since neglect of one phase can cause trouble. (2) Counts obtained in finished products taken from the trade will not necessarily give a true picture of the sanitary condition of the plant in which they were bottled. (3) More study is needed on how various organisms affect a carbonated beverage. (4) More study is needed on effects of CO_2, sugar, and acid in the concentrations found in carbonated beverages on spore forming bacteria which are found in water and soil.

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PRUSSIC ACID POISONING IN COMMON VETCH (VICIA SATIVA) SEED[1]

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INTRODUCTION

Poisoning of livestock by plants long has been a problem with livestock producers. It is a particularly important one in the South because of the production under certain conditions of prussic acid (hydrogen cyanide) by Johnson grass and the sorghums. There are other plants in the South that produce prussic acid poisoning, but they are of little or no economic value and are not present in great numbers. Also, many of these plants are not eaten by livestock unless the animals are on poor pasture.

Prussic acid is produced from glucosides in combination with an enzyme and water, according to Armstrong (1924). The enzyme and the glucoside are contained in the same plant parts, but they are in separate cells. Thus, it is not until the cells are ruptured and the water is added that prussic acid is produced.

Prussic acid is one of the most powerful poisons known. Death results in very little time after a sufficient dose is ingested. The glucoside enters the animals through the digestive tract. However, prussic acid poisoning may result from breathing the fumes, getting the poison in an open wound, or coming into contact with the mucous membranes, according to Nunn (1907).

Morrison (1950) reported that some species of Vicia are poisonous. No references for his statement are shown in the book. Further references in the literature were found which showed that there are some species of Vicia that are poisonous. Muenscher (1939) states that Crown vetch (Coronella varia L.) is poisonous. Although this is not a true vetch, the common name may be responsible for some misunderstandings in the literature.

Pammel (1911) reports that common vetch (Vicia sativa) causes tympanites in swine, but not in cattle. He reports that the seed is fed in Europe in large quantities to cattle.

Roseveare (1948) reports that Fernandez and Echenique have investigated the poisoning of pigeons by the seed of common vetch. They found that these seeds contain a glucoside which, by the action of its own diastase, and that of the pigeons digestive tract, is transformed into hydrocyanic acid, benzoic aldehyde, and sugar. Roseveare (1948) also states that the influence of the Vicia sativa poison on cattle has been proved.

Armstrong (1924) states that the glucoside vicianin has been found in the seeds of narrow leaf vetch (Vicia angustifolia). It is decomposed by an enzyme (vicianase) present in certain vetches. Seed of narrow leaf vetch is not regularly available, but it is commonly present in waste places and along roadsides in the Cotton Belt, according to Wheeler (1950).

The horsebean, (Vicia faba L.) seed was reported by Pammel (1911) to contain a glucoside which has been named convincin. The large seeded horsebean varieties commonly are grown for use as a vegetable and as a stockfeed. There are many varieties of this species, and Wheeler (1950) reports that these plants also are used as a green manure crop.

EXPERIMENTAL PROCEDURE

Fifteen pounds of common vetch (Vicia Sativa) seed were obtained and ground in a Wiley mill. Some hairy vetch (Vicia villosa) seed was present in the sample. This ground seed was then substituted into Diet I at the following levels: 0 per cent, 20 per cent, 40 per cent, 60 per cent, 80 per cent, and 100 per cent vetch seed. The composition of experimental diets used in this study is shown in Table I. Diet 1 had relatively the same protein level as the vetch seed.

Mature female albino rats were used as the experimental animals. Their average initial weight was 231 grams. Twenty-three females were available. They were divided at random into six groups. Four animals were put on each diet except

[1] Research Paper No. 1100. Journal Series. University of Arkansas. Published with the permission of the director of the Arkansas Agricultural Experimental Station.

Diet 6 which had only three animals. Previous to their being put on the experimental diets, the rats had been on Diet 1 for several months.

Table I. Experimental Rations Used in Studying the Toxicity of Common Vetch (Vicia sativa) seed (1953).

Diet	Corn (Pct.)	Soybean oil meal (Pct.)	Alfalfa leaf meal (Pct.)	Vetch seed (Pct.)
1	45	45	10	0
2	36	36	8	20
3	27	27	6	40
4	18	18	4	60
5	9	9	2	80
6	0	0	0	100

The rats were put on experiment January 29, 1953 and were taken off February 25, 1953. Three rats from each diet were posted to determine any abnormalities of the digestive tract.

RESULTS

The results of the use of common vetch seed in the ration of rats in testing the material for prussic acid poisoning are shown in Table II.

Table II. Results of Toxicity Study on Feeding Common Vetch Seed to Rats.

Diet	Number rats	Number died	Average weights Initial (gms)	Final	Average Gain (gms)	Loss
1	4	0	229	225	--	4
2	4	0	229	228	--	1
3	4	0	232	239	7	--
4	4	0	232	239	7	--
5	4	0	230	259	29	--
6	3	0	245	271	26	--

It is apparent from the number of animals that died that either the common vetch seed did not contain a glucoside or that the enzyme was not present to produce prussic acid poisoning. The changes in body weight of the rats also indicate that these levels were no more toxic than Diet 1.

An autopsy revealed that rat one on Diet 1 had two tumor-like growths attached to the mesentery and partially surrounding the intestine. The body cavity was filled with sanguinous fluid. Otherwise the rat appeared to be normal. All other rats were normal except rat three on Diet 6, whose left lung had undergone hepatization. There was no basis for assuming that these conditions were caused by the experimental ration.

CONCLUSIONS

The seed of common vetch (Vicia sativa) was not poisonous to rats even when it constituted the sole source of feed.

The presence or absence of a glucoside capable of producing prussic acid poisoning was not demonstrated, as the enzyme for decomposing a glucoside may not have been present.

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PRELIMINARY OBSERVATIONS ON THE CAVE BATS OF ARKANSAS

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At least seven of the known species of bats in Arkansas generally spend part of the winter in caves, buildings, or hollow trees. They prefer caves, and are generally known as cave bats. The other species, which may be grouped together as tree bats, usually are not found in caves or buildings. They generally migrate south in the autumn.

Whether bats enter a true hibernation during their winter residence in caves is not definitely known (Burbank and Young, 1934; Swanson and Evans, 1936; Rysgaard, 1942). The degree of dormancy varies considerably, even among individuals of the same species, and most species can be aroused quite easily from their state of torpidity.

However, the primary aim of this study has not been to study the phenomenon of hibernation *per se*--although a few pertinent observations have been made, particularly with respect to activity during so-called hibernation. The main objectives have been to study aspects of the general population dynamics of bats by means of banding techniques. So far the investigation has been limited to the study of movements, sex ratios, weights, relative numbers, and longevity.

ARKANSAS CAVES

Arkansas caves may be grouped into two categories--natural and man-made. The natural caves are principally of two types: fissure caves, occurring chiefly in limestone, which are caused by geologic faulting along natural fault lines with subsequent water erosion, and stream erosion caves, found mainly in sandstone, hollowed out by underground streams. Man-made caves include mineshafts and underground limestone or sandstone quarries. Usually these are not frequented by bats until several years after the caves have been abandoned.

The fissure caves are generally narrow, with the entrance somewhere near the top of a bluff face. They follow a somewhat winding, downward path. Caves of this type show little or no stalactite or stalagmite formation. The stream erosion types tend to slope gently upward from the entrance, and the evidence of water action is quite apparent. Small underground streams are quite frequently encountered in this type cave and stalactite and stalagmite formations are not unusual.

CAVE LOCATIONS AND SPECIES DISTRIBUTION OF BATS

Locations of a number of caves occurring principally in Northwest Arkansas are shown in Table I and Figure 1. The writers have not entered more than 15 of the caves on the list, but all of the caves which yielded definite records of bats have been included. Several unlisted caves have been visited by the writers, but they offered no records of bats.

(The various species of cave bats found in the caves listed in Table I are shown in Table II.)

As shown in Table II, pipistrelle, gray, and Indiana bats occur in sizeable numbers most often in the caves of this region. The pipistrelle was found in all but one of the 30 caves listed. It is believed to occupy the other cave also. Most observations were made in the fall and winter, although a few were made in late spring and early summer, and by Black (1936) in mid-summer.

Table II offers an inconclusive report of the length of time the various species occupy the caves, since negative results were not tabulated and the caves were not visited all months of the year. However, a rough index of relative frequency of occurrence in the same and different caves is shown. Also, no indication is shown of the more scattered distribution of the lump-nosed bat, big brown bat, and eastern long-eared bat in the caves which are listed.

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NOTE: Research Paper No. 1112, Journal Series, University of Arkansas.

Table I. Locations of Some Arkansas Caves, Principally in the Ozark Mountain Region of Northwest Arkansas.

Cave name	Cave number	Location
Devil's Den Cave	1*	25 miles S. W. of Fayetteville, Washington County
Devil's Icebox	2*	25 miles S. W. of Fayetteville, Washington County
Delap Caves (2)	3	6 miles W. of Prairie Grove, Washington County
Granny Dean Cave	4	2 miles S. W. of Black Oak, Washington County
Fincher Cave	5	1 mile W. of Black Oak, Washington County
Dexter Cave	6	2 miles S. of Sulphur City, Washington County
Nichol's Cave	7	4 miles S. of Sulphur City, Washington County
Basset Cave	8	10 miles S. W. of Elkins, Washington County
Bat Cave	9	5 miles E. of Springdale, Washington County
Hewlitt Cave	10	14 miles W. of Fayetteville, Washington County
Clear Creek Quarry Caves (2)	11	2 miles N. W. of Johnson, Washington County
White River Cave	12	4½ miles E. of Springdale, Washington County
Bat Cave	13*	5 miles N. W. of War Eagle, Benton County
Crystal Cave	14	5 miles N. of Bentonville, Benton County
Cave Springs Cave	15	At Cave Springs, Benton County
Logan Cave	16	8 miles E. of Siloam Springs, Benton County
Indian Cave (Bella Vista)	17	7 miles N. of Bentonville, Benton County
Gregory Cave	18	2 miles W. of Decatur, Benton County
Denney Cave (Horse Thief)	19*	3 miles E. of Alabam, Madison County
Ferris Cave	20	8 miles S. E. of Huntsville, Madison County
Bat Cave	21	4 miles N. of Ozark, Franklin County
Old Mine Shaft	22	Near Cass, Franklin County
Twigly Cave	23	1 mile E. of Midway, Baxter County
Old Mine Shaft	24*	12 miles N. W. of Hot Springs, Garland County
Cushman Cave (Ferrell)	25	Near Cushman, Independence County
Bone Cave	26	4 miles N. W. of Batesville, Independence County
Forshee's Cave	27	Near Batesville, Independence County
Great Hurricane Cavern	28	5 miles S. E. of Western Grove, Searcy County
Bear Creek Cave	29	1 mile S. of Gilbert, Searcy County
Marcella Caves	30	Near Marcella, Stone County

* Caves in which banding of bats has been undertaken

Table II. Occurrence of Several Species of Bats in Certain Arkansas Caves Located Principally in the Ozark Mountain Region of Northwest Arkansas.[1]

Cave number[2]	Species						
	Lump-nosed Bat (*Corynorhinus rafinasquei*)	Big Brown Bat (*Eptesicus fuscus*)	Gray Bat (*Myotis grisiscens*)	Eastern Long-eared Bat (*Myotis keenii*)	Little Brown Bat (*Myotis lucifugus*)	Indiana Bat (*Myotis sodalis*)	Pipistrelle (*Pipistrellus subflavus*)
1	Oct.1951(2,3)	Oct.1935(1)	Oct.1951 (2,3)	Jan.1951(4) Feb.1951(2,3) Feb.1952(2,3)		Nov.1951 (2,3)	__1935(1) Jan.1951(2) Feb.1951(2,3) Oct.1951(2,3) Nov.1951(2,3) Feb.1952(2,3) Jan.1953(2,3)
2	Jan.1951(2) Feb.1951(2,3) Oct.1951(2,3) Nov.1951(2,3) Feb.1952(2,3) Jan.1953(2,3)						Jan.1951(2) Feb.1952(2,3)
3							--1935(1) Nov.1950(2,3)
4							Sept.1950(2,5) Oct.1950(2,3) Dec.1950(2,4)
5							Sept.1950(2,5) Dec.1950(2,4) Nov.1951(2,3) Oct.1952(6)
6							Dec.1950(2,4)
7						Oct.1950 (2,4) Nov.1951 (2,3)	Oct.1950(2,4) Dec.1950(2,4) Nov.1951(2,3)
8	Nov.1951(2,3)						Oct.1950(2,3) Dec.1950(2,4)
9			Jun.1951 (2,3)				--1935(1) June 1951(2,3)
10	Oct.1950(2,3) Dec.1950(2,3) Nov.1952(2)						Oct.1950(2,3) Dec.1950(2,3)
11			Oct.1952 (2)				Nov.1950(7) Feb.1951(2,3) May 1951(2) Oct.1952(2)
12							Oct.1952(2,8) Nov.1952(2,9)
13		Dec.1934(1)	Jul.1934 (1) Dec.1934 (1) Dec.1951 (2,3) Apr.1952 (2,9)	Dec.1951(2,3)		Jul.1934 (1) Dec.1934 (1) Feb.1938(1) Dec.1951 (2,3) Apr.1952 (2,9)	Dec.1934(1) Feb.1938(1) Dec.1951(2,3) Apr.1952(2,9)

--Continued

Table II. (Continued)

Cave number[1]	Species						
	Lump-nosed Bat (*Corynorhinus rafinesquei*)	Big Brown Bat (*Epstesicus fuscus*)	Gray Bat (*Myotis grisiscens*)	Eastern Long-eared Bat (*Myotis keenii*)	Little Brown Bat (*Myotis lucifugus*)	Indiana Bat (*Myotis sodalis*)	Pipistrelle (*Pipistrellus subflavus*)
14		Sept.1938(10)	Apr.1933(11) May 1938(10)	Apr.1938(10)			May 1938(10)
15						--1935(1)	Feb.1953(8) Mar.1953(12)
16						Oct.1947 (13)	Oct.1947(13)
17			--1935(1)				Oct.1940(10)
18							--1935(1)
19		--1935(1) Nov.1952(8)	--1935(1) Nov.1951(2,3) Dec.1951(2,3) Nov.1952(2,3) Dec.1952(2,3)			Jun.1933(1) Mar.1934(1) Jul.1934(1) Dec.1951 (2,3) Nov.1952 (2,3) Dec.1952 (2,3)	--1935(1) Nov.1951(2,3) Dec.1951(2,3) Nov.1952(2,3) Dec.1952(2,3)
20							--1935(1)
21		--1935(1)					
22							Oct.1947(13)
23		Dec.1952(14)				Dec.1952(14)	Dec.1952(14)
24				Nov.1952(6)	Nov.1952 (6) Dec.1952 (6)	Nov.1952(6)	Dec.1952(6) Jan.1953(6)
25				Mar.1948(5)		Mar.1948(5)	Mar.1948(5)
26		Mar.1948(17) Feb.1953(15)	Mar.1948 (5,16) Jun.1948(5)				Mar.1948(5) Feb.1953(15)
27					Mar.1948 (5)		Oct.1947(5) Mar.1948(5,17)
28						Dec.1952(14)	Feb.1938(18) Dec.1952(14)
29		Dec.1952(14)				Dec.1952(14)	Dec.1952(14)
30		Mar.1948(5)	Oct.1950(5)				Oct.1950(5)
Total caves	4 (13.3%)	9 (30%)	9 (30%)	5 (16.6%)	2 (6.6%)	11 (36.6%)	29 (96.6%)

[1]Numbers in parentheses following dates of observation refer to the following observers: (1) J. D. Black, (2) J. A. Sealander, (3) H. Young, (4) B. Q. Walker (5) C. C. Sanborn, (6) F. B. Truett, (7) D. W. Rust, (8) H. G. Dowling, (9) P. M. Johnston, (10) E. H. Crawley, (11) R. D. Harding, (12) P. Callahan, (13) H. Smith and D. Parker, (14) R. L. Jordan, (15) W. L. Henning, (16) F. C. Wonder, (17) C. Kalinowski, (18) D. Causey.

[2] Cave locations corresponding to cave numbers listed in Table I.

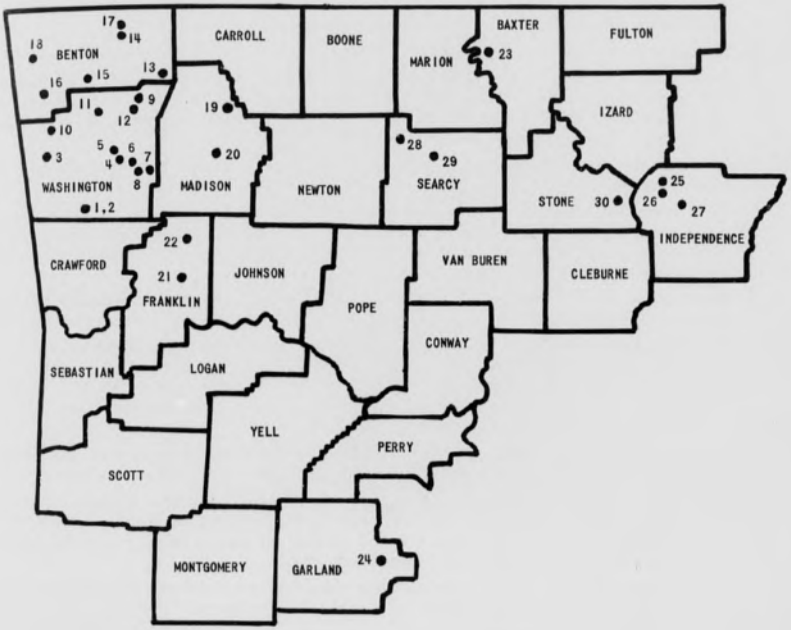

Fig. 1. Map Showing Locations of Caves in Ozark Mountain Region of Northwest Arkansas. (Numbers refer to caves in Table 1).

KEY TO ARKANSAS CAVE BATS

(The following key, based largely on external measurements and pelage characteristics, is intended for identification of live specimens. Certain characteristics included in the key, such as tooth number, are not noted easily in the field, but are included to permit more positive recognition. The teeth in some species are so small that a hand lens or binocular microscope may be required to identify them. Measurements and pelage characteristics are based also on adult specimens and therefore do not always permit recognition of immature specimens. The enlarged, vascular appearance of the epiphyses, particularly of the long bones of the forearm, is used sometimes as a convenient field criterion for distinguishing adults and juveniles, but this requires a fair amount of experience, especially in dark, poorly lighted caves.)

1. Ears very long (30 mm or more) and leaf-like (curled like a ram's horn when in a dormant condition); color clove-brown on back; with a prominent fleshy lump above each nostril; total length over 90 mm; total number of teeth 36----*Corynorhinus*---------- 2.

2. Hairs on abdomen white-tipped; ears joined in middle----------*Corynorhinus macrotus* (LeConte) LeConte Lump-nosed Bat.

2'. Hairs on abdomen buff-tipped; ears joined across forehead-----*Corynorhinus rafinesquei*----------3.

3. Color darker----C. r. rafinesquei (Lesson) Rafinesque lump-nosed bat.

3'. Color lighter----C. r. pallescens (Miller) Pallid lump-nosed bat.

(*Note:* The above two subspecies intergrade with each other. Most Arkansas specimens are referable to C. r. rafinesquei).

1'. Ears shorter; no lump above nostrils----------4.

4. Wing membrane attached to foot near ankle and not at base of toes; upper fur uniform in color from base to tips; color dull brown to mouse gray; total length usually less than 105 mm ; total number of teeth 38----*Myotis grisescens* A. H. Howell Gray Bat.

4'. Wing membrane attached to foot at base of toes; upper fur not uniformly colored from base to tip----------5.

5. Ears when laid forward in normal position extend beyond tip of nose; ears more than 13 mm long from crown to tip; dorsal fur brownish olive, wing membranes grayish; total number of teeth 38----*Myotis keenii septentrionalis* (Trouessart) Eastern long-eared bat.

5'. Ears when laid forward in normal position not extending beyond tip of nose----------6.

6. Interfemoral membrane slightly furred on basal one-fourth or one-third; color yellowish-brown; wing membranes black, contrasting strongly with pelage; forearm less than 36 mm ; total length under 90 mm.; total number of teeth 34----------*Pipistrellus subflavus subflavus* (F. Cuvier) Pipistrelle.

6'. Interfemoral membrane naked or furred at extreme base only; wing membranes not contrasting strongly with pelage----------7.

7. Size large; total length usually more than 105 mm ; length of forearm 40 mm. or more; fur on back bi-color; color sepia brown; fur darker at base than tips; total number of teeth 32---------*Eptesicus fuscus fuscus* (Beauvois) Big brown bat.

7'. Size smaller; total length less than 100 mm ; length of forearm less than 40 mm ; total number of teeth 38----------8.

8. Fur on back tri-colored, sometimes giving a pinkish-gray tinge to pelage----*Myotis sodalis* Miller and Allen Indiana bat.

8'. Fur on back bi-colored, brownish with tips of hairs burnished giving a somewhat metallic sheen to pelage----------*Myotis lucifugus lucifugus* (LeConte) Little brown bat.

BANDING STUDIES

In the fall of 1950 preliminary surveys of approximately 20 caves within a 40-mile radius of Fayetteville were conducted. Four of these caves (Devil's Den, Devil's Icebox, Bat Cave, and Denney Cave) were selected for more intensive study, and banding operations begun in Devil's Den cave February 24, 1951. Banding has been continued in these caves and it is expected to be continued for an indefinite period. A few bats were banded by Robert Truett in an old mine shaft near Hot Springs.

Devil's Den Cave and Devil's Icebox are typical fissure type caves. On the other hand, Bat Cave and Denney Cave appear to have been formed chiefly by stream erosion. Bat Cave and Denney Cave contain underground streams. The old mine shaft near Hot Springs is a straight, level shaft 100 to 150 yards long, about five feet wide, and approximately six feet high.

Techniques. Dormant bats, which could be reached by hand, were taken easily from walls and ceilings. An extension pole with a small flattened wire loop at one end was used to gather bats that were out of reach. All of the bats except those in the highest regions could be dislodged easily with the pole.

When collected, the bats were separated according to sex and placed in large five-gallon cans (Figure 2). The cans were screened on one side with quarter-inch mesh hardware cloth. A smaller can--just large enough to admit the bander's hand--was soldered to the top of the large container. The smaller can

was about six inches long. The edges of the open end, which projected into the large container, were rolled. About four inches of the smaller can were left projecting into the larger can. The most active bats were unable to escape these containers, even with the covers off.

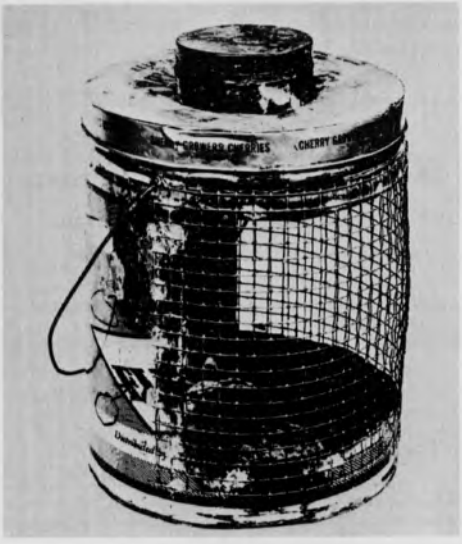

Fig. 2. Collecting can for bats.

Bats were wing-banded according to the method described by Trapido and Crowe (1946). Number 1 bird bands were placed on the fore-arms of the bats. Care was exercised to enable the band to slide freely on the fore-arm without cutting through the wing membrane.

Many bats were banded with colored celluloid as a preliminary experiment to test the effectiveness of observations concerned with the movement of bats in the caves.

An attempt was made to visit each cave at least twice a year--during fall or winter and during the spring. Some caves were visited more than twice a year, and time permitted only a single trip to some other caves.

Banding Results. A total of 1,129 bats have been wing-banded for this study. Table III shows a breakdown of the species banded and the locality of banding.

Recovery of these banded bats has been disappointing. No bats have been found outside the location of original banding. Robert Truett found in an abandoned mine shaft near Hot Springs that most banded bats had disappeared with in 24 hours. Table IV shows recovery records from our best sample, the pipistrelles in Devil's Den Cave. Slightly higher return rates might have been expected if it had been possible to visit the banding caves more often, and to investigate other nearby caves for banded bats. Other studies have resulted in considerably higher recovery rates, especially during the first year after banding. But in these cases, the banding was done where caves were not numerous.

In all species, the males predominate in the caves. Of the 468 pipistrelles banded in Devil's Den at this writing, 324 (70 per cent) were males. The closest to a balanced sex ratio discovered on a single trip was 67 ♂♂ 63 ♀♀ (106:100) (*Myotis sodalis* in Denney Cave, December 1952). The greatest sex-ratio distortion found was 52 ♂♂ 3 ♀♀ (1,733:100) (*Pipistrellus subflavus* in Denney Cave, November 1952). Usually there are twice as many males as females in the caves.

Table III. Summary of Arkansas Bat Banding, 1951-1953.

Cave	Species					
	Pipistrellus subflavus	*Myotis grisescens*	*Myotis sodalis*	*Myotis lucifugus*	*Corynorhinus rafinesquei*	Total
Devil's Den Washington County	468	1	2		1	472
Devil's Icebox Washington County	2				4	6
Denney Cave Madison County	137	73	164			374
Bat Cave Benton County	218	3	41			262
Mine Shaft Garland County	4			11		15
Total	829	77	207	11	5	1,129

Table IV. Recovery Data for Pipistrelles *(Pipistrellus subflavus)* from Devil's Den Cave, Washington County, Arkansas.

Days elapsed since banding	Number of bats banded	Number of bats recovered	Per cent recovered
78	363	20	5.5
123	363	8	2.2
242	363	7	1.9
344	363	6	1.7
384	363	3	0.9
462	264	2	0.8
728	224	1	0.4

Table V. Summary of Pipistrelle *(Pipistrellus subflavus)* Weights from Different Caves During Different Months of the Year.

Date and location	Average weight in grams*		
	Males	Females	Total
11/23/51 Devil's Den cave	5.7 (20)	5.9 (13)	5.8 (33)
12/13/52 Denney cave	6.0 (25)	-----	6.0 (25)
12/15/51 Bat cave	5.6 (25)	6.3 (19)	5.9 (44)
12/29/51 Bat cave	5.4 (50)	5.9 (25)	5.6 (75)
1/28/53 Devil's Den cave	5.1 (50)	5.7 (25)	5.3 (75)
2/9/52 Devil's Den cave	4.9 (50)	5.6 (28)	5.1 (78)
5/3/52 Denney cave	4.3 (25)	-----	4.3 (25)
Total	5.2 (245)	5.8 (110)	5.6 (345)

* Numbers in parentheses refer to number of individuals on which averages are based.

The pipistrelles usually were found alone. They seldom were aggregated in groups of more than two or three. Gray bats and Indiana bats more often were found in groups. Some information as to cluster size and cluster sex ratios of these two species has been learned from this study.

Indiana bats were found both alone and in clusters. The largest cluster observed in this study contained 34 bats--17 males and 17 females. In general, the clusters tended to be small, ranging from 5 to 12 individuals. However, as many as 70 individuals in a cluster have been reported (Black, 1936). As yet, too little information has been accumulated to enable us to observe other than general trends in the sex ratio in clusters. Many clusters had 1:1 sex ratios, although for the most part males were in the majority.

Some observations indicate that gray bats form clusters at the start of hibernation. These clusters evidently disperse as the cave temperatures drop, because the bats aggregate together in narrow crevices later in the winter. Only two clusters of gray bats have been tallied. Males were heavily in excess in both (21:0 and 31:1).

Three mixed clusters were noted. They were composed mainly of *Myotis sodalis* with one *Myotis grisescens* in each cluster. However, it appears that a mixture of the species in clusters is not a common occurrence.

WEIGHTS

Weights of several bat species were obtained. The figures quoted here are average weights derived by weighing groups. The females, on the average, outweigh the males. For *M. sodalis* two male samples, of 25 and 50 each, both averaged 7.1 grams; two female samples of 11 and 50 each, averaged 7.5 grams and 7.4 grams, respectively. For *M. grisescens* there was a single sample of 50 males. These are larger bats and they averaged 11.6 grams.

The best data are for pipistrelles. They are shown in Table V and indicate the heavier weight of the females. (Note also the progressive loss of weight during the hibernating season.) Although bats of this species are known to be active during hibernation, the weight loss would indicate that little or no feeding takes place during hibernation.

DISTURBANCE TO BATS

Persons entering caves often engage in pointless destruction of bats. Reports of destruction with burning torches and by shooting are frequent. Such activities cause only a small loss in the total bat population. However, it may force the bats to desert certain caves. Deaths from natural predators in the caves are believed to be few. Wood rats frequent many caves but they are found mostly near the entrances and probably cause little trouble to the bats. Evidences of other predation have been reported by Rysgaard (1942). Mink predation has been reported in the literature (Goodpaster and Hoffmeister, 1950). Aside from natural mortality due to other causes than predation, it seems that humans are the greatest destructive agents.

PARASITES

No systematic attempt was made to collect parasites from bats, or to study the incidence of parasites in bats. However, several bats taken from caves for preparation as study skins yielded several species of ectoparasites.

Ectoparasites found on the bats were removed, preserved, and forwarded to Lewis J. Stannard of the Illinois Natural History Survey, who either identified them personally or referred them to other taxonomic experts.

A number of larval and adult chiggers were collected from different species of bats. They were usually found on the inner side of the ears near the lower border. A few were found on the wing membranes. One parasitic species, identified as *Euschongastia pipistrelli Brennan,* was recovered frequently from pipistrelles, and several specimens also were recovered from the ears of the eastern long-eared bat *(M. keenii).* Eight individuals of another species of chigger *(Trombicula myotis* Ewing) were found on the ears of a gray bat.

Spinturnicid mites of the species *Spinturnix iowae* Keegan were found on the wings of these bats: *P. subflavus, M. grisescens,* and *M. sodalis.* More than 50

individuals were recovered from a gray bat taken June 20, 1951. According to Stannard (personal communication) these mites are apparently more common in early summer than early spring.

A species of streblid fly (*Trichobius corynorhini* Cockerell) was found on the lump-nosed bat (C. rafinesquei). They were found chiefly on the wing membranes, and at least one seemed to be present on every bat of this species, while most of the lump-nosed bats harbored 10 or more of these flies.

Several small mites recovered from various species of cave bats still are unidentified.

DISCUSSION

The few field observations indicate that some of the larger species, such as the lump-nosed bat and big brown bat, may enter caves in this latitude only for brief periods during coldest winter. At other times they seem to prefer wide-mouthed caves that provide shelter from wind and rain while differing little in temperature from the outside surroundings. Similar observations of some of the hardier species of bats have been made by Mohr (1932) and Rysgaard (1942).

Most of the smaller cave bats seem to prefer narrow-mouthed caves with a fairly constant temperature (about 50° F) and a rather high relative humidity. Exactly how long these bats live in the caves has not been established. But a few species, particularly the pipistrelle, enter caves from late September to early November and do not leave until late April or May. While in the caves, some bats acquire a coating of fine water droplets on the pelage. This causes a whitish appearance, which has given rise to frequent reports of albino bats (Black, (1936, Jones *et al.*, 1952). It is likely that the bat removes this water during periodic grooming of the pelage to provide some of its necessary water supply during the dormant period.

Banding returns so far have been meager, possibly because of:

(1) The large number of nearby caves to which banded bats may disperse. Rapid dispersal was noted during all night observations by R. Truett in a mine shaft, and the writers also have noted considerable movement among the bats in hibernating populations during warm weather.

(2) The solitary habits of the pipistrelle which comprises the majority of our banded bats. Because this species disperses widely in the caves, many banded individuals probably are overlooked on subsequent banding trips.

(3) Unknown mortality factors.

Sex ratios have followed the usual trend in bat banding studies with males decidedly preponderant (Mohr, 1939, 1942, 1945; Hitchcock, 1949; and others). Disproportionate sex ratios apparently are not present at birth (Griffin, 1940). The general explanation is a higher female mortality rate, especially during the first year. However, there has been little definite proof advanced for this hypothesis.

Weights of bats apparently show a downward trend as the period of dormancy extends. Folk (1940) cites evidence of other workers on the feeding of bats during hibernation. From our data, we conclude at present that little or no feeding occurs, and that the bats are living largely off surplus fat accumulated before they entered the caves.

SUMMARY

1. Thirty cave locations are listed for the Ozark Mountain region of Northwest Arkansas. The occurrence of seven species of bats in these caves is shown.
2. A key to Arkansas cave bats is shown.
3. A total of 1,129 bats of five species was wing-banded from February 1951 to January 1953. Recovery data on pipistrelle bats, which comprised the largest number of bats banded, are shown. All recoveries were in the location of original banding.
4. Sex ratios of banded bats showed a marked preponderance of males in all cases. A few sex ratios for clusters of gray and Indiana bats are given.
5. Weights of banded pipistrelles showed a steady decline from autumn to spring.
6. Ectoparasites recovered from several species of bats have been identified.

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CARCASS QUALITY OF INBRED AND CROSSBRED UARK POLAND CHINA SWINE

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A basic problem confronting the swine breeder is obtaining an ideal animal--one that grows rapidly and consumes feed efficiently, giving a dressed carcass with a large percentage of lean and a minimum amount of fat. The ham, loin, picnic shoulder, and Boston butt comprise the four lean cuts of a pork carcass. Because they are the most valuable cuts, they receive special attention. The depth of the fat on the pork carcass wields considerable influence on the wholesale cuts yielded by the carcass. Scott (1930) found that as the depth of the fat increased the lean and bony cuts decreased. The longer carcass feels the effect of the fat covering less.

Hankins and Ellis (1934) found correlation of .84 between the percentage fat in the total edible portion of the carcass and the average back fat in millimeters. Dickerson, *et al.*, (1943) found that external conformation was more apt to indicate a difference in fat thickness and length of bone and muscle thickness. Consequently, they were less accurate in predicting cut out value.

EXPERIMENTAL PROCEDURES

In 1949-50 a total of 70 weanling pigs of both inbred UArk Poland China and crossbred UArk Poland China pigs were dry lot fed a ration of corn and a protein supplement free choice. They were grouped according to breeding and all were fed the same ration. The pigs were fed to a weight of approximately 225 pounds. One pig, considered average of its group, was slaughtered and carcass measurements were taken to determine which were the most desirable carcasses, according to the breeding of the swine. The breeding of the 14 groups is shown in Table I.

The 14 carcasses which were studied came from pigs of the Arkansas Agricultural Experiment Station Inbred Poland China swine herd, the Iowa Agricultural Experiment Station Inbred Poland China swine herd, the Missouri Agricultural Experiment Station Inbred Poland China and Hampshire swine herds, and the Minnesota Agricultural Experiment Station swine herds. A brood sow captured in the mountains near Mena, Arkansas, was identified as a UArk wild hog. These wild pigs had wattles and were similar to small bone Poland China and Black Essex hogs.

The carcass data and measurements were taken on the slaughtered animals. The data and measurements are shown in Table II, which also gives information on Group A, the most desirable carcass, and Group N, the least desirable carcass, according to Dickerson's Index.

Dickerson (1946) constructed an Index for determining carcass scores. The formula follows:

$$\text{Index} = (Yr) + (.4P + .4L + .2H - .5B - 1.5V).$$

Y - Yield of wholesale cuts in percentage of shrunk live weight.

r - Relative price, based on the average of the Chicago weekly quotations for the five-year period, 1937-41 inclusive.

P - Ham plumpness index $\frac{(\text{ham circumference} \times 100)}{\text{ham length}}$.

L - Loin eye muscle index (width x depth of eye muscle).

H - Ham muscle index (width x depth of lean on ham face).

B - Deviation of sum of the backfat thickness from optimum

$$B = 4.5 - \frac{(\text{weight} - 210)}{40}.$$

V - Backfat range (difference between thickest and thinnest backfat measurement).

NOTE: Research Paper No. 1109, Journal Series, University of Arkansas.

Table I. The Breeding of Swine used in Carcass Measurement Studies During 1949 and 1950.

Group	Breeding of		Inbreeding coefficient or Fx		
	Sire	Dam	Sire	Dam	Litter
A	UArk Poland 48-88	UArk Poland 48-60	.5821	.5115	.5115
B	UArk Poland 49-41	UArk Poland 49-350	.6521	.6521	.6225
C	Iowa Poland AX 4090-48S	UArk Poland 48-73	.0000	.5731	.0000
D	UArk Poland 49-215	UArk Poland 49-263	.6521	.6521	.6857
E	Missouri Poland 608-LII	UArk Poland 49-35	.4118	.5821	.0000
F	UArk Poland 48-128	UArk Poland 48-126	.5043	.5043	.6135
G	UArk Wild 48-5-Wild	UArk Wild (Watkins)	.0000	.0000	.0000
H	Missouri Hampshire 269-1M	UArk Chester Poland Cross 49-CP-342	.3436	.0000	.0000
I	Missouri Hampshire 269-1M	UArk Poland 49-33	.3436	.0000	.0000
J	UArk Poland 49-31	Minnesota No. 1 Wild Cross 49-MW-22	.4560	.0000	.0000
K	Missouri Hampshire 269-1M	UArk Chester Poland Cross 49-CP-340	.3436	.0000	.0000
L	Minnesota No. 1 S. E. E. 762	UArk Poland 48-121	.0000	.5043	.0000
M	UArk Chesterwhite 48-C-53	UArk Poland 48-124	.0000	.5043	.0000
N	Minnesota No. 1 S. E. E. 762	UArk Wild 48-1-Wild	.0000	.0000	.0000

Table II. Carcass Data of the Most Desirable and the Least Desirable Carcass.

	Group	
	A (good)	N (poor)
Dressing per cent	*65.19*	*73.58*
Back fat thickness (inches):		
Over first rib	1.50	2.50
Over last rib	1.00	2.50
Over last lumbar vertebra	1.25	2.00
Average thickness	1.25	2.33
Five primal cuts *(per cent of total carcass)*		
Hams	*19.57*	*15.00*
Loins	*15.94*	*10.63*
Butts	*7.61*	*5.00*
Picnics	*9.78*	*6.88*
Bellies	*11.23*	*14.69*
Five primal cuts - total	*64.13*	*52.20*
Four lean cuts - total	*52.90*	*37.51*
Carcass measurements (inches):		
Length (aitch bone to first rib)	28.50	28.37
Depth (spinal canal to breast bone)	8.25	8.00
Width of shoulder	5.00	4.50
Width of ham	6.00	5.50
Plumpness of ham	32.50*	19.75
Length of ham	13.25	12.50
Length of hind leg	20.75	20.25

* Very plump hams.

The relative values given the various cuts in this formula included loin 1.0, ham .93, shoulder. 80, belly .80, fat trim .35, and lean trim .53 (James, 1948).

Dickerson's formula was modified for this data because of lack of information about obtaining the loin eye muscle index, the ham muscle index, and the lean and fat trim.

Table III. The Rank of 14 Different Poland China Matings in Carcass Quality.

Group	Rank	Index Value	Breeding	
			Sire	Dam
A	1	63.92	UArk Poland	X UArk Poland
B	2	61.46	UArk Poland	X UArk Poland
C	3	61.25	Iowa Poland	X UArk Poland
D	4	60.02	UArk Poland	X UArk Poland
E	5	59.92	Missouri Poland	X UArk Poland
F	6	57.72	UArk Poland	X UArk Poland
G	7	57.51	UArk Poland X Wild	X UArk Poland X Wild
H	8	57.46	Missouri Hampshire	X Chester White X UArk Poland
I	9	57.44	Missouri Hampshire	X UArk Poland
J	10	56.81	UArk Poland	X Minnesota No. 1 X Wild
K	11	54.97	Missouri Hampshire	X Chester White X UArk Poland
L	12	52.71	Minnesota No. 1	X UArk Poland
M	13	52.44	Chester White	X UArk Poland
N	14	49.13	Minnesota No. 1	X UArk Wild

RESULTS

This study of carcass quality as indicated by yield of wholesale cuts in percentage of shrunk live weight, plumpness of ham, length of ham, and size of ham muscle face along with back fat thickness, proved valuable in testing the UArk Inbred Poland China swine breeding program. The UArk line of Poland China swine nicks well with other breeds. Table III shows the rank of the different matings.

SUMMARY

The most valuable carcass was obtained when the UArk Poland China swine herd line was crossed. The Index value was 63.92. This carcass came from a pig sired by UArk 48-88 with a coefficient of inbreeding of .5821. The dam, UArk 48-60, had an Fx of .5115. The pig had an Fx of .5115.

The second most valuable carcass was obtained from a crossing of two UArk Inbred Poland China Swine. The sire, UArk 49-41, had an Fx of .6521 and the dam, UArk 49-350, had an Fx of .6521. The carcass came from a pig with an Fx of .6225. The top six placings were all pure bred Poland China swine.

An Iowa Poland China inbred sire produced the third most valuable carcass. A Line II Missouri Poland China produced the fifth best carcass. Of all the carcasses studied the UArk Poland China swine herd produced four out of the top six.

The program of swine improvement at the University of Arkansas has developed a line of purebred Poland China swine with superior carcass quality.

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EFFECT OF INSUFFICIENT NUTRIENTS DURING THE SEEDLING STAGE ON GROWTH AND YIELD OF COTTON PLANTS[1]

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When temperature, light, and water are not limited, growth and yield of crop plants are correlated closely with the available supply of mineral nutrients. Symptoms of a deficiency of a single essential mineral element, such as nitrogen, phosphorus, or potassium, may be striking. On the other hand, when there is an insufficiency of nutrients, but no marked unbalance between the essential elements, the effect on growth and yield is more difficult to evaluate. By regulating the quantity of a relatively balanced nutrient solution applied to cotton plants, the rate of height growth can be controlled without revealing symptoms of nutrient deficiency. Yield may be controlled in a similar manner.

Under field conditions, crops are planted with the fertilizer placed some distance beneath or to the side of the seed. When natural fertility of the soil is low, the seedling temporarily may have an inadequate supply of mineral nutrients for maximum growth. This paper deals with the effect of a temporary insufficiency of mineral nutrients during the early seedling stage on growth and yield of cotton.

METHODS

Cotton (*Gossypium hirsutum* L., variety Arkot 2-1) was grown in the greenhouse in six-inch pots containing quartz sand. Two of the four replications were harvested at 56 days for fresh and dry weights and chemical analyses, and the remaining two were grown to maturity for yield data. A complete nutrient solution was applied daily at the rates shown in Table I. All treatments were maintained on a 1-1-1 nutrient ratio of N-P-K, except Treatment 7 which received a 2-1-2 ratio after the two-week period of insufficiency. The composition of the 1-1-1 solution and a slightly different 2-1-2 solution have been reported previously (1). The molar concentration of N, P, and K in the 1-1-1 ratio was 0.005. The pots were flushed with distilled water twice each week to wash out excess salts. Height measurements were made at weekly intervals.

RESULTS

Heights and fresh and dry weights of the harvested plants are shown in Table II. One week's delay in supplying adequate nutrients had no effect on height or weight, but extending the period of nutrient insufficiency decreased both height and weight of the 56-day-old plants.

The height-age curves for this experiment are shown in Figure 1. Only the three- and four-week delay in adding sufficient nutrients caused an appreciable lag in height growth. Plants receiving less nutrients were shorter (Treatment 1).

The effect of nutrient insufficiency on development of squares, flowers, and mature fruit are shown in Table III. The appearance of the first blossom was delayed a full week because of a three-week period of nutrient insufficiency during the seedling stage and almost two weeks by the four-week period. Where 2-1-2 nutrient solution was applied, there was less delay in the appearance of the first blossom than where 1-1-1 was applied (Treatments 4 and 7).

The yield data for the various treatments are shown in Table IV. The delay in supplying adequate nutrients had no effect on number of mature bolls per plant. The plants receiving the 2-1-2 ratio produced 13 bolls while those receiving the 1-1-1 ratio produced approximately eight bolls.

DISCUSSION

Under the conditions of this experiment, up to a four-week period of nutrient insufficiency during the early seedling stage had no effect on yield as measured by the number of mature bolls per plant. Nevertheless, the delay in onset of

[1] Research Paper No. 1102, Journal Series, University of Arkansas. Published with the permission of the Director of the Arkansas Agricultural Experiment Station.

Table I. Milliequivalents of Nitrogen, Phosphorus and Potassium Applied Daily.

Days from planting date	Treatment Number								
	1	2	3	4	5	6	7		
							N	P	K
0-4	0	0	0	0	0	0	0	0	0
5-6	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125
7-13	0.500	1.000	0.125	0.125	0.125	0.125	0.125	0.125	0.125
14-20	0.750	1.500	1.000	0.125	0.125	0.125	0.125	0.125	0.125
21-27	1.000	1.750	1.500	1.000	0.125	0.125	2.000	1.000	2.000
28-34	1.250	1.750	1.750	1.500	1.000	0.125	3.000	1.500	3.000
35-41	1.250	1.750	1.750	1.750	1.500	1.000	3.500	1.750	3.500
42-48	1.250	1.750	1.750	1.750	1.750	1.500	3.500	1.750	3.500
49-98	1.250	1.750	1.750	1.750	1.750	1.750	3.500	1.750	3.500
98-maturity	1.250	1.250	1.250	1.250	1.250	1.250	2.500	1.250	2.500

Table II. Effect of Insufficient Nutrients During Early Seedling Stage on Height and Weight of 56-Day-Old Cotton Plants.

Treatment number	Nutrient Solution			Height	Weight	
	Ratio N-P-K	Maximum applied	Delay (weeks)		Fresh	Dry
		ml.		cms.	gms.	gms.
1	1-1-1	250	none	64.4	95.67	17.82
2	1-1-1	350	none	71.3	124.82	19.34
3	1-1-1	350	1	76.4	124.35	19.89
4	1-1-1	350	2	67.8	110.59	16.97
5	1-1-1	350	3	54.5	82.82	11.57
6	1-1-1	350	4	41.4	56.29	6.95
7	2-1-2	350	2	62.7	144.82	20.81

Table III. Effect of Nutrient Insufficiency During Early Seedling Stage on Fruiting of Cotton Plants.

Treatment number	Nutrient solution			Delayed appearance (days)						
	Ratio N-P-K	Maximum applied	Delay (weeks)	Squares (0.5 cm) 1st	2nd	3rd	4th	Open blossom 1st	2nd	Open boll 1st
1	1-1-1	250	none	0	0	0	0	0	1	2
2	1-1-1	350	none	0	0	0	0	0	0	3
3	1-1-1	350	1	0	0	0	0	3	4	5
4*	1-1-1	350	2	1	1	1	2	5	6	5
5	1-1-1	350	3	4	5	6	7	7	9	11
6	1-1-1	350	4	8	9	11	13	13	15	15
7	2-1-2	350	2	0	1	1	2	1	1	0

* Values from single plant.

Table IV. Effect of Nutrient Insufficiency During Early Seedling Stage on Yield of Cotton Plants.

Treatment number	Nutrient solution			Number of blossoms	Number of mature bolls	Per cent blossoms producing bolls
	Ratio N-P-K	Maximum applied	Delay (weeks)			
		ml.				
1	1-1-1	250	none	18.0	6.0	33.3
2	1-1-1	350	none	22.0	7.5	34.1
3	1-1-1	350	1	22.5	8.0	35.1
4	1-1-1	350	2	21.0*	7.0*	33.3
5	1-1-1	350	3	21.5	8.5	39.3
6	1-1-1	350	4	16.0	8.0	50.0
7	2-1-2	350	2	30.0	13.0	43.3

* Values from a single plant.

flowering and boll maturation is of practical importance, particularly where the growing season may be cut short by early frosts. For each two-week delay in applying adequate nutrients, there was approximately one week delay in harvest. Under field conditions, the location of adequate fertilizer near the seedling would minimize the period of nutrient insufficiency, thereby insuring maximum early growth as well as an earlier harvest.

SUMMARY

Cotton plants maintained on a low level (0.125 milliequivalents each of N, P and K daily) of mineral nutrients for one to four weeks beginning seven days after planting in the greenhouse, matured as many bolls as plants maintained on a high level (1.00 to 1.75 milliequivalents each of N, P, and K supplied daily) during the same period.

Height growth was curtailed sharply during the third and fourth weeks of this period of insufficiency. Lengthening the period of nutrient insufficiency also delayed resumption of growth following application of adequate nutrients. A four-week period of insufficiency delayed opening of the first blossom and boll 13 and 12 days, respectively. Each week of delay in providing adequate mineral nutrients resulted in approximately a three-day delay in harvest. The data suggest that height growth may be curtailed more readily by nutrient insufficiency than differentiation of floral primordia.

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WATER-STABLE SOIL AGGREGATES STABILIZED BY POLYELECTROLYTES[1]

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Workers in agriculture have observed repeated situations in which crop yields have decreased because of the physical condition of the soil and not because of its lack of fertility (4, 5). The physical limitation invariably involves the breakdown of the good structural soil condition.

The soil structure, or arrangement of the primary particles, is important for many reasons. In general, a favorable structural condition is one in which the soil particles are aggregated into groups or clods of various sizes (1). This condition provides for a sufficient number of large soil pores to permit adequate aeration. At the same time, this structural condition will provide small pores within and between the clods, where water is held for use by the plant life. A proper balance is essential for the complete satisfaction of the requirements of the plant and the microorganisms within the soil.

It is well known that organic matter plays an essential role in securing the structural condition or tilth required for high productivity. The natural soil aggregating substances consist of three general types, polar organic substances of polysaccharides, polyuronides, and polyuronic groupings resulting from gradual decomposition of fresh organic matter, and a group consisting of hydrated oxides, fats, waxes, and resins, which are less efficient in aggregation. The soil organic matter is continually undergoing decomposition and thus it is destroyed about as fast as it is added. Structural decay of the soil clods results when the valuable organic substances are decomposed and not replaced.

Recently, artificial stabilization of the soil clods has received considerable attention (3). The purpose was to introduce a substance into the soil which would be similar to the polyuronic material naturally present. This substance would resist decomposition by microorganisms and at the same time take the important place of maintaining the structural soil condition indefinitely. The result was what is known widely as Soil Conditioners.

Materials currently being studied for soil stabilization are classed in three general groups: acrylic acid derivatives, cellulose gums, and silicate derivatives. This paper includes chemicals from the acrylic acid derivatives group only. The purpose of this study was to determine the effect of slaking and drying on soil stabilized with these conditioners and to determine the effect of these chemicals on Bolivar, Crowley, and Sharkey soil.

EXPERIMENTAL

In order to study the effect of the soil conditioners on the soil aggregates and to compare the effects of different materials, it was necessary to establish a standard procedure. The grain sizes of small aggregate particles in the soils were determined by means of sedimentation and Stoke's law. Separation for large aggregates was done by means of a nest of sieves. Thus, not only were the individual particles determined, but the sizes of the aggregates stabilized were determined and any differences in size distribution among soils were noted.

The two conditioner types involved in this study were hydrolized polyacrylonitrile (K-9 or HPAN) and a copolymer of vinyl acetate-maleic acid (K-6 or VAMA) both of which now are available commercially.[2]

The soil to be treated with conditioner was air dried and carefully crushed to pass a 40 mesh (.42 mm) screen. The calculated amount of conditioner was added to the weighed soil and thoroughly mixed. The amount of conditioner used was 0.15, 0.08, 0.04, 0.02, and 0.00 per cent by weight-active material. The

[1] Research Paper No. 1103, Journal Series, University of Arkansas. Supported in part by a grant from Mathieson Chemical Corp. Contribution of the Agricultural Experiment Station.

[2] The chemicals were supplied by the Monsanto Chemical Company.

mixture was moistened and stirred under an atomizer spray until the moisture equivalent was reached. This process encouraged thorough mixing, adsorption of the electrolyte, and aggregate formation. The samples were allowed to stand 24 to 96 hours.

These samples were then carefully crushed through a 5 mm screen and then washed into a standard hydrometer jar. The suspension then was shaken end over end for one minute and the percentage of particles less than .05 mm in diameter was determined by use of the standard Bouyoucos soil hydrometer (2). No dispersing agent was added. The material which was used for the sedimentation study then was poured through a nest of screens. The per cent of aggregates on each screen was determined by a modified procedure of Yoder (6). The total aggregates >0.25 mm then were calculated. The data thus obtained gave aggregate grain size distribution of percentages greater then 0.05, 0.25, 0.42, 0.84, and 2.0 mm, respectively. Only the total aggregates greater than .05 mm and .25 mm, are reported in this paper, because these sizes are most indicative of stability and state of aggregation.

Alterations in the procedures were made in order to determine the slaking effect of water on the aggregates and the permanency of the cemented aggregate. The three treatment conditions thus imposed on the Bolivar soil were:

A. Addition of conditioner, moistened and set 24 hours, determination of 0.05 mm aggregates by sedimentation, screening separation; all processes performed successively without time lag.

B. Addition of conditioner, moistened and set 24 hours, determination of 0.05 mm aggregates by sedimentation, soak for six days, screening separation after the sixth day.

C. Addition of conditioners, moistened and set four days, determination of .05 mm aggregates by sedimentation, screening separation immediately.

Data for additional soils in the study are given for aggregates greater than .05 mm in diameter which is the sand-size particle. Method A was used.

RESULTS AND DISCUSSION

Effect of slaking and drying on aggregates. The aggregate analysis of the Bolivar soil, according to the methods and modifications previously described, is shown in Figure 1 and Figure 2. Both of the conditioner types studied showed increases in percentage of water-stable aggregates greater than 0.05 mm diameter and 0.25 mm diameter size with increases in concentration. No differences among methods used can be shown for the 0.05 mm aggregates. Modification C showed significant increases in aggregation for large aggregates using K-6. K-9 did not produce a significant response by this modification.

A consideration of Figure 1 and Figure 2 indicates little difference in the relative position of the curves for the conditioners used. There is no significant difference between the location of the lines in the two figures for the same method modification, with the exception of modification C for K-6.

Modification C, employing a drying cycle for the treated soil, appears to show greater amounts of 0.25 mm aggregates at the higher concentrations. It appears that pretreatment by drying is most desirable for good results. This drying cycle serves to cement and fix the particles together by the binding action of the conditioners. Particles so held are highly resistant to dispersion. These larger aggregates were produced by stirring, indicating the importance of thorough incorporation of the chemicals with the soil. Concentrations above 0.08 per cent by weight appear to be of little importance in producing added amounts of stable aggregates.

Effect of conditioners on soils. Aggregate analysis showed little difference between the effect of K-9 and K-6 on Bolivar silt loam (see Table I). Increasing amounts of conditioner increased the amount of stable aggregates >0.05 mm formed. The greatest increases are found at the lower concentrations with linear, small increases at higher rates of added material. Little or no difference between the two types of conditioners was found or expected.

This soil is formed from the sandstone formations in Northwest Arkansas and while its textural class is that of silt loam, the grade tends to be on the sandy side of the tolerant range for this class.

In the case of the Crowley silt loam soil, differences between these conditioners can be noted (see Table I). The effect of the K-9 was to form aggregates larger than the 0.05 mm size at rather low concentrations. This effect was somewhat decreased where more than 0.04 per cent conditioner was used. Other data seem to indicate that at high concentrations these chemicals also may act as dispersing agents as well as aggregants (3). The K-6 (VAMA), however, showed a marked increase in aggregates of 0.05 mm through the entire range of concentrations used. The increase was greatest at 0.04 per cent. Further increases due to the added conditioner were minor.

The Crowley is a silt loam soil from the plains formed from the White River. Since its texture is one in which the silt and clay are high enough to place it on the clay side of the silt loam range, it appears that the clay content plays an important role in the aggregate formation with these conditioners. Also, it is shown that K-6 may have a slight superiority and greater stability than does K-9 on Crowley with the high silt and clay content. This also is shown in data elsewhere.

In the case of Sharkey clay, the effect of the conditioner is reported for K-6 only. It is apparent that a greater amount of conditioner may be needed in high clay soils to give appreciable effects. While the amount of 0.05 mm aggregates in this soil is high under the experimental conditions in the check treatment, Sharkey clay in the field becomes dispersed and puddled after long exposure to water. This is due in part to the relatively high amount of montmorillonite type clay present in this soil. Stabilizing effects on this soil may be highly important in the field.

When the effect of K-6 is considered on all of these soils and the conditions imposed, it can be seen that a concentration of greater than 0.08 per cent has little value in causing formation of, or maintaining aggregates of, these sizes as studied. High concentrations, however, tend to promote the larger size aggregates as previously discussed.

These data all indicate that while K-9 may be an effective aggregant, the K-6 produces larger aggregates which appear to be more stable in water if they have had an opportunity to become fixed.

Table I. Stabilization of Soil Aggregates Larger than 0.05 mm Size in Three Soils by Use of Synthetic Polyelectrolytes, K-9 (HPAN) and K-6 (VAMA) by Method A.

Rate (Pct.)	Per cent of total aggregates>0.05 mm				
	Crowley silt loam		Bolivar silt loam		Sharkey clay
	K-9	K-6	K-9	K-6	K-6
Ck	36.7	40.0	44.1	45.0	55.2
.02	69.2	56.1	46.6	56.0	57.2
.04	73.7	73.4	54.1	56.0	60.2
.08	65.2	76.5	58.9	59.6	68.2
.15	54.2	79.4	64.2	64.0	71.7

SUMMARY

Increases in soil aggregation were brought about by HPAN (K-9) and VAMA (K-6), both of which are now commercially available. The effect of these aggregants was noticeable, and the results obtained with them give them an important place among agricultural chemicals.

Time is needed between the addition of the soil conditioning chemicals and an expression of their beneficial effects.

Generally the effect of the conditioners was to increase the proportion of the aggregates in the larger size groups. The greater the amount of conditioner used the greater was the tendency toward this effect.

The effect on the increasing increment of the soil aggregation appeared to be greatest at about 0.08 per cent by weight active ingredient.

Thorough incorporation into the soil mass is necessary for proper results to be obtained.

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BRANCHIOBDELLIDAE IN ARKANSAS

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The small oligochaetes discussed here occur on the gills or on the ventral surface of the crawfish. They are noticeable particularly on the ventral side of the abdomen. When the crawfish are preserved, the worms usually drop off and fall into the detritus at the bottom of the container. Apparently, there is no agreement on the relationship that exists between the worms and the crawfish.

Stephenson (1930) says: "These are parasites of the external surface and gills of freshwater crayfishes... not parasitic when young, the intestinal tract showing debris and small animals; but in the adult the jaws are used to break the skin of the host in order to suck the blood." This report is similar to one by Hall (1915), who also reported that he had found "several pieces of striated voluntary muscle fiber in the intestine of the adult worms." Moore (1895) reported seeing blood from the crawfish in the worm intestine. Goodnight (1940), a more recent American student of the group, expresses the opinion that they are at most only faculative parasites and in general non-parasitic.

All accounts seem to be based on an observation of the contents of the worm digestive tract in which the indestructible diatom shells attract attention first. Other things are visible--such as algal detritus, nematode worms, and stages of sporozoan life cycles.

The constant association with the crawfish, the chitinous jaws with strength enough to break the skin, the well developed suckers for holdfast organs--all these provide circumstantial evidence that the small worms are parasitic.

A critical study of the relationship between the worms and the hosts would be interesting. There seems to be no host specificity beyond that of the West Coast *Astacus*, which are different species from those of the eastern crawfish, which are Cambarinae (Pennak, 1953). Apparently, young crawfish tend to have more worms than the older, but present collections are not adequate to prove this. Goodnight's (1940) monograph is recent and complete, while Pennak's (1953 Freshwater Invertebrates) offers the literature published since 1940 and has a key derived from Goodnight. Nine genera and 26 species of North America are described.

The records described in this paper are mainly from Northwest Arkansas. Since there is no evidence of host specificity known, and since the specimens mainly are derived from the detritus in the bottoms of jars containing a variety of crawfish species, no attempt has been made to associate the worms with particular crawfish.

This report is based on 39 collections of crawfish in Arkansas.

DISTRIBUTION OF SPECIES

Branchiobdella americana

Arkansas:

Clarksville
Farmington
Fayetteville
Johnson
Ouachita River
Springdale

This appears to be a widespread species. The type was described from Texas, and has been reported from North Carolina and New York. The collections are all from Northwest Arkansas, with the exception of a vague Ouachita River record, which represents an area near Camden, Arkansas.

Cambarincola chirocephala

Arkansas:

Alma
Devils Den
Farmington
Johnson
Mena

Missouri:

Roaring River

[1] The author wishes to thank Dr. Nelle B. Causey, Dr. Carl E. Hoffman, and Dr. Hugh Iltis for specimens. A number of students also provided material which was helpful in the research reported here. They were Robert Bronaugh, P. M. Daniels, A. M. Hulsey, R. G. Leonard, Mrs. Ola Murry, R. R. Ratton, J. P. Redman, R. L. Slaughter, and Miss Ruth Steuart.

NOTE: Research Paper No. 1110, Journal Series, University of Arkansas.

This is also a widespread species. It was reported from Missouri originally, but since then it has been found in Illinois, New York, Kentucky, Virginia, Indiana, North Dakota, Iowa, Pennsylvania, Alabama, Mississippi, and Tennessee, and in Ontario, Canada.

Cambarincola elevata

Arkansas:
- Fayetteville
- Johnson

This species has been reported from Illinois, Wisconsin, and Missouri, a list to which this paper adds Arkansas.

Cambarincola macrodonta

Arkansas:
- Banks
- Bentonville
- Boxley
- Bradley County
- Durham
- Elkins
- Farmington
- Johnson

Missouri:
- Roaring River

Oklahoma:
- McAlester

This species is widespread in Arkansas. The lateral teeth of the upper jaw tend in the Arkansas specimens to be larger than reported in the original description. This species has been reported previously from Mena, Arkansas, by Goodnight (1940). The species was originally described from Colorado. Other states reporting it include Texas, Louisiana, New Mexico, Mississippi, Illinois, Virginia, Missouri, Michigan, South Dakota, Kansas, and Nebraska. This Oklahoma record appears to be the first report from that state.

Cambarincola vitrea

Arkansas:
- Johnson

This species has a wide distribution. It was described originally from Michigan, and then reported from Wisconsin, Colorado, Missouri, Illinois, Indiana, Florida, Oklahoma, Alabama, New York, Kentucky, North Dakota, Texas, Mississippi, Wyoming, Georgia, and also from Ontario, Canada. There is no explanation for this single record, other than inadequate coverage of Arkansas. Many of the records of distribution of these various species of worms are based upon single collection sites.

Pterodrilus mexicanus

Arkansas:
- Durham
- Goshen
- Johnson
- Stone County

This is an improbable and unexpected record. The species was originally described from Mirador, Vera Cruz, Mexico, by Ellis (1919). A single, poorly preserved specimen was available. It is characterized, within the genus, by segment VIII bearing a simple four-horned appendage. No other segments have appendages. The Arkansas specimens agree with this description.

Xironodrilus formosus

Arkansas:
- Fayetteville
- Stone County

Originally described from Indiana, it also has been reported from Michigan, Illinois, Missouri, and New York. This is the first record from Arkansas.

Xironodrilus dentatus

Arkansas:
- Bentonville
- Devils Den
- Farmington
- Fayetteville
- Norfork Lake
- Polk County
- Stone County

Oklahoma:
- McAlester

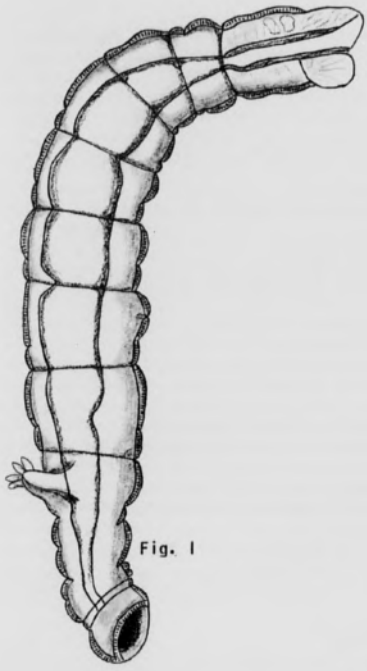

Fig. 1

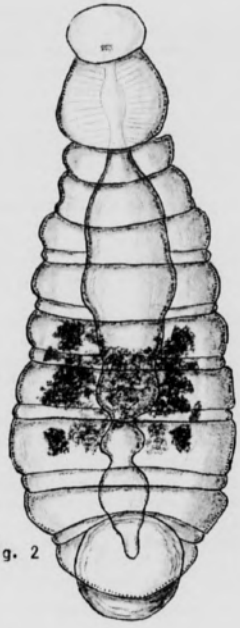

Fig. 2

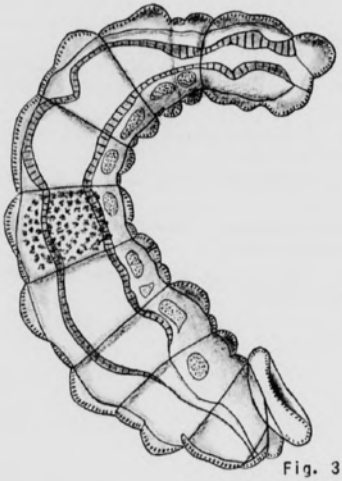

Fig. 3

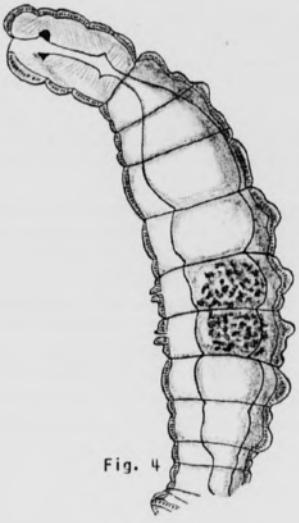

Fig. 4

Fig. 1. *Pterodrilus mexicanus*, lateral view showing processes on segment VIII.
Fig. 2. *Xironodrilus dentatus*, dorsal view.
Fig. 3. *Branchiobdella americana*, lateral view.
Fig. 4. *Cambarincola macrodonta*, lateral view.

Xironodrilus pulcherrimus originally was described by Moore(1894), and Ellis (1919) recognized two subspecies. These were named *X. pulcherrimus pulcherrimus* and *X. pulcherrimus dentatus* by Goodnight (1940). In a later paper, Goodnight (1943) elevated *X. pulcherrimus* to specific rank, with the holotype from Missouri. *X. pulcherrimus* seems restricted to North Carolina, while *X. dentatus* is widespread, with reports from Missouri and Oklahoma in the western part of its range and West Virginia in the eastern portion. This is the first record for Arkansas.

KEY TO KNOWN SPECIES OF BRANCHIOBDELLIDAE IN ARKANSAS*

1. (2) With one pair of testes, in fifth segment. *Branchiobdella americana.*
2. (1) With two pairs of testes, in fifth and sixth sgements.....3
3. (4) Body with an appendate bearing four horns on the eighth segment..... *Pterodrilus mexicanus.*
4. (3) Body without an appendage bearing four horns.....5
5. (14) Body cylindrical, *e.g.*, not flattened.....6
6. (7) Upper lip of mouth of four subequal lobes; the major annulations of the body segments distinctly and visibly elevated over the minor annulations. *Cambarincola chirocephala.*
7. (6) Upper lip of mouth entire, excepting a small median emargination.....8
8. (9) Major annulation of eighth segment distinctly elevated over minor annulations..... *C. elevata.*
9. (8) Major annulation of eighth segment not so elevated.....10
10. (11) Middle tooth of upper jaw long and prominent when compared with the small lateral teeth..... *C. macrodonta.*
11. (10) Middle tooth of upper jaw longer than other four teeth, but small enough that all 5 teeth may be considered subequal..... *C. vitrea.*
12. (5) Body flattened, sucker ventral..... *Xironodrilus dentatus.*

* Based on Goodnight's 1940 key.

SUMMARY

Four genera and eight species of Branchiobdellidae--*Branchiobdella americana, Cambarincola chirocephala, C. elevata, C. macrodonta, C. vitrea, Pterodrilus mexicanus, Xironodrilus formosus, and X. dentatus*--are reported from Arkansas, with a few records from Missouri and Oklahoma.

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THE LOWER JAW AS A DIAGNOSTIC AID IN THE IDENTIFICATION OF MAMMALS[1]

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University of Arkansas

This paper is intended to aid archeologists to identify mammalian skeletal remains in the field. Thus, since the paper was designed primarily for archeological research in Arkansas, it has been limited to mammals most likely to be associated with Arkansas Indian remains. Most had a definite food value, and a few, such as the panther and bobcat, were ornamental.

The illustrations show the left side of the lower jaw. In some cases, an upper view of the lower jaw has been included. The purpose of the skull profile is to show the placement of the jaw. It is not for identification.

In the upper left-hand corner of each figure is a series of numbers. The numbers represent the dental formula of one side of the jaw. The numbers above the horizontal line refer to the teeth of the upper jaw, and those below the line to the teeth of the lower jaw. The first numeral indicates the number of incisors, the second the number of canines, the third the number of premolars, and the fourth the number of molars. In some cases, some of these groups may be absent. The dental formulas may be useful even if the teeth have been lost, because the corresponding tooth sockets will remain.

Small arrows in the drawings point to features of primary importance in identification, such as the presence of a canine tooth, the presence of a large incisor followed by a gap in the tooth row, location and shape of jaw processes.

Examination of the tooth sockets should be the first step in identification. This will reduce the possibilities. The next step should be a study of the posterior processes of the jaw bone.

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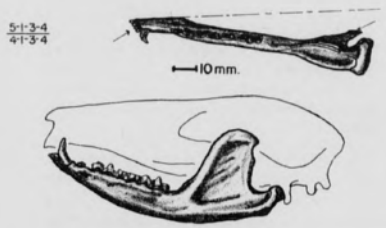
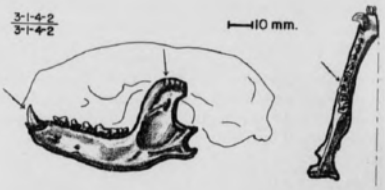
[1] The author thanks Dr. John A. Sealander of the Zoology Department, University of Arkansas, for his helpful suggestions concerning form and content of this paper.

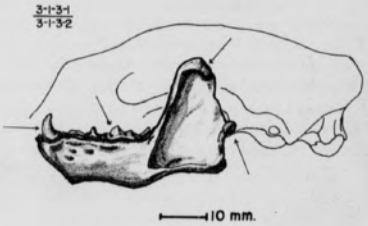
OPPOSSUM *Didelphis virginianus* (Fig. 1)



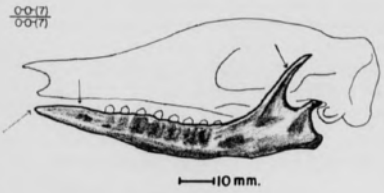
RACCOON *Procyon lotor* (Fig. 3)



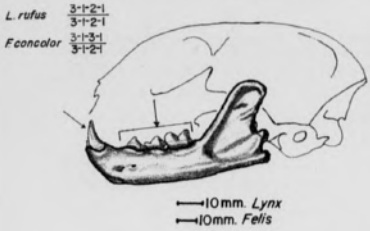
SKUNK *Mephitis mephitis* (Fig. 4)



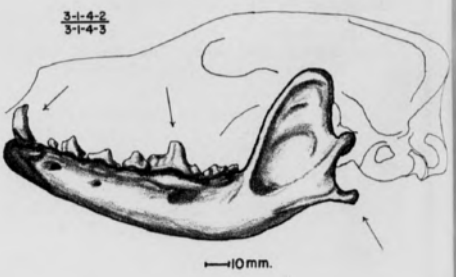
ARMADILLO *Dasypus novemcinctus* (Fig. 2)



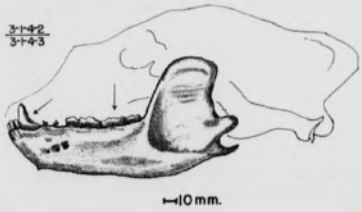
PANTHER *Felis concolor*
BOBCAT *Lynx rufus* (Fig. 5)



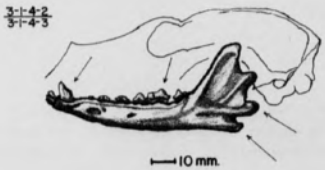
COYOTE *Canis latrans*
WOLF *Canis niger* (Fig. 7)



BLACK BEAR *Ursus americanus* (Fig. 6)



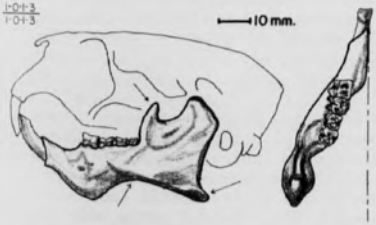
GRAY FOX *Urocyon cinereoargenteus* (Fig. 8)



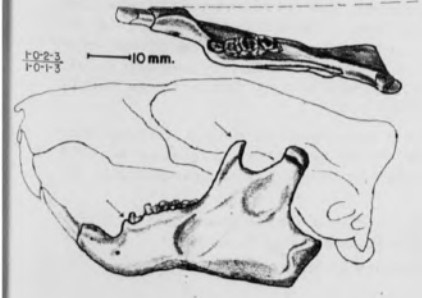
BEAVER *Castor canadensis* (Fig. 11)

MUSKRAT *Ondatra zibethica* (Fig. 12)

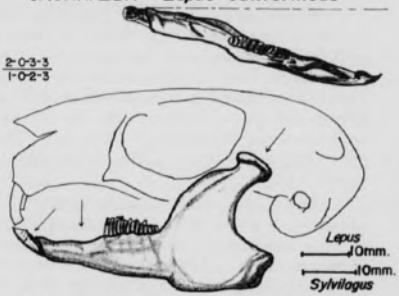
PORCUPINE *Erethizon dorsatum* (Fig. 13)



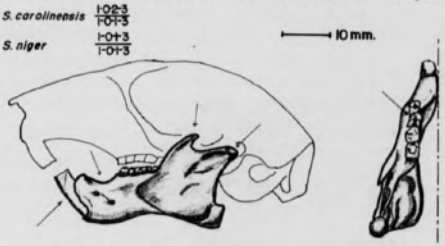
WOODCHUCK *Marmota monax* (Fig. 14)



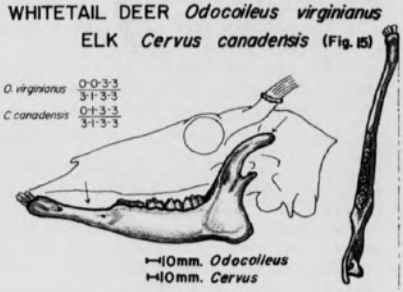
SWAMP RABBIT *Sylvilagus aquaticus*
COTTONTAIL *Sylvilagus floridanus* (Fig. 9)
JACKRABBIT *Lepus californicus*



GRAY SQUIRREL *Sciurus carolinensis*
FOX SQUIRREL *Sciurus niger* (Fig. 10)



WHITETAIL DEER *Odocoileus virginianus*
ELK *Cervus canadensis* (Fig. 15)



BISON *Bison bison* (Fig. 16)

THE NORMAL HISTOLOGY OF BROWN FAT OF CERTAIN ARKANSAS BATS[1]

P. M. JOHNSTON and J. A. SEALANDER
University of Arkansas

Brown fat, which is found in many species of mammals, has been called the "hibernating gland." It also is known as the interscapular or subscapular gland, multilocular adipose tissue, and lipoid gland. In man, brown fat is present in the embryo, but in the adult it changes into ordinary adipose tissue or is scattered through the common adipose tissue. This tissue is very noticeable in rodents and bats and appears to be especially prominent in those species which undergo long periods of dormancy. The existence of brown fat has been known for many years (Cramer, '20), although it has received relatively little attention until recent years.

The universal occurrence of brown fat in bats (Dalquest and Werner, '51), along with its conspicuous development, suggests that it plays an important role in the periods of dormancy or hibernation that most species of bats undergo. Although the exact function of the interscapular gland is still not certain, there is general agreement that it is a more concentrated source of reserve energy than the common adipose tissue because of its rich store of phospholipids, cholesterol, and glycogen (Lemonde and Timiras, and Selye and Timiras). The relationship of the functional activity of the interscapular gland and the adrenal cortex and thyroid have been pointed out by Lachance and Page, Lemonde and Timiras, and Seifter, Christian and Ehrich.

This study is planned as the groundwork for further studies of the effects of stressor agents on the structure and physiology of the gland, and investigation of possible seasonal changes in the tissue.

MATERIALS AND METHODS

The observations reported here are based on gross examination and histological sections of the interscapular glands of the gray bat *(Myotis grisescens* A. H. Howell), the Indiana bat *(Myotis sodalis* Miller and Allen), the pipistrelle bat *(Pipistrellus subflavus* F. Cuvier), and the lump-nosed bat *(Corynorhinus rafinesquei* [Lesson]). The bats were collected in caves near Fayetteville, Ark., where they were hibernating during the fall of 1951 and the spring of 1952.

The animals were killed by percussion. The interscapular tissue was removed quickly and fixed in Bouin's fluid. The glands subsequently were imbedded in paraffin and sectioned at 10 and 15 micra. All sections were stained with Harris' hematoxylin and counter-stained with eosin. No special fixation or staining for lipoid substances was done.

OBSERVATIONS

Gross Morphology. All interscapular glands collected had the same basic gross structure. All of the glands filled the interscapular fossa and extended posteriorly to the lumbar region (Figure 1). Early dissection indicated that the gland was a single mass of tissue, but when the overlying connective tissue was removed it was seen that the gland consisted of two dorsal interscapular lobes continuous with two lateral or cervical lobes (Figure 1). The cervical lobes extended ventrally around the neck, almost to the base of the ears, where they met the parotid salivary glands. A small encapsulated lymph node was found near the tip of each of the cervical lobes. In freshly killed specimens, the interscapular glands were dark red in color and richly supplied with blood. The shape of the glands apparently depended upon adjacent scapular musculature. The glands were distinctly lobular, as seen grossly (Figure 1). They were not dissected to ascertain the blood and nerve supply. However, it was noted that a large artery entered the ventral side of each interscapular lobe.

Histology. All of the interscapular glands were covered with a fibrous connective tissue capsule which penetrated the gland as septa, dividing it into macro- and micro-lobules (Figure 2). This lobulation is usually characteristic of

[1] This study was supported by grants from the American Association for the Advancement of Science through the Arkansas Academy of Science and from Ciba Pharmaceutical Products.

NOTE: Research Paper No. 1107, Journal Series, University of Arkansas.

the large tubulo-alveolar glands, such as the salivary glands. This would indicate that perhaps the interscapular gland is an incipient tubulo-aveolar gland.

The connective tissue capsule of the interscapular gland of *Pipistrellus subflavus* was more pronounced than those of the other species. Normal unilocular fat appeared irregularly in the capsule and in the gland.

The white fat cells in the interscapular gland were distinguished easily from gland cells by the typical "signet ring" configuration, containing only one large fat vacuole (Figures 2 and 4). There was a sharp demarcation between the two types of fat, and it was apparent that there was no intergradation between the two types.

The brown fat cells were polygonal. They contained vacuoles of varying size which were occasionally as large or larger than the nucleus (Figure 3). This type of vacuolation usually is considered indicative of lipoidal storage. The intervacuolar cytoplasm was markedly eosinophilic and was filled with granules of varying sizes. The brown fat cells had a delicate cell membrane, with numerous small irregular nuclei on the outside. Presumably, these were reticular cell nuclei. The nuclei of the brown fat cells stained metachromatic and usually were excentrically located. A small nucleolus and fine "powdery" chromatin granules could be seen within the nuclei. Mitotic figures were not seen.

Vascularity was one of the most prominent differences of brown and white fat. Almost without exception, moderately-sized arteries and veins were present in each of the micro-lobules (Figures 2 and 3). Numerous capillary channels next to the gland cells were seen also.

DISCUSSION

The histology and gross structure of the interscapular glands of the bats observed in this study agrees with other reports of different species. No indication of the formation of ducts was observed as was reported by Dalquest and Werner in the interscapular gland of the tropical fruit bat, *Artibeus jamaicensis*. Histologically, the interscapular gland represents a glandular organization comparable with the tubulo-alveolar glands in its vascularity and connective tissue pattern.

Although quantitative data are lacking on the capillary density of brown fat, its blood supply apparently is richer than that of white fat. It has been suggested (Fawcett) that this difference in degree of vascularity is related to a difference in physiological activity. The rich blood supply of the interscapular gland would suggest that it is, perhaps, an endocrine gland. However, recent cytochemical studies (Fawcett) fail to support this suggestion. The vacuolar pattern of the brown fat cells indicates that it is rich in stored lipids. It seems probable that the gland is a concentrated source of energy-rich compounds that enable the animal to survive long periods of fasting. Fawcett believes that some of the dark color of the brown fat is due to phospholipid in the mitochondria and also to compounds produced in the metabolism of the stored fatty acids in the gland.

SUMMARY

The gross and microscopical anatomy of the interscapular gland of several species of bats has been described. The lobulation found in the glands and the blood vascular pattern indicate compound tubular alveolar glands, and suggest that the interscapular gland possibly is an incipient type of compound tubulo-alveolar gland. The vacuolar pattern in the cytoplasm and the numerous cytoplasmic granules indicate lipoid storage.

Fig. 1. The position of the interscapular gland of *Pipistrellus subflavus* F. Cuvier. The superficial connective tissue has been removed to show the gross lobulation. The left hand margin of the gland is slightly pulled away from the scapular masculature (circled).

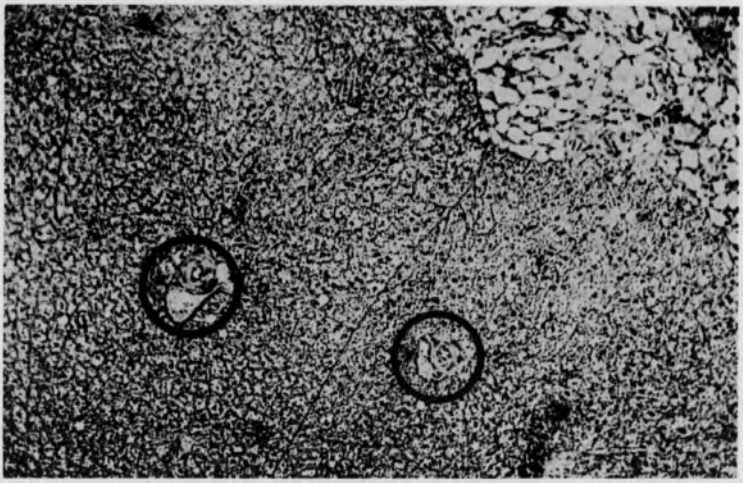


Fig. 2. A cross section of a portion of the interscapular gland of *Myotis grisescens* A. H. Howell. A patch of unilocular fat is visible in the upper right-hand portion of the figure. There is a sharp line of demarcation between the brown fat, below, and the white fat. Also visible are the thin connective tissue septum and the blood vessels to the right (x) and the left (y) of the septum.

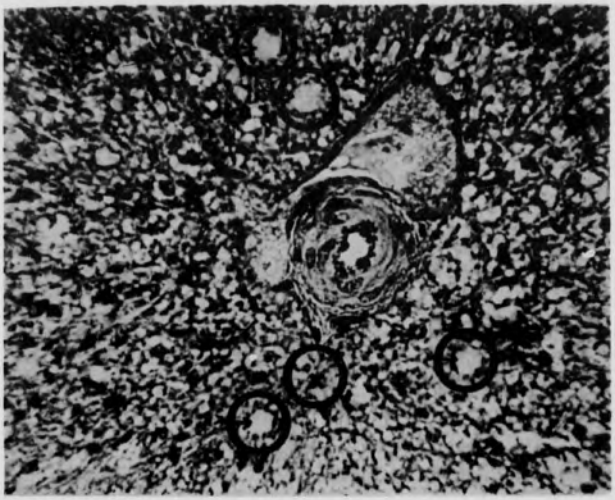


Fig. 3. A high-power photomicrograph of a portion of Figure 2, showing the artery and vein and adjacent brown fat. Visible are the large vacuoles in the cells of the brown fat (circled), and the thin connective tissue septum (x) which extends from the connective tissue sheath surrounding the artery and vein.

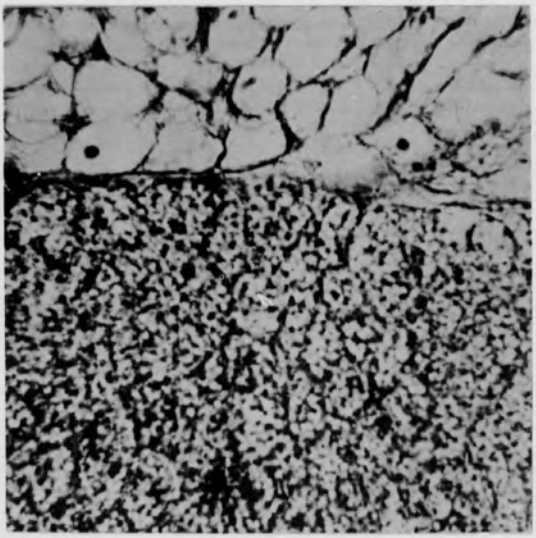


Fig. 4. A high-power photomicrograph of the area of juncture of white fat with brown fat. Visible are the lines between the two types of fat, and the large single vacuole of the white fat above and the many vacuoles of the cells of brown fat below.

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SAMPLE NUMBERS FOR FORAGE PRODUCTION DETERMINATIONS[1]

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University of Arkansas

Range scientists and technicians constantly are confronted with the problem of determining the number of samples necessary to attain a given degree of accuracy in forage production measurements. This is due to the variability that occurs in vegetation because of changes in the soil, plant species, or physiographic differences--such as slopes, exposure, etc.--and the habits of the animals grazing on the area.

Literature on the variability of native vegetation is limited. Pechanec (1941) reported a coefficient of variation for forage production of 20 per cent for the sagebrush-grass ranges of Idaho. He also reported (1940) coefficients of variation of 64 per cent for arrowleaf balsamroot and 103 per cent for tapertip hawksbeard, with other species as high as 141 per cent. Davies (1931) in Australia reported forage yields of natural vegetation with a coefficient of variation of 32.5 per cent. Beruldsen and Morgan (1934), also working in Australia with pastures composed of ryegrass, Kentucky bluegrass, cocksfoot, and clovers, reported similar variations in forage production. Hanson (1934) reported a coefficient of variation of 27.8 per cent for the mixed prairie of North Dakota. Neven (1945) found a coefficient of variation of 23.7 per cent for bluegrass pastures of Illinois. Costello and Kipple (1939) state that no relationship exists between the size of vegetational type and the number of samples needed for any given degree of accuracy on the ranges of Colorado and Wyoming.

Formulae for the determination of sample numbers are important to the investigator since no tables appear in the literature showing the number of samples necessary for a given degree of accuracy. Hanson (1934) and Neven (1945) have used the formula $N = S^2(p\bar{x})^2$ to calculate the number of samples necessary to achieve the accuracy of p (percentage of the mean). The odds are 2 to 1 that the population mean lies within the desired limit (p) in the above formula. Any estimates calculated by the use of this formula would err in one-third of the cases. Pechanec (1941) states that the sampling error of the estimated forage yield of a section of sagebrush-grass range was 18 per cent. He further states that the odds are 2 to 1 that the actual forage yield of the section of land was within 18 per cent of the estimate. Experimental work in other fields has shown that odds of at least 19 to 1 or 99 to 1 should be used.

Other formulae are available that permit the investigator to obtain estimated sample numbers that are more reliable than those used by Pechanec. Such formulae are shown by Snedecor (1946).

$$1.\ N = t^2s^2/(\bar{x} - m)^2$$

$$2.\ N = (100)^2t^2s^2/p^2\bar{x}^2$$

$$3.\ N = t^2C^2/p^2$$

$$4.\ C^2 = (100)^2s^2/\bar{x}^2$$

N = number of required samples
t = the value of students
s = the standard deviation
$\bar{x}$ = sample mean
p = desired limits in per cent of the mean
C = coefficient of variation
100 = one hundred per cent
m = population mean

In most range work these formulae provide an estimate of the number of samples required for a given degree of accuracy in the measurements made on any set of values. These formulae are applicable to forage production and botanical composition data.

[1] Helpful comments and suggestions of Dr. R. E. Comstock of the Statistical Laboratory at Raleigh, N. C., were appreciated.

NOTE: Research Paper No. 1111, Journal Series, University of Arkansas.

The first formula lends itself readily to determinations of the number of samples necessary to set a desired limit around the sample mean. Suppose that an area of range land has been sampled to determine the forage yield and that 300 samples were used, and that the standard deviation was 100 pounds per acre, and the desired limits around the mean were 50 pounds per acre ($\bar{x}$ - m), and the mean was 400 pounds per acre. For a sample as large as 300, a t value of 2.6 is a close enough approximation to the one per cent level of significance. Therefore, $N = (2.6)^2 (100)^2/(50)^2$ and N = 27.04 is an indication of the number of samples necessary to measure the production to within 50 pounds per acre of the mean when the standard deviation is 100 pounds per acre with odds of 99 to 1 that the population mean falls within the limits set around the sample mean. This formula can be used in terms of the coefficient of variation and the limits should then be expressed as a percentage of the mean. Thus the second formula becomes of value to the investigator.

$$N = (100)^2 t^2 s^2 / p^2 \bar{x}^2$$

$$N = 27.04$$

Under the conditions of the above problem, the limits of 50 pounds per acre were equal to 12.5 per cent of the mean. Substitution in the above formula gives the same value for N as in the first formula. Thus the statement may be made that 28 samples (any fraction must be counted as a whole) are necessary to determine the production within 12.5 per cent of the mean. The formula may be simplified if the coefficient of variation has been calculated.

Therefore, $N = t^2 C^2/p^2$ (Formula 3).

Values of N required for a known size of the mean and standard deviation have been calculated. They are shown in Table I. Data calculated from Formula 2 indicate that 400 samples are necessary when the standard deviation is equal to the mean and that 100 samples are necessary to measure the forage production when the standard deviation is equal to one-half of the mean with an accuracy of 10 per cent at the .05 level of significance. Table II shows the calculated values for N at a limit of one per cent of the mean and at P .05.

Tables I and II permit the investigator who has a knowledge of the size of the mean and standard deviation to determine the number of samples needed without calculating the actual figures. These tables also serve to emphasize the need for using methods which will reduce the variability which occurs naturally in native vegetation. Sampling within a vegetational type may reduce the amount of variability with which the experimenter must contend. Thus, it lessens the amount of work that must be done for any desired degree of accuracy for the type, but may increase the total amount of work if the area being sampled contains more than one vegetational type when the area of each type is not known nor easily measured. The influence of vegetational type on the sampling needed for any given degree of accuracy is shown in Table III in which two vegetational types have been measured and the mean and standard deviations determined for each type. On the basis of the formulae given in the preceding pages, 129 samples are necessary to sample each area separately--that is, the sum of the samples necessary to sample type A plus the number of samples necessary to sample type B. One hundred and twelve samples are necessary to sample the total area of A plus B as calculated by the given formula. These data indicate that it would require fewer samples to consider the two vegetational types as one and not two. However, if the information shown above already is known and the area covered by each can be determined, then the number of samples required for estimating the mean at some given limit is considerably smaller than the sum of the required numbers for each area or the two areas as one.

Let c be the fraction of the total area covered by Little Bluestem (Area A) and 1-c the fraction of Improved Pasture (Area B). Then if $\bar{x}_1$ is the mean for A samples and $\bar{x}_2$ is the mean for B samples, the estimated mean for the total area will be $\bar{x} = c\bar{x}_1 + (1-c)\bar{x}_2$ and the variance of $\bar{x}$ will be

$$V_{\bar{x}} = \frac{c^2 \sigma_1^2}{n_1} + \frac{(1-c)^2 \sigma_2^2}{n_2}$$

where σ_1^2 is the variance of A samples, σ_2^2 is the variance of B samples, n_1 is the number of A samples and n_2 is the number of B samples.

It is recognized that making n_1 and n_2 equal would seldom result in the most efficient use of time, labor, and money in studying forage production. Likewise, the type which contributes most to the total should be estimated best if the most efficient use of labor is to be made. The problem then is to determine the optimum ratio of n_1 and n_2. This may be done as follows:

Let the total number of samples to be taken be N and let $\underline{a}$ signify the fraction of these to be of type A, then,

$$n_1 = aN$$

$$n_2 = (1-a)N$$

$$\text{and } V_{\bar{x}} = \frac{c^2\sigma_1^2}{aN} + \frac{(1-c)^2\sigma_2^2}{(1-a)N}$$

Now find the value of $\underline{a}$ that makes $V_{\bar{x}}$ as small as possible with any fixed number (N) of samples. This may be done as follows: Equate the derivative of $V_{\bar{x}}$ with respect to $\underline{a}$ to zero and solving for $\underline{a}$. This derivative is:

$$\frac{dV_{\bar{x}}}{da} = \frac{-c^2\sigma_1^2 N}{a^2N^2} + \frac{(1-c)^2\sigma_2^2 N}{(1-a)^2N^2}$$

Setting it equal to zero, we have:

$$\frac{-c^2\sigma_1^2 N}{a^2N^2} + \frac{(1-c)^2\sigma_2^2 N}{(1-a)^2N^2} = 0$$

Multiply by N:

$$\frac{-c^2\sigma_1^2}{a^2} + \frac{(1-c)^2\sigma_2^2}{(1-a)^2} = 0$$

Transfer first term to the right side:

$$\frac{(1-c)\sigma_2^2}{(1-a)^2} = \frac{c^2\sigma_1^2}{a^2}$$

Taking the square root:

$$\frac{(1-c)\sigma_2}{1-a} = \frac{c\sigma_1}{a}$$

Solve for $\underline{a}$:

$$\underline{a} = \frac{c\sigma_1}{c\sigma_1 + (1-c)\sigma_2}$$

Now substitute c = .62, σ_1 = 413, and σ_2 = 220

Then $\underline{a}$ = .75

Thus, the optimum distribution of samples is ¾ to Type A, and ¼ to Type B. Now if the mean is to be estimated within 10 per cent with 95 per cent assurance ($P = .05$) $V_{\bar{x}}$ must equal $(.1\bar{x}/t)^2$. Set them equal and the following calculations provide the number of samples necessary for estimating the mean production.

$$V_{\bar{x}} = \frac{c^2\sigma_1^{\ 2}}{aN} + \frac{(1-c)^2\sigma_2^{\ 2}}{(1-a)N} = \frac{(.1)^2\bar{x}^{\ 2}}{t^2}$$

Substituting numerical values:

$$\frac{(.62)^2\ (413)^2}{.75N} + \frac{(.38)^2\ (220)^2}{.25N} = \frac{(.01)\ (923)^2}{4}$$

Solve for N:

N = 54.2, which should be estimated at 55 when the numbers are rounded.

Thus, N being equal to 55, we have achieved a considerable saving in the number of samples required to achieve a given degree of accuracy. In this case, 55 represents a reduction in the number of required samples of approximately 60 per cent as compared with sampling the areas A and B as one area and a reduction of 57.4 per cent in the numbers required for separate sampling where the mean production and variance of the two areas are considered separately.

As long as the relative sizes of sub-areas are known, sampling by type will always be more efficient if the means for the types differ. As the differences grow greater, more will be gained from sampling by types. If the magnitude of the sub-areas is not known, then one is confronted with the problem of determining whether measuring them will be less costly than the extra samples required for equal precision when sampling is completely random. As the differences in strata means increase, the information derived may be less accurate to allow estimates from stratified sampling to be better than estimates obtained with equal cost under a program of random sampling.

Sampling by vegetational type allows for wider application of the results within the same general climatic and edaphic area. The sampling of areas with an artificial boundary that does not follow changes in the vegetation does not permit the wide use of the results and their application to other areas because other areas will not contain the vegetational types in the same proportions as in the experimental area. Thus, results obtained by sampling vegetational types are applicable over a greater range of area than are the results obtained by sampling artificial units, such as pastures. This does not mean that vegetation should be sampled on the smallest type available but that the sampling should be based on the vegetational type that is present over a wide area, and that it should not be limited to areas bounded by artificial boundaries such as fences.

Many investigators wish to set limits of a certain size around the mean. This may be done by the use of the first formula, where $(x - M)$ is equal to the limits desired. Calculations based on this formula are shown in Table IV.

A certain amount of regularity in the table permits the formulation of two rules:

1. If the limit desired is 50 per cent of the standard deviation, 16 samples are required.
2. If the limit desired is 25 per cent of the standard deviation, 64 samples are required.

Table IV is of less value than Table I and Table II to the investigator who fails to recognize that the limits expressed are not in terms of a certain percentage of the mean, but are in relation to the size of the standard deviation. Thus, the investigator must determine the desired limits in relation to the mean before using Table IV. Hodgson (1942), Lommasson (1942), and Rhoads (1945) have

attempted to measure forage yields in terms of animals, or they have tried to devise methods whereby the forage production could be estimated.

The reason that studies that have tried to use clipping data to estimate animal consumption have not been successful is apparent in Table V. An accuracy of one per cent at P .01 or P.05 is deemed to be greater than can be obtained by clipping samples. Yet, when this accuracy is applied to clipping data, the error on 640 acres may be as high as 23 animal unit grazing days when the forage production is only 100 pounds per acre. When the average forage production is 2,000 pounds per acre, the number of grazing days in error may be as high as 457. On a section of land that will carry one animal unit on 10 acres, this is an error of 7.14 grazing days for each of the 64 animal units on the pasture. If a five per cent limit of the mean were used, the error per animal unit may be as high as 35.73 grazing days. A limit of 10 per cent has often been accepted as a reasonable limit. When this limit is applied to a section of land with an average forage production of 1,400 pounds per acre, the error may be as high as 3,200 animal unit grazing days or 50 grazing days per animal unit, if the pasture will carry one animal unit on 10 acres.

These calculations would indicate that a one per cent error is necessary if the number of grazing days on a pasture were to be calculated from clipping data. Table II shows the number of samples necessary to obtain this accuracy in clipping measurements. Often, the investigator is unable to take the number of samples indicated in Table II. The only recourse is to take as many samples as possible and to use the data to calculate his actual limits and interpret his data in terms of the limits which were obtained.

Even if an investigator uses the estimated number of samples necessary for desired limits, he should always calculate the actual limits obtained in his measurements. This may be done by the formulae used for the calculation of the sample size.

While important, the random errors considered here may not be as important as errors resulting from the possibilities (1) that what the animal harvests may be different from that which is harvested with the clipper, or (2) that due to qualitative variation in forage (*i.e.*, 28 pounds) may not truly represent an animal unit grazing day.

SUMMARY

Formulae and tables are listed for the calculation of the number of samples needed to measure forage production within desired limits. These tables enable the investigator to determine sample size without calculating.

Data are given to indicate the amount of error that occurs when desired limits of accuracy are applied to clipping data and the results are evaluated in terms of animal unit grazing days. The one per cent error of the mean at P .05 was judged most desirable for critical work on grazing capacity.

Stratification of range areas on the basis of natural vegetative units is advocated as increasing the value of data obtained by clipping in relation to their application to similar range areas and to reduce the amount of labor and money required for a given degree of accuracy.

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Table 1. The Number of Samples Required to Determine Forage Production to an Accuracy Within 10 Per Cent of the Mean Production. Formula 2.(P.05 = 2.00).

Ave. prod. (lbs. /acre)	Standard deviation (pounds per acre)											
	50	100	150	200	250	300	350	400	450	500	550	600
100	100	400	900	1,600	2,500	3,600	4,900	6,400	8,100	10,000	12,100	14,400
150	45	178	400	712	1,112	1,600	2,178	2,845	3,600	4,445	5,378	6,400
200	25	100	225	400	625	900	1,225	1,600	2,025	2,500	3,025	3,600
250	16	64	144	256	400	576	784	1,024	1,296	1,600	1,936	2,304
300	12	45	100	178	278	400	545	712	900	1,112	1,345	1,600
350	9	33	74	131	205	294	400	523	662	817	988	1,176
400	7	25	57	100	157	225	307	400	507	625	757	900
450	5	20	45	80	124	178	242	317	400	494	598	712
500	4	16	36	64	100	144	196	256	324	400	484	576
600	3	12	25	45	70	100	137	178	225	278	337	400
700	3	10	19	33	52	74	100	131	166	205	247	294
800	2	7	15	25	40	57	77	100	127	157	190	225
900	2	5	12	20	31	45	61	80	100	124	150	178
1,000	1	4	9	16	25	36	49	64	81	100	121	144
1,100	1	4	7	14	21	30	41	53	67	83	100	120
1,200	1	3	7	12	18	25	35	45	57	70	85	100
1,300	1	3	6	10	15	22	29	38	48	60	72	86
1,400	1	3	5	9	13	19	25	33	42	52	62	74
1,500	1	2	4	8	12	16	22	29	36	45	54	64
1,600	1	2	4	7	10	15	20	25	32	40	48	57
1,700	1	2	4	6	9	13	17	23	29	35	42	50
1,800	1	2	3	5	8	12	16	20	25	31	38	45
1,900	1	2	3	5	7	10	14	18	23	28	34	40
2,000	1	1	3	4	7	9	13	16	21	25	31	36
2,200	1	1	2	4	6	8	11	14	17	21	25	30
2,400	1	1	2	3	5	7	9	12	15	18	22	25
2,600	1	1	2	3	4	6	8	10	12	15	18	22
2,800	1	1	2	3	4	5	9	9	11	13	16	19
3,000	1	1	1	2	3	4	6	8	9	12	14	16
3,200	1	1	1	2	3	4	5	7	8	10	12	15
3,400	1	1	1	2	3	4	5	6	8	9	12	13
3,600	1	1	1	2	2	3	4	5	7	8	10	12
3,800	1	1	1	2	2	3	4	5	6	7	9	10
4,000	1	1	1	1	2	3	4	4	6	7	8	9

These values of N may be converted to the odds of 99:1 by multiplying by 1.69.

$$(P.01)^2/(P.05)^2 = (2.6)^2/(2)^2 = 1.69.$$

Table II. The Number of Samples Required to Determine Forage Production Within an Accuracy of One Per Cent of the Mean Production. Formula 2. (0 .05).

Avg. prod. (lbs. /acre)	Standard deviation (pounds per acre)											
	50	100	150	200	250	300	350	400	450	500	550	600
100	10,000	40,000										
150	4,445	17,778	40,000									
200	2,500	10,000	22,500	40,000								
250	1,600	6,400	14,400	25,600	40,000							
300	1,112	4,445	10,000	17,778	27,778	40,000						
350	817	3,266	7,347	13,060	20,409	29,388	40,000					
400	625	2,500	5,625	10,000	15,625	22,500	30,625	40,000				
450	494	1,976	4,445	7,903	12,347	17,780	24,200	31,609	40,000			
500	400	1,600	3,600	6,400	10,000	14,400	19,600	25,600	32,400	40,000		
600	278	1,112	2,500	4,445	6,945	10,000	13,612	17,778	22,500	27,778	33,612	40,000
700	205	817	1,837	3,266	5,103	7,347	10,000	13,062	16,531	20,409	14,694	29,388
800	157	625	1,407	2,500	3,907	5,625	7,657	10,000	12,657	15,625	18,907	22,500
900	124	494	1,112	1,976	3,087	4,445	6,050	7,902	10,000	12,346	14,939	17,787
1,000	100	400	900	1,600	2,500	3,600	4,900	6,400	8,100	10,000	12,100	14,400
1,100	83	331	744	1,323	2,067	2,976	4,050	5,290	6,695	8,265	10,000	11,901
1,200	70	278	625	1,112	1,737	2,500	3,403	4,445	5,625	6,945	8,403	10,000
1,300	60	237	533	947	1,480	2,131	2,900	3,787	4,793	5,918	7,148	8,521
1,400	52	205	460	817	1,276	1,837	2,500	3,266	4,133	5,103	6,174	7,347
1,500	45	178	400	712	1,112	1,600	2,178	2,845	3,600	4,445	5,378	6,400
1,600	40	157	352	625	977	1,407	1,915	2,500	3,165	3,907	4,727	5,625
1,700	35	139	312	554	866	1,246	1,696	2,215	2,803	3,461	4,187	4,983
1,800	31	124	278	494	772	1,112	1,513	1,976	2,500	3,087	3,735	4,445
1,900	28	111	250	444	693	998	1,358	1,773	2,244	2,771	3,352	3,989
2,000	25	100	225	400	625	900	1,225	1,600	2,025	2,500	3,025	3,600
2,200	21	83	186	331	517	744	1,013	1,323	1,674	2,067	2,500	2,976
2,400	18	70	157	278	435	625	851	1,112	1,407	1,737	2,101	2,500
2,600	15	60	134	237	370	533	725	947	1,199	1,480	1,790	2,131
2,800	13	52	115	205	319	460	625	817	1,034	1,276	1,544	1,837
3,000	12	45	100	178	278	400	545	712	900	1,112	1,345	1,600
3,200	10	40	88	157	245	352	479	625	792	977	1,182	1,407
3,400	9	35	78	139	217	312	424	554	701	866	1,047	1,246
3,600	8	31	70	124	193	278	379	494	625	772	934	1,112
3,800	7	28	63	111	174	250	340	444	561	693	838	998
4,000	7	25	57	100	157	225	307	400	507	625	757	900

These values of N may be converted to the odds of 99:1 by multiplying by 1.69.

$$(P.01)^2/(P.05)^2 = (2.6)^2/(2)^2 = 1.69.$$

Table III. The Influence of Widely Divergent Means and Standard Deviation on the Number of Samples Necessary for an Accuracy of 10 Per Cent of the Mean at P .05.

Vegetational type	Mean (lbs. per acre)	Standard deviation (lbs. per acre)	Number of samples necessary for 10 per cent error at P.05
A. Little Bluestem (ungrazed)	1,188	413	48
B. Improved Pasture (heavily grazed)	490	220	81
C. A plus B	923	488	112

Table IV. The Size of Sample Necessary for Determination of the Forage Production Within Desired Limits of Mean with a Known Standard Deviation. p .05.

Limits (lbs. /acre)	Standard Deviation (pounds per acre)									
	50	100	150	200	250	300	350	400	450	500
25	16	64	144	256	400	576	784	1,024	1,296	1,600
50	4	16	36	64	100	144	196	256	324	400
100	1	4	9	16	25	36	49	64	81	100
150	1	2	4	7	11	16	22	28	36	44
200	1	1	2	4	6	9	12	16	20	25
250	1	1	1	3	4	6	8	10	13	16
300	1	1	1	2	3	4	5	7	9	11

Table V. The Amount of Error in Forage Production Measurements in Terms of Animal Unit Grazing Days per Section of Land (640 acres) in Relation to the Mean Production and the Desired Accuracy of Sampling. (28 pounds of dry matter per day per animal unit).

Average forage production (lbs/acre)	Accuracy desired (per cent of the mean forage production per section)				
	Animal unit grazing days				
	1	5	10	15	20
100	23	114	229	343	457
200	46	229	457	686	914
300	69	343	686	1,029	1,371
400	91	457	914	1,371	1,829
500	114	571	1,143	1,714	2,286
600	137	686	1,371	2,057	2,743
700	160	800	1,600	2,400	3,200
800	183	914	1,829	2,743	
900	206	1,029	2,057	3,086	
1,000	229	1,143	2,286	3,429	
1,200	274	1,371	2,743		
1,400	320	1,600	3,200		
1,600	366	1,829			
1,800	411	2,057			
2,000	457	2,286			
2,200	503	2,514			
2,400	549	2,743			
2,600	594	2,971			
2,800	640	3,200			
3,000	686				
3,200	731				
3,400	777				
3,600	823				
3,800	869				
4,000	914				

A NEW LOCATION FOR OPHIOGLOSSUM CROTALOPHOROIDES WALTER IN ARKANSAS[1]

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In the spring of 1951, a blade or two of an *Ophioglossum* was found among some *Houstonia* gathered from the lawn of the Conway Memorial Hospital at Conway, Arkansas. It was thought that this fern might be *O. crotalophoroides*, which had been reported from Prescott, Arkansas. (2). The entire plants, which were needed for identification, could not be found. However, several plants were gathered March 24, 1953, and identified as *Ophioglossum crotalophoroides* Walter.

The plants found at this time were growing in a dense mat of *Houstonia*, *Trifolium*, and grasses, in a low, damp place, on the lawn of the hospital. The description of the fern agrees with that of *O. crotalophoroides* in the monograph of the family (1). The cordate blade of the fern is borne horizontally, and the slender fertile segment exceeds the blade. The rootstock is globose-bulbous, about 3 mm in diameter.

Specimens have been deposited in herbaria of Arkansas State Teachers College, the University of Arkansas, the University of Tennessee, and the Gray at Harvard.

This location extends the known range of this fern northward from Nevada County in southern Arkansas to Faulkner County.

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[1] Contributions from the Botanical Laboratory, the University of Tennessee, *N. Ser.* 152.

THE BRENTWOOD LIMESTONE OF MADISON COUNTY, ARKANSAS

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INTRODUCTION

The Brentwood limestone, the lower limestone member of the Bloyd formation, is of lower Pennsylvanian age, and a part of the Morrow Group. It is exposed in a wide belt across South Central Madison County, trending generally in an east-west direction (Figure 1). Most of the outcrops are found on small hills on the northern edge of the Boston Mountains. The area included approximately 160 square miles.

GEOGRAPHY

The topography of the area varies from moderately rough to extremely rugged. Most of the hills are the outlying regions of the Boston Mountains, and are not as high as the Boston Mountains. The maximum relief in southern Madison County ranges from 800 to 900 feet.

BLOYD FORMATION

The Bloyd formation was named by A. H. Purdue (2) from Bloyd Mountain in Washington County, where it is well exposed. The Bloyd formation (Table I) consists of the Brentwood limestone member, the middle shale or "coal-bearing shale," which in some areas contains the Baldwin coal, the Kessler limestone, and the upper shale member. However, throughout Madison County, all of the beds above the Brentwood member are missing.

Brentwood limestone is the most persistent member of the Bloyd formation in Madison County. It occurs on the mountains on the north side of the Drakes Creek Fault in a belt trending generally east-west, and extending from the Washington County line to the vicinity of Kingston in eastern Madison County. In the vicinity of Kingston the Brentwood belt disappears and probably is absent to the east and north.

Thickness. The Brentwood member is characterized by a great variation in thickness. Sections measured within relatively small areas show great changes in thickness. One section near Aurora in Sect. 11, T. 15N., R. 26W., consists of 93 feet of Brentwood displayed in a massive bluff overlooking the highway. Only four miles to the northeast another section consists of only five feet of sandy limestone. In general, the thickness of the Brentwood member varies from 20 to 30 feet.

Lithology. The Brentwood consists of one, two, or three layers of calcitic limestone, interstratified with beds of shale. The limestone beds vary from lithographic to coarse crystalline.

A thin section study of some of the Brentwood shows an interesting grain size relationship. The limestone consists of three different sizes of grain. The larger grains are fossil fragments, measuring about 0.85 millimeters. Between the larger grains, occurring as interstitial material, numerous oolites measuring about 0.25 millimeters are found. These two types of grains are cemented by a very fine grained calcite. The crystals measure at most 0.067 millimeters. The smallest of these cementing grains was 0.0071 millimeters, and the average size was 0.026 millimeters.

In places the Brentwood is oolitic. Some of the oolites are elongated and appear to have formed around a nucleus of bryozoan branches. These oolites are microscopic in size.

The limestone is predominantly blue-gray, but the color is often variable. In some places it is light red, while in others it is light gray.

Sedimentation. The beds of the Brentwood were deposited during Bloyd time in a synclinal basin. Apparently they were deposited on a sea floor that was moving alternately up and down, as evidenced by the thin beds of alternating limestones and shales. The lower shale was formed by the deposition of much mud on a slowly subsiding sea floor, after which the sea became free from muddy sedi-

NOTE: Research Paper No. 1108, Journal Series, University of Arkansas.

ments and elements of marine life were deposited to form the limestone, most of the limestone seems to have as its origin the piling up of remains of the marine organisms.

Ripple marks and cross bedding found at various places suggest that the deposition of some of the Brentwood beds occurred in shallow water.

An angular unconformity above the Bloyd indicates that the land was uplifted at the end of Bloyd time and the surface was eroded before the deposition of the Atoka formation. During this erosion, the upper part of the formation was removed in many places, leaving only the Brentwood. In places the entire formation was removed, or never was deposited, and the Atoka formation was deposited on the Hale formation. Before deposition of the Atoka, the Bloyd beds were tilted, forming a conspicuous angular unconformity.

The general direction of thinning of the Brentwood in Madison County is to the northeast. Near the Madison-Newton County line it is very thin and is probably absent over a large area east of this line. This suggests two possibilities: (1) That the Brentwood first was deposited and later removed by erosion in this area, or (2) that the Brentwood never was deposited in that area, which may represent an ancient land mass present during the time of deposition of the Brentwood. Some field evidence has been found that supports the second possibility to a certain extent. In the area south and east around Huntsville, very near where the Brentwood seems to disappear, many sandy phases of the limestone are found, including pure sandstone channels in the limestone. These suggest the possibility that an ancient shoreline is represented here, with the land mass lying to the north and east of Huntsville.

Weathering. Normally the Brentwood weathers to a smooth, rounded surface. Two exceptions to this weathering were observed during field work. In the first, the lower bed of limestone, which is sandy, has weathered to a distinct honeycombed pattern. The other exception was noted in the lower bed of limestone at another location, where the limestone has weathered out into small squares of about two inches each.

A weathered surface of the Brentwood limestone generally shows many fossils which form small protrusions above the smooth surface of the rock. The more fossiliferous a given bed is, the rougher the surface will be. The smoother surfaces normally are restricted to the non-fossiliferous zones of the limestone.

Stratigraphic Relations. In previous reports the Brentwood member of the Bloyd formation has been considered to rest conformingly upon the underlying Hale formation. However, during the present investigation, certain field evidence suggests that there may be no justification for placing a formational break between the Brentwood and the Hale. The faunas of the two formations are very similar, each having both Mississippian and Pennsylvanian forms. In fact, the Brentwood limestone, which is younger than the Hale, has more definitely Mississippian forms than does the older Hale formation (1).

In several places, the upper sandstone bed of the Hale grades vertically upward into the lower limestone bed of the Brentwood without a sharp lithologic break. One of the most striking examples of this was observed near Aurora, in the SE¼ of NW¼ Sect. 11, T. 15N., R. 27W. The outcrop is an excellent example of large bluffs formed by the Brentwood. This is also one of the greatest known thicknesses of the Brentwood in Madison County--93 feet. The top of the Hale is encountered at the level of the highway at the foot of the bluff. The Hale at road level is a brown, almost pure sandstone. But only a few feet higher it becomes limey, and passes on into the Brentwood through a gradational zone of about 10 feet. The transition is so smooth that a break could not be found.

During the field work which is the basis for this report, several other instances were found which suggest the gradational conditions between the Brentwood and the Hale. Out of the 25 sections measured, eight of them contained evidence suggesting such conditions. South of the outcrop mentioned above, a section was measured in Sect. 14, T. 15N., R. 26W., that shows the gradational zone at the bottom of the lower limestone. Above this there is 11 feet of fossiliferous, bluish-gray, medium grained limestone, without arenaceous characteristics. But, above this there is 16.5 feet of sandstone with two thin limey zones about one-third and two-thirds of the way up, respectively. This bed is in places nearly pure sandstone, and does not appear to be calcareous at these places. On top of

this bed is two feet of very arenaceous limestone, and above that, approximately two feet of almost pure limestone. This section is unique in that it was the only section observed during the field work that contained beds of pure sandstone between the normal limestone beds of the Brentwood. It is possible that this may represent an ancient channel.

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System	Series	Group	Formations & Members
Carboniferous	Pennsylvanian	Pottsville	Atoka Formation
			Bloyd Formation
		Morrow	Kessler L.S. Member
			Brentwood L.S. Member
			Hale Formation
	Mississippian	Chester	Pitkin Formation
			Fayetteville Fm.
			Wedington S.S. Member
			Batesville Formation
			Hindsville L.S. Member
		Osage—Kinderhook	Boone Formation
			St. Joe L.S. Member

Table 1, Classification of the Rocks Exposed in Southern Madison County

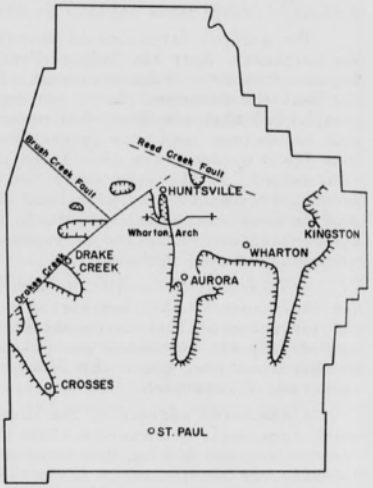

Figure 1, Area of Outcrop of the Brentwood Limestone in Madison County

GEOLOGY OF DEVILS DEN STATE PARK

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University of Arkansas

INTRODUCTION

Devils Den State Park is located in southern Washington County, Arkansas near the northwestern boundary of the Boston Mountain Province (in parts of sections 23, 24, 25, 26, 35, and 36, Township 13 North, Range 31 West). The park is on Arkansas Highway 170, about 18 miles southwest of West Fork and 15 miles northwest of Winslow. Both of these towns are on U. S. Highway 71.

For a better understanding of the sequence of geologic events in the park area, it was necessary to study sections 22 and 27 in the western part of the park. Similarly, since sections 35 and 36 added little information of geologic interest, they were deleted from this investigation. As a result, the discussed area includes sections 22, 23, 24, 25, 26, and 27, and these sections will be referred to as the park area.

The region was mapped during the late winter and early spring of 1953 by plane table surveying, from air photographs, and by compass traverse.

PHYSIOGRAPHY

The area has a relief of more than 800 feet, and the mountains have elevations in excess of 1,800 feet. These mountains are erosional remnants in the Boston Mountain Plateau, which has been dissected deeply in this area by two streams--Lee Creek to the east and Ellis Branch to the west (Figure 1). The stream pattern is generally dendritic, but Lee Creek is conspicuously abraided in sections 24 and 25 where it courses through the Bloyd shale. The streams cut through the Brentwood and Pitkin limestones in other parts of the park area. The streams join in the north central part of section 34 at an elevation of about 980 feet above mean sea level.

The region represents late youth in the erosion cycle. This is evidenced by the flat-topped mountains which are the remnants of the original plateau and also by the stage of development of the drainage system.

STRATIGRAPHY

The surface rocks are Upper Mississippian and Lower Pennsylvanian in age; they are well exposed at many points, especially along the streams. However, in places, there has been an extensive amount of slumping of the Atoka sandstone on the underlying Atoka and Bloyd shales, and several critical points of investigation have been covered.

Mississippian System. The Mississippian system in the Devils Den area is represented by the Pitkin formation which is in the Chester series (all age determinations are from Croneis, 1930). The formation crops out along Lee Creek from below the dam in section 26 southwestward into section 35 (Figure 1) and forms the surface rock over much of the east central part of section 26. Along Ellis Branch it is well exposed in the creek bed and in its valley in the south central part of section 27.

Pitkin Limestone Formation. The Pitkin formation is a light-colored, gray or blue-gray limestone which is often dense and is sometimes massive. The normal thickness of exposed limestone is a little more than 30 feet. The formation is composed of several limestone beds of different textures which range from fine-grained, sublithographic in lower parts to medium and coarse grained near the upper portions. Most of the beds show a rough crinoidal weathering in outcrops where the formation is a scarp former. There is local development of oolitic limestone in the lower and middle portions of the formation. Near the top of the Pitkin formation is a well-defined zone of nodular, crossbedded, fine-grained calcareous siltstone. At a place about 300 yards downstream from the dam in section 26, there is an exposure of blue and tan shale below the limestone. This exposure is about eight feet thick and contains small lenses of sublithographic limestone and a few concretions. It is lithologically different from the brown or black Fayetteville shale which ordinarily underlies the Pitkin formation non-

conformably (contact relations are also from Croneis, 1930); therefore, the shale has been referred to the Pitkin formation.

On weathered surfaces the Pitkin formation is usually a very light gray color. Lichens and mosses often grow on the exposed face of the rock. Where streams have cut across the formation the rock has a smooth surface and a pale blue color. Numerous potholes have been developed by stream abrasion and solution. The weathering of the nodular zone in the upper part of the formation can be observed in the lichen-covered, crumbly ledges in the southeastern part of section 27.

One cave has been developed in the Pitkin by the solution of the limestone by ground water. The cave, Farmers Cave, is 25 yards northwest of the county road bridge over Ellis Branch in the south part of Section 27.

The formation is generally fossiliferous, but collecting is difficult because of the hardness of the rock at most exposures. The bryozoan, Archimedes, is fairly abundant. There are many assemblages of gregarious horn corals. Brachiopods, coiled cephalopods, and bryozoans can be seen in section or relief in many of the stream exposures.

The Pitkin formation is overlain unconformably by the Hale formation.

Hale Formation. The Hale formation is the oldest of the Pennsylvanian rocks in Northwest Arkansas. It is the basal formation of the Morrow group, which is Pottsville in age. The formation outcrops along the valley walls of Lee Creek and Ellis Branch in sections 26 and 27. The average thickness of the formation is about 140 feet. A large shale interval comprises the lower part of the formation in the park area, and true thicknesses are difficult to measure because long, gentle, covered slopes have developed on this basal shale. The lower shale is a light brown or tan color and includes some fissle beds. There is development of small clay concretions throughout the lower Hale, but no fossil nuclei have been found. The middle portion of the Hale formation is made up of thin-bedded shales and fine-grained sandstones. The percentage of shale decreases upward in the formation, and the upper middle part is largely fine-grained, thin-bedded, calcareous sandstone which has been cross-bedded and ripple-marked extensively. The ripple marks are particularly evident at exposures near Ellis Branch in the central part of section 27. The trend of the ripple marks is about N80E; the ripples are primarily of the current type and the trends indicate currents moving from a northerly direction.

The upper part usually consists of a very dense, massive, fine-grained, calcareous sandstone which ranges from 15 to 20 feet in thickness. Frequently the contact between this sandstone and the overlying Brentwood is difficult to locate since the lower Brentwood is rather arenaceous and the two beds have similar weathering characteristics.

The formation is fossiliferous throughout, particularly in the upper portions, but the fauna is poorly preserved and good specimens rarely are found. Brachiopod and Bryozoan remnants are forms which are found commonly in this area.

The Hale formation is conformably overlain by the Bloyd formation which is the uppermost formation of the Morrow group.

Bloyd Formation. The Bloyd formation in the Devils Den area is characterized by extreme lateral and vertical variations in thickness and lithology of the various component members. The formation consists of the Brentwood limestone member at the base, the Bloyd shale, the Baldwin Coal, and the Kessler limestone member. The Bloyd shale occurs between the Brentwood and Kessler members and contains the Baldwin Coal; the Bloyd shale also occurs above the Kessler member. The Bloyd formation is overlain with angular unconformity by the Atoka formation, which is also Pottsville in age.

Brentwood Limestone Member. At points where the contact can be seen, the Brentwood member rests conformably upon the massive upper Hale sandstone. The limestone outcrops along Lee Creek in section 26 and along the stream bed and valley walls of Lee Creek in the northern part of section 24. In the northern part of section 27 the limestone can be followed in the stream bed nearly to section 15 (Figure 1).

The Brentwood limestone varies in thickness from about 50 to more than 100 feet, including the shale intervals between the several limestone beds. In sec-

AREAL GEOLOGICAL MAP

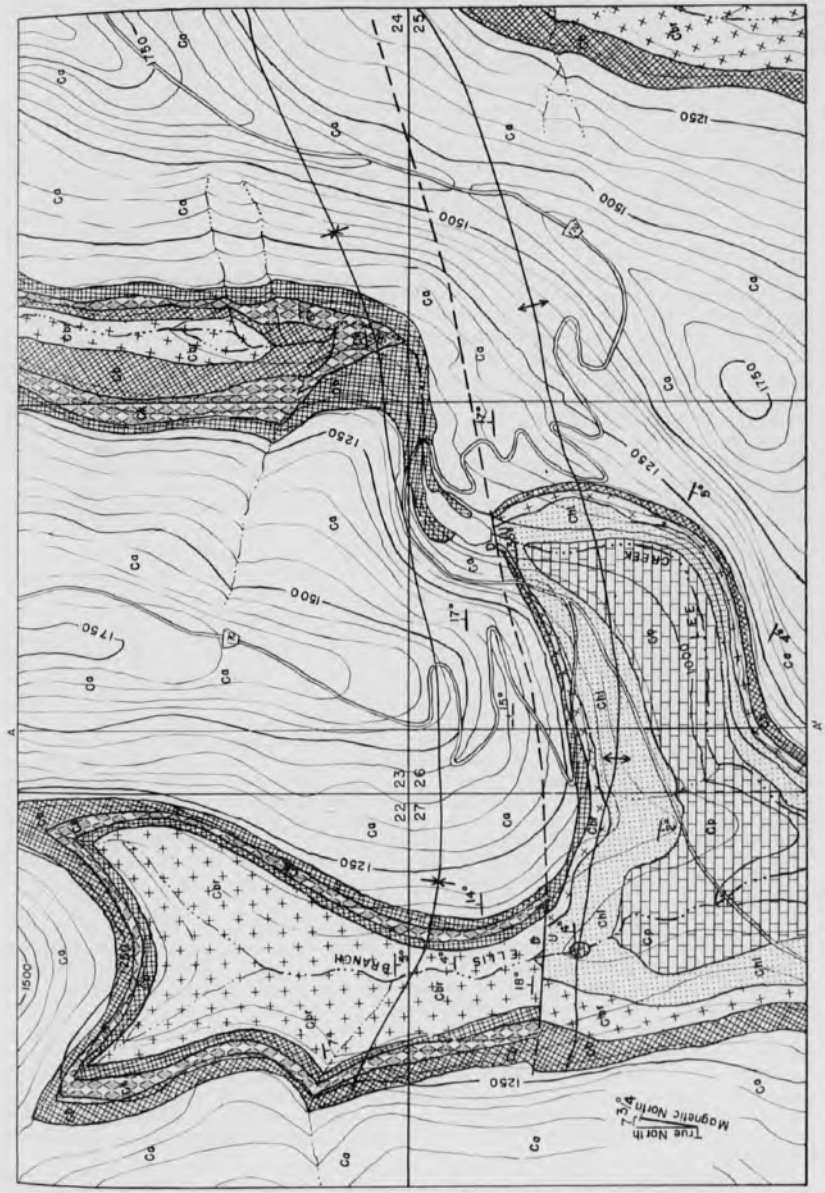


Figure 1. Sections 22, 23, 24, 25, 26, and 27, T 13 N, R 31 W, Washington County, Arkansas. Contour interval, 50 feet. Datum is mean sea level.

tion 26 and in the southern part of section 27 the entire Brentwood sequence is not present because the upper Brentwood limestone and remainder of the Bloyd formation were removed by pre-Atoka erosion, following faulting which elevated the southern portion of the Devils Den area. North of the trace of the axis of the fault, in the southern parts of sections 22 and 24, and in the northern part of section 27, the entire Bloyd formation is present.

The member is made up of several limestone beds which are generally blue-gray to light gray in color and range from sub-lithographic to coarsely crystalline types. There is some local development of oolitic limestone near the lower middle parts of the sequence. The thickness of the individual beds varies considerably, and they appear to interfinger with one another; there is also some lateral gradation of limestone to shale. The shales within the member are generally blue to tan, fissle, sparsely fossiliferous lenses. They range in thickness from one inch to about 15 feet. The shales are lithologically similar to the Bloyd shale lying between the Brentwood and Kessler members.

There is one fairly persistent massive limestone layer, about 15 feet thick, at the base of the member. The lower beds are sometimes arenaceous, and there is a local development of conglomeratic limestone at several different levels. There has been much replacement and filling of fossils in the beds by calcite.

In this area some of the weathered Brentwood limestone appears similar to the Pitkin limestone, but the lichens and mosses do not grow as abundantly on the surface of the Brentwood limestone; it also does not have the mottled-dark appearance of the weathered Pitkin formation. The yellow calcite crystals and sandy material in the Brentwood member give many exposures a yellow-brown appearance which is not common in the Pitkin; the Brentwood commonly weathers to rounded blocks, whereas the Pitkin often breaks in angular masses. The Brentwood fossils are so abundant and characteristic that they serve to identify doubtful exposures.

The member is very fossiliferous throughout the area of outcrop. The index blastoid, *Pentremites*, usually can be seen in section on stream-cut exposures. Plates of *Eupachycrinus* and *Hydreionocrinus*, calices of *Delocrinus*, and well-preserved specimens of many brachiopod species can be found in the park area. There is a locality near the center of section 24 on Lee Creek where a bioherm-like mass of very weathered, crumbly, crinoidal limestone contains many different species of Brentwood fossils and, in particular, yields excellent specimens of *Gastrioceras*, a coiled cephalopod. Collecting in the area is good because Brentwood often weathers to easily broken masses.

Bloyd Shale Member. The Bloyd shale, a varying lithologic unit lying between the Brentwood limestone and the Kessler limestone members of the Bloyd formation, also occurs above the Kessler member. The thickness of the shale varies considerably, but the average distance between the two limestones is about 60 feet. An arbitrary figure has been set on the thickness of the upper Bloyd above the Kessler; the dividing line between the Bloyd shale and the basal Atoka shale has been set at a point halfway between the Kessler and the lower sandstone scarp of the Atoka formation. The resulting thickness of the upper Bloyd shale is about 40 feet.

The shale ranges from tan to blue and brown to black in color. It occurs as medium-bedded, compact masses in places. In other localities it is notably fissle. There is an excellent exposure of the fissle type within the upper Bloyd interval on Lee Creek in the southwest corner of section 24 north of the abandoned spillway. The fissility is so great in the shale at this point that it has a greasy feel. Several joint systems in the shale are evident.

Baldwin Coal Lentil. In the Bloyd shale interval between the two limestones is a persistent coal seam, the Baldwin Coal, which outcrops around the valley walls and in the creeks in sections 22 and 24. The coal is approximately eight inches thick at most exposures. The coal can be traced by the "bloom" which appears through the covering shales and by the old workings which have been made by farmers.

No fossil flora were found in the roof shale in the park area, but an extensive search was not made. The underclay shows fossil roots.

The best exposures of the coal are found up a western tributary of Ellis Branch in section 22 on the northern side of the tributary wall at an elevation

of about 1,150 feet.

Kessler Limestone Member. The Kessler limestone member is the most variable of the stratigraphic units in the park area. It occurs as several beds of varying thicknesses and of widely diverse lithologies. The entire member ranges in thickness from about 20 to 80 feet in sections 22, 23, and 24. Some of the Kessler is a dark, fossiliferous, coarse-grained limestone which weathers to a chocolate brown color. Other types are found which are lithologically identical with common Brentwood limestone. This Kessler limestone is medium to coarse-grained, dense, fossiliferous, and light blue-gray in color. Sand fragments and yellow calcite crystals give the common Brentwood a weathered appearance. These limestones normally are found in the upper portion of the Kessler interval. As is common in the Brentwood member, the various component beds are separated by shale intervals, which, however, are generally more arenaceous than those of the Brentwood sequence.

Conglomeratic beds are seen throughout the Kessler member, some occurring in the limestone beds and others in beds which are calcareous siltstones. These siltstones are very dense, dark gray in color, and weather to a dark brown. They have a flagstone-like appearance and are almost invariably conglomeratic. There are several lenses of this material--one at or near the top of the Kessler member and another at the bottom. However, both lenses have not been found in the same vertical section. On Lee Creek, in the southeastern part of section 24, the siltstone conglomerate outcrops near the stream bed. Here it is the basal Kessler. On Ellis Branch, in section 22, an identical siltstone occurs at the top of a very thick Kessler section.

In the extreme northwest corner of section 24 there is a sandstone bed about five feet thick within the Kessler interval. This bed is argillaceous and easily weathered, and contains a most prolific assemblage of productid brachiopods of many different species.

The Kessler member is generally fossiliferous, containing numerous small horn corals, species of *Michelinia,* and many species of brachiopods. Good collections can be made in the northwestern part of section 24.

Atoka Formation. The Atoka formation overlies the Bloyd formation with angular unconformity. It has the largest areal distribution and the greatest vertical extent of any of the formations in the park area. The lower part of the Atoka formation is a black shale that is lithologically similar to the upper Bloyd shale. An arbitrary contact line has been drawn between the two shales. There is a persistent bed of calcareous, massive sandstone near the base of the formation, which is a prominent scarp former and can be traced on air photographs. Above the lower massive Atoka sandstone is a series of alternating thin bedded sandstones and shales. The shales are variable in terms of color, ranging from light blue to black. Near the middle of the formation is another prominent sandstone which is very dense, fine-grained, and quartzitic. This bed often shows a pink color on fresh surfaces. Above this sandstone are more series of sandstones and shales.

There are several notable original sedimentary structures in the formation. Ironstone concretions in the sandstones are common at nearly all levels in the Atoka formation. They weather to concentric rectangular structures when viewed in section. They are useful in identifying slump blocks of the formation. In addition to these unique concretions one can find exposures of sandstones which show branching, feather-like outlines parallel to the bedding surfaces. These have a small relief and a random orientation. Possibly, they are swash marks of a specialized kind.

There has been much extensive slumping of the lower Atoka sandstone on the lower Atoka and upper Bloyd shales. Some of the slump blocks are large, and the crevices between the block and wall are well-known tourist attractions--featuring such picturesque names as "Devils Ice Box." The lower Atoka sandstone occasionally shows honeycomb weathering in the vicinity of waterfalls.

The total thickness of the formation exceeds 800 feet. The best accessible exposures can be seen in the northeastern corner of section 25 where park trails have been constructed between the large slump blocks and the rock in place.

A few fossils can be found in the Atoka formation, but collecting is usually limited to casts of spirifiroid and productid brachiopods in sandstone.

STRUCTURAL GEOLOGY

Diastrophic movements in the area have resulted in the formation of three major structural elements--a syncline, fault, and anticline. The existence of the structure is indicated by dips in the various formations, abutting of different strata against each other, truncation of lower bedding surfaces by beds which are stratigraphically higher and by the absence of beds which should be present. Interpretation of the structural geology has been difficult because of the overlapping of the three main elements.

The fault was mapped in 1903 and the other structures were discussed but not figured (Purdue, 1907).

The syncline extends from the southwestern quarter of section 24 to the southwest, passing out of the area in the northwestern part of section 27. The trace of the axis of the syncline is slightly curved, as shown by dip relationships (Figure 1). The structure is asymmetrical--the dips south of the trace of the axis are greater than those to the north. The dips on the south limb range from four degrees in the Pitkin limestone in section 27 to 17 degrees in the Hale formation in section 26. The dips on the northern limb vary from seven degrees in the Brentwood limestone in section 22 to nine degrees in the Kessler limestone in section 24. On the northern limb of the syncline, in section 24, the tilted beds become nearly horizontal near the north section line. The structure has been observed in a valley to the east of section 24, indicating that the structure is elongated in a general east-west direction. The relationship of the syncline to the other structural elements can be seen in the structure section (Figure 2).

The southern limb of the syncline has been faulted--the upthrown side is to the north, and the downthrown side is to the south. In the north-central part of section 27 the fault can be seen in the creek bed and valley, where the middle Hale formation, a thin-bedded, calcareous, ripple-marked sandstone abuts against the massive, calcareous upper Hale sandstone. The stratigraphic displacement is about 60 feet. Faulting is exposed in Lee Creek below the dam in section 26. Here there are several faults, roughly parallel, trending in a general northeast-southwest direction. There is a confused stratigraphic relationship here because of pre-faulting tilting of the strata and fault drag. However, exposures show the middle Hale sandstone abutting against the upper Hale sandstone. Instead of the middle Hale being south of the trace of the fault--as the other locality was found to be--it is north of the trace.

The fault or zone of faulting extends to the valley east of section 25 where the upper Bloyd shale has been downfaulted against the middle Brentwood limestone.

Dip relationships due to drag tend to obscure the precise relationship of the fault to the folding which occurred.

The faulting occurred before the deposition of the Atoka formation. On the upthrown side of the fault the upper Brentwood limestone and the remainder of the Bloyd formation were removed by erosion before the deposition of the Atoka formation.

There is a pronounced anticlinal structure which is very asymmetrical. In fact, it was referred to by Purdue (1907) as a monocline. It trends parallel to the fault and syncline, passing out of the park area to the east, continuing for some distance. The anticline is best shown in the lower resistant sandstones of the Atoka formation. The beds of the Atoka dip northward at an angle of 18 to 19 degrees in the northern part of section 25 and the southern part of section 23. However, the beds south of the trace of the axis of the fault dip south or southeast at about four degrees. The dips are pronounced in the Brentwood limestone in sections 22 and 27 and in the Hale formation in section 27. The prevailing dip on the north limb of the structure in these beds is about 17 degrees. Within the Atoka formation the dips die out upward in indication that the arching occurred during the deposition of the lower sands.

HISTORICAL GEOLOGY

The history of the deposition of the various formations and the diastrophic agencies acting upon the deposited beds in the Devils Den area is somewhat complex. The following hypotheses are not intended to represent a final, authoritative interpretation of the environmental conditions existing during the geologic past within the region.

The Pitkin formation was deposited in a warm sea which contained much carbonate matter as indicated by the character of the faunal assemblage (horn corals, crinoids) and the limestones which comprise the formation. At one time, or several times, during the deposition of the Pitkin formation the water of the sea was shallow and agitated as is shown by the occurrence of oolitic limestones. The seas withdrew from the region at the end of the Mississippian period, and there was a short period of erosion or non-deposition. In a few locations the bedding planes of the Pitkin formation seem to be truncated by the shales of the Hale formation.

At the beginning of the Pennsylvanian period the Hale formation was deposited in a shallow sea which, at first, lacked carbonate material. The bottom shales were derived from muds which apparently came from a northern source. Throughout Hale time the seas were encroaching as is indicated by the increase in clasticity upward in the formation. The thin-bedded, ripple-marked middle Hale sandstone is indicative of shallow waters in which moderately strong currents moved constantly from a northerly direction. An alternate reason for the increase in the clasticity of the Hale sediments is that a land area was rising to the north as time progressed.

There was an encroaching, fluctuating sea during the deposition of the Brentwood member of the Bloyd formation. The shallowness is shown by the oolitic limestones and local, small-scale cross-bedding. During the deposition of the shale, forming muds of the Bloyd interval, the seas were somewhat less favorable to animal life and at least one time the sea withdrew entirely and coal was deposited under swamp conditions.

The Kessler interval represents a re-initiation of conditions favorable to prolific growth of animal life and favorable to deposition of fossiliferous-fragmental limestones. Following the carbonate Kessler sea there was some deepening of the water and the upper Bloyd shale was deposited.

During the deposition of the Bloyd formation there was a series of downwarps re-initiated along the same parallel lines. Possibly, this was due to block faulting in the basement rock contemporaneous with sedimentation (Payne, 1953). Between the time of deposition of the Bloyd formation and the Atoka formation, faulting cut through the members of the Bloyd formation and a period of strong erosion followed, removing the middle and upper Bloyd formation on the upthrown side of the fault. The Atoka seas then encroached and there was apparently recurrent movement along the same fault lines. This threw the Atoka formation into steeply dipping beds along the margin of the original syncline.

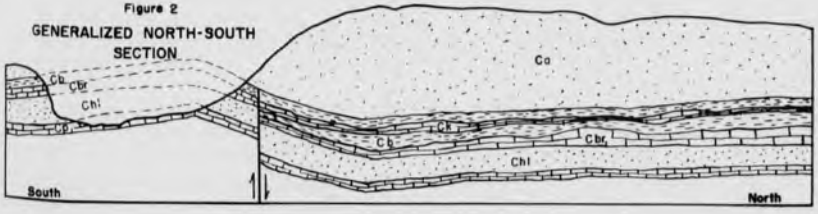
The recurrent faulting ceased during the deposition of the quartzitic sandstones during Atoka time and the uppermost beds of the formation show only the normal regional dip to the south.

ECONOMIC GEOLOGY

There is little of economic value in the park area. At one time, the coal was utilized by farmers for fuel, but this is not done today. The vast amount of limestone and sandstone in the area could be used as building material, but there is no nearby market. The limestones are too impure for use as commercial limes.

The scenery produced by the combination of geologic phenomena, topography, and plant life have economic use in that they are tourist attractions.

Figure 2
GENERALIZED NORTH-SOUTH SECTION



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NON-RECOGNITION OF RED CHINA: REASONS AND RATIONALIZATIONS

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Arkansas State Teachers College

In 1949 the Nationalist government of China, under the leadership of Chiang Kai-shek, was driven off the China mainland to an uncertain island refuge on Formosa by its long-time civil war enemy, the Chinese Communists. These Chinese Reds subsequently proclaimed at Peiping September 29, 1949 that they were the new Communist government of China, the so-called Peoples' Republic. Party Chairman Mao Tse-tung became Chairman of the Central Peoples' Government. His regime, three days later, made a formal request for recognition by the foreign governments that had consulates at Peiping--including the United States.

Some nations extended recognition immediately. The United States, among others, did not. There were no reasons, in particular, for the refusal to act at this early date--except time, to wait to see what would happen.

But what sort of thing was to be looked for in that waiting period? The basis of the impending recognition decision apparently was a matter of some difference of opinion. Twenty-five consultants, including scholars, businessmen, and politicians, met October 6-8, 1949, at Washington to advise the State Department on its Red China recognition problem.[1] Thirteen of these consultants favored recognition in time, three were opposed to recognition, and nine were noncommital. A clear majority thus recommended that the United States recognize Red China, but only at a later and more appropriate time.

The representatives of the State Department agreed that recognition of Red China by the United States would have to wait. But there was less agreement on what the United States was waiting for. The advisors were waiting to see if the Mao Tse-tung regime was actually in control of China; the Department was waiting to see how the Mao Tse-tung regime behaved.

It behaved badly. It repudiated the Nationalist United Nations delegation and announced that it would re-examine all Nationalist treaties, deciding in due course which it would keep and which it would scrap. A new revolutionary government might be expected to do this to its predecessor, but the predecessor in this instance was still recognized by the United States. Consequently, such precipitous action was not calculated to win American favor.

More directly and dramatically, the Peiping regime brought pressure to bear on individual American officials and citizens in China. It caused the arrest of United States Consul-General Angus Ward at Mukden October 24. Ward and others on his staff were arrested for alleged assault on a Chinese employee. A month later Mukden Vice Consul William Stokes was taken into court and questioned about his alleged espionage activity.

Red China was trying to force the American hand. It would not be forced. When Peiping finally repudiated the Nationalist delegation in the United Nations, as it did November 16, the United States immediately announced its support of the Nationalist delegation. That same day, in a press conference, Secretary of State Dean Acheson gave his reasons. The arrest of Angus Ward, Acheson said, had killed any chance of early recognition of Red China.[2] In short, bad behavior was the reason.

Then for a while, tensions seemed to relax. Angus Ward and the others, sentenced to various terms, were released and deported November 24. India became the first non-Communist country to recognize the Peiping government December 30, 1949. Britain followed suit seven days later. The West seemed to be moving toward recognition. The following week, on January 12, Secretary Acheson spoke on Asiatic policy to the National Press Club in Washington. He complained bitterly against the Soviet Union, to be sure, for "detaching" Manchuria and other areas from

[1] Full text of these conversations in U. S. Department of State, *Transcript of Round Table Discussion on American Policy Toward China Held in the Department of State, October 6, 7, and 8, 1949.* (Confidential classification cancelled).

[2] *St. Louis Post-Dispatch*, 17 November, 1949.

actual Chinese control, but his speech was in general conciliatory of the Peiping regime.[3] The State Department still was waiting and watching.

It did not have to wait long. Two days later, January 14, the Chinese Communists forcibly took over the consulates of the United States, France, and The Netherlands, in Peiping. If Red China seriously were seeking American recognition--this is open to possible doubt--this was not the way to do it. The United States reacted quickly and angrily. It closed all its China consulates and ordered all American officials out. Administration Spokesman Senator Tom Connally of Texas endorsed this action. "The Chinese Communist government," he explained in a statement released to the press that night, "is seeking recognition. But no nation is entitled to recognition when it does not respect international law and does not respect the representatives of other governments and the rights of their citizens."[4] It was less a lawyer's theoretical complaint than a demand for a minimum of common decency and the ordinary mutual conveniences of diplomacy.

The Netherlands, apparently pressured in part by this consulate seizure, extended recognition to the offending Peoples' Republic March 27, 1950. The United States did not, and Red China's early opportunity for recognition was lost. The basic standard for continuing non-recognition was still, in the main, bad behavior.

It was in this atmosphere of angry suspension, on June 25, 1950, that Communism launched its lightning invasion of South Korea. For the moment, all other problems were pushed aside. Through the summer of 1950 hard-pressed and undermanned South Korean, American, and other United Nations forces were pushed back to the "Pusan perimeter." The tide turned with the Inchon landings of mid-September and by early October the 38th parallel had been recrossed. The general feeling in the West was that the war was over. In General Douglas MacArthur's phrase, the boys would be "home for Christmas."[5]

Chinese Communists, however, had other ideas. Peiping's premier, Chou En-lai, had warned October 1 that Red China would "not supinely tolerate seeing their neighbors being savagely invaded by imperialists."[6] In late October, Chinese "volunteers" began to take the field. On November 26, in overwhelming numbers, the Chinese "volunteers" launched a crushing counteroffensive. Two days later MacArthur was forced to report to the United Nations: "We face an entirely new war."[7] And the United Nations lost it. Or at least, it did not win it. The explanation and the symbol of this frustration was Communist China. This was not mere misbehavior. This was war. And in war, one must hate the enemy.[8] Consequently, the recognition issue became clouded with ideology.

Assistant Undersecretary of State Dean Rusk addressed the 25th anniversary dinner meeting of the China Institute of America May 18, 1951. It was both a tirade and a turning point. Said Rusk:

> We do not recognize the authorities in Peiping for what they pretend to be. The Peiping regime may be a colonial Russian government--a Slavic Manchukuo on a larger scale. It is not the government of China. It does not pass the first test. It is not Chinese.
>
> It is not entitled to speak for China in the community of nations. It is entitled only to the fruits of aggression upon which it is now willfully, openly and senselessly embarked.

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[3] Full text in U. S. Department of State, *Bulletin* xxii:551 (23 January, 1950), 111-118.

[4] *New York Times*, 15 January, 1950.

[5] *St. Louis Post-Dispatch*, 26 November, 1950.

[6] *Arkansas Gazette*, 2 October, 1950.

[7] *St. Louis Post-Dispatch*, 29 November, 1950.

[8] See, for example, the melancholy prophecy of the idealist, Woodrow Wilson, immediately prior to America's entrance into World War I: "A nation couldn't put its strength into a war and keep its head level; it had never been done." Quoted in Morison and Commager, *The Growth of the American Republic* (3rd edition, New York, 1942) II, 468-9.

> We recognize the National Government of the Republic of China, even though the territory under its control is severely restricted. We believe it more authentically represents the views of the great body of the people of China, particularly their historic demand for independence from foreign control.[9]

It was the difference between the free and the un-free. Furthermore, Rusk added, if in spite of their Russian Communist masters "the Chinese people decide for freedom, they shall find friends among all the peoples of the earth who have known and love freedom." This was a thinly veiled threat to wage eternal war against the Communist government of China until it was overthrown.

Future Secretary of State John Foster Dulles, from the same platform, was less subtle. The Mao Tse-tung regime was without doubt, in his estimation, a "puppet regime" and any opposition to it should receive encouragement and, by inference, assistance from the United States.[10] This would appear to be the kernel of the famous "liberation" idea that Dulles expounded so actively during the 1952 presidential campaign and since.

The thinking expressed here by Rusk and Dulles continues in United States policy. Satelliteism, or subservience to Moscow in particular, was united with bad behavior in a new double standard of non-recognition. These were the main themes. But other propositions, sometimes incidentally revealed, are also worthy of attention. For example, November 25, 1949, nearly two months after the proclamation of the Peoples' Republic of China, a new government was installed by *coup d'etat* in Panama--a bloodless revolution engineered by the national chief of police, his third such action in six days. Three weeks later the United States recognized this government. Why? Because the transition had been realized without any "foreign intervention."[11] Thus the means were apparently less important than the pedigree. By extension, this standard also applied to Red China, which was, of course, not recognized.

Also, in October 1951, when his qualifications as United States delegate to the United Nations were being investigated by a subcommittee of the Senate Foreign Relations Committee, Ambassador-at-large Phillip Jessup was asked his opinion on the question of recognizing the Mao Tse-tung regime. He recalled an Acheson Formula of recognition "more than two years ago": That a government control the country it claims to control, that it recognize its international obligations, and that it rule with the acquiescence of the people who are ruled.[12] "Under the present circumstances," Jessup concluded without further elaboration, "we cannot recognize Communist China."[13] It was not clear here which counts were being held against Peiping. Certainly there was little doubt about its control of China; if anything, this test should have worked hardship only on the Nationalists who were in effective control of approximately one-third of one per cent of the territory usually included in the Chinese political unit. The fact that the Communists did not recognize their international obligations was mostly a repetition--none the less valid--of the bad behavior charge. The prerequisite of ruling with the acquiescence of the people was an added item in the general ideological complaint which has received new emphasis since 1950.

Altogether, then, the continuing indictment which is the basis for non-recognition of the Peoples' Republic of China seems to include: That it has misbehaved, that it was established through "foreign intervention," that it is not "entitled" to speak for China (because of its apparent status as a "colonial Russian government"), and that it does not rule "with the acquiescence of the people who are ruled."

An argument that the final standard--acquiescence--is entirely unreal can be demonstrated easily by reference to the American policy toward other new and questionably democratic regimes during the period covered by these events. From

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[9] Complete text in State Department *Bulletin* xxiv:621 (28 May, 1951), 843 ff.

[10] *Ibid.*

[11] *St. Louis Post-Dispatch*, 15 December, 1949.

[12] *New York Times*, 13 October, 1949.

[13] *St. Louis Post-Dispatch*, 6 October, 1951.

September 1949 to the present, the United States has extended recognition, almost immediately, to governments by *coup d'etat* in Panama, as already noted, in Syria December 17, 1951, in Cuba March 27, 1952, and in Bolivia June 2, 1952.

This contrary practice seems to cast additional doubt on the validity of the "colonial Russian government," or satellite charge--if what is meant here is that this further proves that the government in question is without popular support. The same might be said concerning "foreign intervention" in the initiative stages of any regime. If the complaint is, however, against *Russian* domination and *Russian* intervention in particular, then there is also obvious conflict with the original and continued recognition of all firmly established Russian satellite states and, indeed, of Russia herself. And yet, in October 1952, when Republican Senator William Knowland of California called, logically, for the breaking of diplomatic relations with the Soviet Union in retaliation for their having demanded the recall of United States Ambassador to Moscow George F. Kennan, Secretary Acheson refused to undertake such action. Acheson based his decision on the grounds that it "would be a step of the utmost seriousness with worldwide consequences."[14] If there is any point in not recognizing the existence of things Russian, then there is much un-recognizing to be done.

Misbehavior, and American displeasure with it, seems to be the one sincerely valid count against Communist China. But it is important to realize that non-recognition based on this reasoning, places the United States in a serious dilemma. It cannot easily trade recognition for China's *good* behavior if good behavior is the precondition of the United States and recognition is the precondition for the Chinese Reds. As Correspondent Thomas J. Hamilton points out in a recent newspaper dispatch from United Nations, New York, the United Nations probably cannot get a general truce in Korea without recognizing Communist China, nor can the United Nations readily extend that recognition without first getting a general truce.[15]

The additional problem of dealing with realities, regardless of preference, was revealed strikingly last spring by a diplomatic dilemma of a different sort. The United States, Great Britain, and France submitted to the United Nations Disarmament Commission May 28, 1952, a proposal for limiting the size of armies among the great powers. A ceiling of 700,000 or 800,000 men was to be fixed for Britain and France and of 1,500,000 for the United States, the Soviet Union, and--"China." The last designated party was nowhere otherwise defined in the plan. Since the Nationalist government on Formosa has, by the most optimistic estimates, no more than 500,000 men under arms, its adherence to such agreement would have been meaningless. When questioned later about which one of the two Chinas was meant, Western representatives differed in opinion somewhat, at least in degree. French Delegate Jules Moch was quoted as saying that "nobody had thought of Formosa" in this connection.[16] Great Britain's Sir Gladwyn Jebb "made it obvious that he had Communist China in mind."[17] American delegates, however, according to reputable report, "displayed a great reluctance to state flatly that 'China' was Communist China. They were afraid that direct mention of Communist China might involve them in the problem of recognition. In their corridor explanations they preferred to say that they were talking about whatever China was in command of the troops on the Chinese mainland."[18]

This was sheer fantasy. If the United States is currently unwilling or unable to call a fact a fact, even when, as in this instance, it was in its own obvious best interests to do so, it will find the real world, at least in Asia, increasingly difficult to deal with. We must keep in mind that misbehavior is the only defensible standard on which our non-recognition of the Peoples' Republic of China is based. If we can bargain it away, which apparently was our intention in withholding recognition in the first place, for better behavior, as

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[14] *New York Times*, 8 October, 1952.

[15] *Ibid.*, 13 January, 1953.

[16] *St. Louis Post-Dispatch*, 31 May, 1952.

[17] A. M. Rosenthal dispatch to the *New York Times*, 29 May, 1952.

[18] *Ibid.*

possibly in Korea, or for achievement of our best interests, as in disarmament, we must be prepared to do so, regardless of extraneous ideological overtones. We must remember when and if the time for hard bargaining comes, particularly in Korea--and the writer is not predicting that it necessarily will come--that words are not meanings and symbols are not realities.

United States non-recognition of the Peoples' Republic of China has been imposed since 1949, and thus far ineffectually, as a sanction. The sanction has been employed legitimately only against misbehavior. If it works at all, which it may not, the United States must be willing to abandon it in return for the results it was designed to achieve.

ORGANIZING THE FREEDMEN'S BUREAU IN MISSISSIPPI

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When General Ulysses S. Grant marched into Mississippi in the fall of 1862, he encountered an unusual army, an "Army of Contrabands." It was friendly, yet dangerous; docile, but impeding.[1] Grant's victory at Corinth had driven most of the plantation owners out of the vicinity, which left a multitude of slaves to seek refuge with the Union army. The Negroes came in droves; as Chaplain John Eaton, an eyewitness, said, "an army in themselves." They were clothed in rags and in silks; some were shod and some were not; many were ravaged by disease and debility. Without plan or direction, they irresistibly and instinctively made their way to those whom they supposed would grant them the necessities of life and the freedom for which they longed.[2]

Previously Grant had met small contingents of this "Black Army" and, with the aid of northern benevolent societies, had employed them on fortifications under the supervision of his division officers.[3] But never had he met an "oncoming of cities," as Eaton expressed it. Now in the real black belt he was faced for the first time with the problem of what to do with Negroes whose freedom was only promised.[4] To facilitate their care, Grant named Chaplain Eaton to take charge of the contrabands who came into camp, and to organize them into companies while they worked in the cotton fields which the owners so quickly had deserted.[5] This was the beginning of almost three years of inefficient, bickering supervision of the Negroes by military commanders, treasury officials, and benevolent associations.[6]

During the same period Congress labored to establish an organization to supervise efforts in behalf of the freedmen. In December, 1864, a bill was introduced to establish a bureau in the War Department to handle freedmen's affairs. From the beginning, this proposal met decided opposition, public and private, in the House and in the Senate. Supporters of the bill carried the day, however, and March 3, 1865, the Bureau of Refugees, Freedmen, and Abandoned Lands was established.[7]

The purpose of the "Freedmen's Bureau," as it frequently was called, was to control "all subjects relating to refugees and freedmen from the 'rebel states,' or from other districts embraced in the operation of the army." Under this charge came the responsibility of supervising and assigning abandoned lands, protecting recipients for three years, and issuing fuel and clothing to the destitute.[8] General Oliver Otis Howard was named commissioner of the Bureau. Establishing his headquarters at Washington, he divided the South into 10 districts, each of which was under the jurisdiction of an assistant commissioner who had seen military service and had become familiar with the social and economic conditions of the South. They were generally men of ability and good repute, having had some experience in the affairs of freedmen.[9]

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[1] The greatest danger came from the variety of freedmen's diseases. John Eaton, *Grant, Lincoln and the Freedmen, Reminiscences of the Civil War with Special Reference to the Work for the Contrabands and Freedmen of the Mississippi Valley* (New York, 1907), 13.

[2] *Ibid.*, 2; James W. Garner, *Reconstruction in Mississippi* (New York, 1901), 249.

[3] Paul Skeels Peirce, *The Freedmen's Bureau, A Chapter in the History of Reconstruction* (Iowa City, 1904), 9.

[4] The Emancipation Proclamation of September 22, 1862, was not to become effective until January 1, 1863.

[5] Eaton, *Grant, Lincoln, and the Freedmen*, 5; Garner, *Reconstruction in Mississippi*, 249 *Personal Memoirs of U. S. Grant*, 2 vols. (New York, 1885).

[6] Eaton, *Grant, Lincoln, and the Freedmen*, 171-72.

[7] Peirce, *Freedmen's Bureau*, 40-41; *Statutes at Large*, Vol. XIII, Chap. 90, 38 Cong., 2 Sess., 507-509.

[8] Peirce, *Freedmen's Bureau*, 44.

[9] *Ibid.*, 48-49.

General Howard named Colonel Samuel Thomas, a former assistant to Colonel Eaton in the Freedmen's Department in Mississippi, assistant commissioner of Mississippi. Thomas had become familiar with the social, economic, and political problems of both the black and white peoples. He was an educated man with administrative ability and a good reputation, and had served successfully as a colonel of the United States Colored Infantry.[10]

Economic, social, and political disorder presented a discouraging picture of Mississippi's 400,000 freedmen. This study concerns the organization of the Bureau, the methods Thomas used to insure its proper functioning, and the problems he faced during his administration.

Colonel Thomas assumed his duties June 20, 1865. He divided the State and the Louisiana parishes along the Mississippi River from the Red River to the Arkansas line, which were also under his command, into three districts. These districts, designed to coincide with the military organization, were placed in charge of acting assistant commissioners.[11] Realizing that efficiency and experience with Negroes would be invaluable, Thomas chose officers of colored regiments for these positions.[12] The Northern District, the largest of the three, composed of the northern and eastern two-thirds of Mississippi with an estimated 225,000 freedmen, was placed under the charge of Lieutenant Colonel R. S. Donaldson of the 64th United States Colored Infantry. The Western District, the smaller of the three with 45,500 freedmen, was assigned to Captain J. H. Weber, also of the 64th United States Colored Infantry. The Southern District, with 76,100 freedmen, was under Major G. D. Reynolds of the 6th United States Colored Artillery.[13]

The districts then were divided along county lines into subdistricts to conform to the military subdivision of Mississippi.[14] General Howard issued instructions to the assistant commissioners July 12, 1865, establishing offices in the subdistricts with at least one agent in each subdistrict.[15] In this year as provost marshal general of freedmen of Mississippi, Thomas developed men who were qualified to become subcommissioners of the Bureau.[16] With the aid of his acting assistant commissioners, Thomas set to work to detail officers to every county in the state. Although Howard had indicated that citizens of the community might serve as Bureau officers, Thomas declined to appoint them. He felt there was danger that they would wish to stand well with their neighbors, and that they would be unable or unwilling to do justice to the Negroes. As a consequence, Thomas felt, Negroes would have little or no confidence in the Bureau officers, and its purpose would be thwarted.[17]

Great care had to be taken in the selection of Bureau officers. The sudden about-face in the system of labor, and the new relationship of black and white, demanded prudence and caution from these officers. Nevertheless, Thomas found

[10] Eaton, *Grant, Lincoln, and the Freedmen*, 237; Peirce, *Freedmen's Bureau*, 48; Samuel Thomas to Oliver Otis Howard, June 22, 1865, RG 105, XIV, 1-2. The material taken from the official records of the Bureau deposited in the National Archives is indicated by RG 105.

[11] Thomas J. Wood to Howard, July 13, 1866, *ibid.*, XVII.

[12] Thomas to Captain J. W. Miller, June 28, 1865, *ibid.*, 48.

[13] General Orders No. 4, Thomas, July 24, 1865, *ibid.*, XXXI, 6. In August, 1865 there were Bureau officers in only Warren and Yazoo Counties and Madison Parish, Louisiana, in the Western District. Sixteen counties had officers in the Northern District and eight counties in the Southern District. The latter also included Concordia and Tensas Parishes of Louisiana. Thomas to Howard, August 15, 1865, *ibid.*, XIV, 238-50.

[14] Thomas to Howard, October 12, 1865, *ibid.*, 400.

[15] O. O. Howard, "Instructions to Assistant Commissioners," July 12, 1865; Walter L. Fleming (ed.) *Documentary History of Reconstruction*, 2 vols. (Cleveland, 1906), I, 230; Thomas to Howard, July 29, 1865, RG105, XIV, 166-72.

[16] Thomas to Howard, October 12, 1865, RG 105, *ibid.*, 400.

[17] Colonel J. L. Haynes to Captain B. F. Morey, July 8, 1865, *ibid.*, Box 357; Thomas to J. H. Weber, June 26, 1865, *ibid.*, XIV, 35-38. Thomas forbade Weber to appoint any civilian as provost marshal, which the sub-district supervisor was called. On July 27, 1865, the designation was changed to subcommissioner. Special Orders No. 4, Office of Acting Assistant Commissioner, Southern District, Mississippi, July 27, 1865, Natchez, *ibid.*, CCCXVII, 3.

enough men who had served previously in the Department of Freedmen and the regular army to be able to report optimistically July 29, 1865, that almost every county was provided with an officer who had a complete set of orders, books, circulars, blanks, and registers and who was thoroughly fammliar with his duties. Since many of the officers he had appointed already were operating under orders favorable to the freedmen, Thomas did little more than provide general principles. Later, when he more nearly had perfected his organization, he issued more detailed instructions.[18]

In addition to the officers in the field, Thomas appointed a staff to serve in his headquarters at Vicksburg. Here also he placed men who had served in the Freedmen's Department or in some relationship with the Negroes, generally with the colored infantry. To facilitate the operation of both his staff and his subcommissioners, Thomas permitted the hiring of clerks when necessary.[19] In July, 1865 there were 160 civilian employees of the Bureau. Besides the clerks already mentioned, there were acting assistant surgeons, hospital stewards and attendants, printers, nurses, cooks, laborers, carpenters, teamsters, and porters. Although most of them were low salaried and their number varied from time to time, they were indispensable in the hospitals, asylums, and general work of the Bureau.[20]

The Freedmen's Bureau maintained a close relationship with the army of occupation. Not only were they both under the same authority, the War Department, but most of the Bureau officers came from the regular army. The military was commanded to uphold Bureau authority in the performance of its official duty. Major General Henry W. Slocum, commander of the Department of Mississippi, issued an order August 3, 1865, calling the attention of his officers to the Bureau Bill of March 3, 1865, and to subsequent orders and circulars that defined the Bureau's work and its relationship to the army. Officers who possessed abandoned property, money collected as taxes or rentals, and records of freedmen affairs were ordered to turn them over to Bureau officials and to send Colonel Thomas a complete list of property held and quarters occupied by the army. The army also detailed such officers and soldiers as needed by the Bureau and stood ready to render "any aid that may be required by them in the performance of their official duties."[21] Although the close relationship and interdependence of the army and the Bureau promised friction and jurisdictional jealousy, Howard and Thomas attempted to keep such discord at a minimum by clearly defining the relationship and responsibility of each. Evidently they were successful.[22]

The chief policy maker of the Bureau was Commissioner Howard. Aided by his general staff, he handed down--through letters, general and special orders, and circulars--the principles by which the Bureau operated. Howard did not intend to give minute instructions to his assistant commissioners. Realizing that their situations and problems would vary with the locality, he first issued only general principles and relied upon the integrity and intelligence of his subordinates for their application. In turn, Assistant Commissioner Thomas, by the same devices, and often with the same vagueness, sent these principles on to his staff.[23]

Although white refugees received some aid, Negroes were the Bureau's major responsibility. In defining the Bureau's authority over the freedmen, Assistant Adjutant General Stuart Eldridge said, "You have the right to prevent any injustice being done the freedman by anyone, even himself. Therefore, if you see

[18] Thomas to Howard, July 29, 1865, *ibid.*, XIV, 166-72. There was an attempt to locate the officers with respect to population as well as to geographical location. G. D. Reynolds to Stuart Eldridge, October 5, 1865, *ibid.*, Box 358.

[19] General Orders No. 6, Thomas RG 105, I, 8-9; Thomas to Howard, October 12, 1865, *ibid.*, XIV, 400-423.

[20] Monthly Report of Citizen Employees, Mississippi, September, 1865, *ibid.*, Box 368.

[21] General Orders, No. 10, General Henry W. Slocum, Headquarters Department of Mississippi, Vicksburg, August 3, 1865; Natchez *Courier*, August 8, 1865.

[22] Thomas to Howard, January 1, 1866, RG 105, XVI.

[23] Circular No. 1, Thomas, July 3, 1865, *ibid.*, XXXI, 25-51; Thomas to Weber, June 26, 1865, *ibid.*, XIV, 35-38.

him throwing away opportunity to help himself, you should use measures to force him to the road to improvement." [24]

Besides feeding and clothing the refugees, the Bureau attempted to find homes for the freedmen in colonies or with employers, in orphanages, or as apprentices. It transported them when necessary, and regulated their contractural association with the employers. It sought justice for the freedmen by mediating in minor cases, but in serious offenses the Bureau turned to a military commission or to the civil courts. Freedmen were encouraged to better themselves by education, another field of endeavor in which the Bureau gave much aid. It sought to raise the level of morality and integrity among the freedmen and to enforce all laws and presidential proclamations. Generally speaking, the Bureau was a "wetnurse" organized to take in hand temporarily the new-born "freedmen" and nurture and develop them until they could stand on their own feet. [25]

Thomas sent out his Bureau officers armed with current orders and circulars, some designed for the Bureau officer only and others prepared for circulation among both blacks and whites. These printed circulars--disseminating Bureau policy--were scattered widely over the districts. Often they were printed in the newspapers. In one instance, where printing was not available, written copies were distributed in a community. [26] Thomas suggested that meetings of freedmen be held where the circulars could be read and explained, and that copies be given to preachers, teachers, and other friends of the Negro. [27]

The Bureau officers were sent periodically on tours of the territory under their jurisdiction. In addition to seeking information, they made formal and informal talks, presenting the freedmen with the "truth of the matter." The meetings usually were well attended and always drew a number of white citizens. [28] Although frequent tours of inspection and reports by the subcommissioners enabled Thomas to gain a picture of the whole operation of the Bureau and its effects, he did not fully trust his subordinates, and he constantly checked on their work. Major Thomas S. Free, the assistant inspector general of the Bureau in Mississippi, was empowered to investigate and clarity misunderstandings. General Howard set the pace for this officer when he said that his inspector general and aides were "footloose, ready to go to any point within our official dominion at a moment's notice." Thomas himself occasionally took the field to inspect freedmen's affairs. One such trip, in January, 1866, included Jackson, Meridian, Lauderdale, Macon, Columbus, Aberdeen, Okalona, Corinth, Holly Springs, Grenada, and Canton, talking to mayors, magistrates, influential citizens, and the "better class" of freedmen. [29]

Since the Bureau was in the War Department, all its officers and civilian employees were obligated to conduct their business and report their operations according to military regulations. Monthly reports were required of the subcommissioners and Thomas demanded that they be careful and accurate reports. [30] In addition to regular monthly reports, Thomas required ration and school reports, a monthly roster of officers, a list of civilian employees, and quarterly historical and statistical reports. [31] Each officer on duty in the Bureau also

[24] Eldridge to Lieutenant C. W. Clarke, July 27, 1865, *ibid.*, XIV, 150-51.

[25] General Orders No. 5, Thomas, July 29, 1865, *ibid.*, XXXI, 6-8; Circular No. 7, Thomas, July 29, 1865, *ibid.*, 6-8; General Orders No. 6, Office Acting Assistant Commissioner, Freedmen's Bureau for Southern District of Mississippi, August 1, 1865, *ibid.*, Box 380; Circular No. 1, Thomas, July 3, 1865, *ibid.*, CCLXIV, 1-2; Donaldson to Lieutenant H. B. Quimby, February 14, 1866, *ibid.*, CLV.

[26] General Orders No. 5, Thomas, July 29, 1865, *ibid.*, XXI, 6-8; William R. Gallian to Reynolds, August 4, 1865, *ibid.*, CCCXXI, 201; Natchez *Daily Courier*, November 24, 1865; Eldridge to Donaldson, August 3, 1865, RG 105, XIV, 205-206.

[27] Circular No. 7, Thomas, July 29, 1865, RG 105, XXXI, 257-61.

[28] Jackson Daily Mississippian, November 12, 1865; Canton *Semi-Weekly Citizen*, November 16, 1865.

[29] *Autobiography of Oliver Otis Howard*, 2 vols. (New York, 1907), II, 216; Eldridge to Clarke, July 27, 1865, RG 105, XIV, 150.

[30] Circular No. 2, Thomas, July 4, 1865, RG 105, XXXI, 251-52.

[31] Circular No. 1, Thomas, January 1, 1866, *ibid.*, 274-75; Eldridge to Reynolds, September 26, 1865, *ibid.*, XIV, 370.

was expected to keep a set of books for his office. One book was to contain copies of letters received, whether from official sources or citizens. Another was reserved for copies of written orders; a third for copies of letters, endorsements, and communications sent to other offices of the Bureau or to private citizens. A fourth book required by the Acting Assistant Commissioner of the Southern District of Mississippi, was a Memoranda Book, in which his men entered complaints, methods of handling them, and an itemized account of expenses.[32] Colonel Thomas ordered July 29, 1865, that officers of the sub-districts would compile an enrollment of the freedmen under their charge, including names, ages, residences, and occupations. This record was to be revised from time to time as the freedmen came and went.[33] As may be expected, accuracy and completeness of records varied with the competence of the officers in charge.[34]

Perhaps one of Thomas' most vexing problems was getting and keeping officers in the service of the Bureau. Regiments constantly were mustered out of service and valuable officers were lost to the Bureau, which prevented the extension of its activities as far into the interior as Thomas desired. Often, when officers were stationed in the interior, it was difficult for them to reach the freedmen. Impassable roads and occasional high water added to the problem. Major Reynolds and Colonel Thomas tried to reach Woodville February 22, 1866, but failed to do so. Reynolds reported: "Hannibal crossed the Alps; so did Napoleon; Julius Caesar crossed the Rubicon, but we did not cross the Coniochitta."[35]

It was difficult to find men to serve the Bureau who were conscientious about meeting their responsibilities to the white and the black. On the whole, the rank and file apparently did a creditable job and some received praise from Mississippians. But, on the other hand, many of them took bribes, drank heavily, and extorted. Howard and Thomas issued orders, but often when these orders reached the people, if they reached them at all, they were so garbled they were of little value.[36] General Howard wrote a letter to Thomas February 23, 1866, in which he said, "Immoralities, corruption, neglect of duty, and incapacity are sometimes complained of against the officers and agents of the Bureau. If either of these charges be sustained on investigation, the guilty Agent will be at once removed, whether he can be replaced or not." It was more easily said than done.[37]

The Bureau's difficulties were increased by the uncooperative attitude of many Mississippians. In January, 1866, Thomas toured the state and heard remarks like the following:

"That's a damned Yankee," "What does he want here?" and "He had better not stop long." Without military force it was almost impossible to command respect or courtesy.[38] Thomas believed it was impossible to please the whites while caring for the Negroes. Although an assistant commissioner might have the "abilities, virtues and powers of a Lincoln," he was doomed to disappointment, Thomas felt.[39]

One reason for the strong feeling against the Bureau was the presence and behavior of the Negro troops. Angry passions were aroused by the appearance of a "noisy, boisterous squad of colored soldiers" on almost any public square,[40]

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[32] Circular No. 3, Thomas, July 23, 1865, *ibid.*, 253; Circular No. 2, Office Acting Assistant Commissioner, Freedmen's Bureau, Southern District of Mississippi, Natchez, Mississippi, February 18, 1866, *ibid.*, Box 380.

[33] General Orders No. 5, Thomas, July 29, 1865, *ibid.*, XXXI, 6-8.

[34] Captain E. Buckwalter to Donaldson, July 31, 1865, *ibid.*, Box 396; Preston to Eldridge, April 12, 1866, *ibid.*, Box 360; Eldridge to Thomas, April 6, 1866, *ibid.*, Box 359.

[35] Reynolds to Eldridge, February 28, 1866, *ibid.*, Box 360.

[36] J. S. McNeily, "War and Reconstruction in Mississippi," *Publications of the Mississippi Historical Society*, Centenary Series, II (1918), 327-29, Jackson *Daily Clarion*, October 17, 1865; Eldridge to Thomas, April 6, 1866, RG 105, Box 359; Reynolds to Eldridge, August 7, 19, 1865, *ibid.*, Box 358.

[37] Howard to Thomas, February 23, 1866, RG 105, Box 360.

[38] Thomas to Wood, January 28, 1866, *ibid.*, XVI, 245-49.

[39] Thomas to Howard, November 2, 1865, *ibid.*, XIV, 487-92.

[40] Garner, *Reconstruction in Mississippi*, 104.

and there was frequent conflict between the races. In Corinth a young doctor was killed by Negro soldiers after he accidentally brushed against them while passing on the sidewalk.[41] At Lauderdale a whole garrison of Negro troops, with the exception of one corporal, attacked a railroad car in which ladies were riding. Forcing the conductor to flee, they cursed the ladies in "most vulgar and disgraceful language," and threw stones and brickbats at the car.[42] At Natchez a policeman was shot by Negro soldiers, after arresting one of their drunken crew, and a riot followed. Only the cool courage of the post adjutant prevented much bloodshed.[43]

Negro troops also were having a bad effect upon the freedmen, leading them to believe that the troops were to "hold the white man in subjugation," and that the law would not necessarily be enforced against the Negro. The swaggering, cursing troops and the hordes that often gathered about their camps led to much ill-feeling.[44] The petitions and requests to the civil authorities ultimately led to the removal of the Negro troops from Mississippi by May 20, 1866. But the damage had been done and, as Thomas said, "the Freedmen's Bureau gets the credit of all such 'Spread Eagle' efforts."[45]

In the fall of 1865 another problem threatened the successful operation of the Bureau in Mississippi. When the courts of the state again were made responsible for the administration of Justice to the freedmen, there was a reduction of their work. A large portion of the state was not occupied by Bureau officers.[46] The work of the Bureau had been reduced to a benevolent character while the civil authorities administered justice and assumed responsibility for the orphans, marriage records, and the destitute. Bureau officers could no longer make arrests, assess fines, collect taxes, or take part in court action, and almost all confiscated property had been returned. Bureau agents were merely sentinels to watch civil officials in their treatment of freedmen, to appear in court as their "next friends," and to look after their hospitals, asylums, and schools.[47] This resulted in a decrease in the number of officers and men on duty in the Bureau. In October 1865 Thomas ordered subcommissioners to discharge their clerks.[48] A month later Reynolds ordered his acting assistant quartermaster and the supervisor of the Home Colony at Washington, Mississippi, to discharge all paid employees. Teamsters or laborers were to be applied for from the troops.[49]

The limitation of authority discouraged some subcommissioners. One wrote from Winchester that he did not know the extent of his authority, and therefore he was doing very little. Another, asking to be relieved from duty, said, "Owing to the limited instructions under which I am acting, my position has been that of an idle 'spectator.' When aggravated cases of flogging have been reported, a few arrests have been made, and the parties turned over to the civil authorities; but out of more than fifty well-authenticated cases, but one has been acted upon."[50]

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[41] Natchez *Daily Courier*, December 21, 1865.

[42] Natchez *Democrat*, November 23, 1865.

[43] Natchez *Daily Courier*, March 14, 1866.

[44] Petition to Governor Humphreys from Macon, Mississippi, Citizens, October 31, 1865, Ser. E., Vol. LXXVII Governor's Records, Jackson; A. Gillespie to William L. Sharkey, July 29, 1865, Ser. E., Vol. LXX, *ibid.*

[45] Thomas to Marcus Bestow, December 8, 1865, RG 105, XVI, 92-93.

[46] Thomas to Howard, December 13, 1865, *ibid.*, XVI; Weber to Eldridge, December 31, 1865, *ibid.*, Box 358; Thomas to Wood, November 23, 1865, *ibid.*, XVI, 61-64.

[47] Thomas to Howard, November 13, 1865, *ibid.*, 20-22; Thomas to Howard, November 21, 1865, *ibid.*, Thomas to Wood, November 23, 1865, *ibid.*, XVI, 61-64.

[48] Clarke to Reynolds, October 6, 1865, *ibid.*, XV, 428.

[49] Reynolds to Lieutenant James W. Steele, November 7, 1865, *ibid.*, CCXI.

[50] H. H. Matthews to Reynolds, November 27, 1865, in *Report of the Joint Committee on Reconstruction at the First Session Thirty-Ninth Congress* (Washington, 1866), 184-85.

The withdrawal of troops seemed to be the signal for intimidation of Bureau officers and freedmen. From all over Mississippi subcommissioners reported that their position was untenable without armed guards. Some of the citizens threatened to "shoot the first damned Yankee" found unprotected on their premises. Officers were attacked and robbed, and in some cases were forced to leave their assignment. Negroes were whipped, turned off plantations, and generally abused.[51]

Economy became another obstacle for the Bureau. The lack of funds to hire clerks forced officers to perform clerical duties, although they were needed in the field.[52] Inadequate office space and furniture was another result of economy. At Grenada the office was in a rough board shanty situated away from the business center.[53] At Brookhaven a subcommissioner inherited an office but no furniture from his predecessor; there never had been any. He borrowed a table and two chairs but they were subject to recall at any time.[54]

Thomas faced numerous difficulties in the construction and operation of the Bureau in Mississippi. Throughout his administration he was plagued by the paucity of capable officers, hostility of Mississippians, limitation of authority, occasional conflicts with the military, and lack of sufficient funds to render the kind of service he wished to give the freedmen. Despite these and other hindrances, Thomas attempted to guide and protect the freedmen. Through letters, speeches, publications, and personal contact the Bureau instructed the freedmen and warned the planters to meet faithfully their new responsibilities. Although there was much justified criticism of the Bureau, it generally had a wholesome effect upon the Negroes in their transition from slavery to freedom, and the attitude of the Southerner gradually became less hostile to the Bureau later in Thomas' administration.[55]

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[51] R. D. Mitchell to Reynolds, March 3, 1866, RG 105, Box 359; Gallian to Reynolds, November 10, 1865, *ibid.*, CCCXXI, 225-26; A. J. Yeater to Thomas, January 18, 1866, *ibid.*, Box 360; Reynolds to Weber, November 4, 1865, *ibid.*, Box 358.

[52] J. J. Knox to E. Bamberger, February 10, 1866, *ibid.*, CXCVII, 10-12.

[53] Preston to Eldridge, April 12, 1866, *ibid.*, Box 360.

[54] Robert Gardner (addressee unknown), April 20, 1866, *ibid.*, XLVII.

[55] Thomas to Assistant Adjutant General's Office, Freedmen's Bureau, Washington, April 12, 1866, *ibid.*, General Records, CXXV, 148-53.

EXISTENTIALIST PHILOSOPHIES AND POLITICAL DECLINE

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One of the major tasks confronting the historian who is engaged in the study of ideas is an understanding of the relationship between manifest political change and the shifting currents of formal philosophic thought. It falls within the historian's province to shed light on the order of precedence existing between philosophy and polity in any particular situation. The phenomenal growth of interest in existentialist philosophies among European intellectuals in recent decades is a matter for inquiry. Existentialism has attracted such wide notice that Jean Wahl, a proponent, lamented that the philosophy had become a world problem.[1]

The popularity of existentialism in Europe seems to coincide with national political decline and insecurity. The two publications which marked the beginning of the movement in the twentieth century[2] appeared in Germany after World War I. These early writings received wide notice, and after their appearance several German universities initiated the study of the philosophy. During the 1920's many German commentaries on existentialism were published. It was during this time that the works of Soren Kierkegaard, whose thought is regarded as the foundation of contemporary existentialism, became available to German readers.

Kierkegaard's works stimulated further interest in existentialism in Germany, and by 1930 it was evident from the widespread discussion and sizeable literature that a major trend in formal thought was in the making.

During the 1930's, however, Germany's economic and political hopes were resuscitated under the leadership of the National Socialists, and the existentialist trend was stemmed with the rise of Hitler. Existentialists such as Karl Jaspers[3], who stood on the prestige of his university position to speak out against the Nazis, were deprived of their posts, and their teachings were suppressed. Others, like Martin Heidegger, accepted the new government and either refrained from publication or joined the officially sanctioned neo-Hegelian school of political thought. Thus, it seemed that German existentialism was unable to cope with the reconstruction of political might, and would die without a fight.

But the German school was not without its offspring. The writings of Jaspers, Heidegger, and Karl Barth were read outside Germany, especially in France. Under the leadership of Gabriel Marcel, a French school of existentialism was founded in 1930, and the translation of Kierkegaard's works into French was begun. During the 1930's the new thought made great headway among French intellectuals, so that the decline in Germany was paralleled by a rise in France. By 1940, when France was overrun and occupied by German troops, existentialism had acquired the status of a major philosophic school. Through the years of occupation, existentialist writings continued to appear in France, often in the form of plays or novels, and existentialist leaders risked imprisonment and death as leaders of the French resistance movement.

By the end of World War II existentialism had become as much a fad as a philosophy in France, and Jean-Paul Sartre, who had emerged during the war as the school's most colorful representative, was something of a national hero. In the period of political malaise which has gripped France since 1945, existentialism has persisted. Marcel and Sartre have been joined by scores of writers, and the sale of existentialist literature continues to be brisk.

The disastrous defeat and subsequent partitioning of Germany opened the door to a revival of the philosophy there. With the fall of the Nazi government, Jaspers resumed his university post and his writing, and he was received avidly

[1] *A Short History of Existentialism*, Philosophical Library, 1949, 1.

[2] These were Karl Barth's *Commentary upon the Epistle to the Romans*, and Jaspers' *Psychologie der Weltanschauungen*.

[3] Jaspers was professor of philosophy at Heidelberg University from 1921 to 1937 when he was dismissed for political reasons. He was reinstated in 1945.

throughout western Germany. Jaspers' works, along with those of other existentialists, have been termed in Russian-controlled zones as manifestations of western decadence. With the revival of existentialism in the universities, the philosophy has won attention elsewhere in Germany, where it holds a dominant place in German thought.

The movement has attracted notice elsewhere in Europe, and since 1945 Kierkegaard's books and those of his followers have been translated into all the major languages of western Europe. To what extent existentialism may influence the thought of intellectuals in England, or Italy, or Spain, is difficult to determine, for the philosophy is relatively new in each of these nations. It may be noted, however, that each of these countries has produced thinkers who are influenced by the assertion of the school.

The question which emerges in the light of the apparent widespread interest in existentialism is this: What is the appeal of this philosophy to the European of the mid-twentieth century? There are several possible answers. Norberto Bobbio, an Italian thinker, ascribes its growth to the toxic decadentism which today permeates European culture.[4] Or the movement might be regarded as the manifestation of temporary unrest following war. Whatever the explanation, it must emerge in relationship to a *Weltanschauung* created in an atmosphere of power recession and decline.

The institutions which supported the past greatness of Europe, today seem incapable of holding back the difficulties which plague Europe's society or of guaranteeing any future security. The shattered hopes and the physical ruin following World War II drove Europeans to a stage of despair and anguish, on which existentialism dwells.

The philosophy of existentialism is a melancholy one, having won for Kierkegaard the sobriquet the Melancholy Dane. Existentialists agree on one point at least--that man must undergo a personal crisis of forlornness, isolation, and despair before he can comprehend life. The reward of the philosophy is the gift of alertness, awareness, participation. Existentialism is harshly critical of thought systems which tend to sacrifice free man to institutions or systems. In the words of Emmanuel Mounier, existentialism is primarily a reaction to all philosophies which deal excessively with things and ideas, to the exclusion of man.[5] It fears that formal thought too often reduces man to the merest part of a vast cosmic mechanism, by making him a machine which operates without choice or effect.

This objectification of man--that is, his reduction to mere essence, a classifiable object of known quantity and quality and predictable responses--is the fundamental error of philosophers, according to existentialists. Catalog all the observations of man that you wish, but when you have done this you have not understood him. There is something about man which is above classification, and this is the existence of man. What is existence? Here is the question to which essentialist philosophy has no answer, but more than this, it is the question which essentialism fails to ask.

The fact that I am, says the existentialist, is for me the central fact of the universe. But this is not the same as *cogito, ergo sum*, for my being is more than thought. Being is anxiety. I am anxious that I exist, and that I do so in a certain time and place, and may not do so always. Problems of philosophy are outside of me, but they must be studied in relationship to me, for their very existence as problems depends upon me and my existence.

The problem of defining the term existence occupies a major place in existentialist literature. But it leaves the reader with little satisfaction, because existence is found within personal involvement and experience, rather than through observation and identification. Defining existence poses a problem akin to that which would be encountered if we were to attempt definition of some such word as pain or love to a person who had never encountered these sensations. Existence must be felt, not reasoned, and can be felt only under certain conditions. It never can be known, if knowledge implies objectification. There is

[4] *The Philosophy of Decadentism, A Study of Existentialism*, Macmillan, 1948, 60.

[5] *Existentialist Philosophies*, Macmillan, 1949, 20.

no degree of existence, no gradual understanding of existence, no transition period of becoming an existent.

The existent person undergoes a profound emotional experience involving frustration, anguish, forlornness, despair, and rejection. During this crisis he feels that there is no hope, that knowledge is in vain, that science and its results are meaningless, that progress is ephemeral and apparent. Where, then, should he turn? To God? To love? To society? To himself? He discovers here that he is possessed with a dreadful freedom, the freedom of complete decision, and in this discovery he finds the meaning of existence, the meaning of mankind. At this point, in existentialist language, he looks over the brim of knowledge into the Nothingness, or into the Face of God, or into existence, and he finds an infinite relationship between himself and his destiny. He realizes the Infinite. He transcends.

This emotional experience, or crisis situation, is the fundamental assertion of the school. Divergence among the existentialists begins with its assessment. All agree that it is the instrument which lifts the existent being from the category of Everyman. Kierkegaard saw it as containing the conversion experience of the Christian. Sartre says it represents the revelation that there is nothing beyond--no God, no other. Heidegger saw in it an answer to the problem of ontology.

The interpreters of the crisis situation may be separated into two main groups. The first, of which Barth and Marcel may be considered representative, agree with Kierkegaard, and have led in a movement toward neo-orthodox Christianity. Barth, who has influenced profoundly Reinhold Niebuhr, is credited by Helmut Kuhn with having resuscitated Protestant theology in our time.[6] The crisis situation, according to Barth, leads to the enthronement of faith as the source of ultimate truth, and the discovery of a God who resembles the God experienced by the prophets of the Old Testament. Barth's version calls for an ultimate rejection of formal philosophy and a return to religion. In a similar vein, Marcel arrives at a Christian humanism. The crisis results in communion with another, and the nature of Being is discovered through the communion, which is called the I-Thou relationship.

The second branch, non-Christian existentialism, includes philosophers whose interpretations range from the amoral, analytic beliefs of Jaspers through the ontological concerns of Heidegger to the moral atheism of Sartre. For this school the crisis situation teaches man that he simply is flung into the web of existence for no apparent reason. Man discovers himself and is fearful of the freedom which is his. There is no predetermined purpose or goal to guide him. He is alone, and choice is completely and frightfully his. His freedom is neither a delusion nor the gift of God. It simply exists, for no reason. Man's tragedy lies in the odds against him, in the effect or lack of effect of his choices.

Sartre urges moral responsibility. Since the crisis situation shows the existent that there is no other, no God to blame for misfortune, he knows that he must shoulder the burden of his own behavior. Man must be responsible for his behavior and for the well-being of others, and he should not participate in movements which he judges to be immoral. It is better to commit suicide than to fight in an unjust war. This doctrine of individual moral responsibility, devoid of religious implication, has held a wide appeal among those whose faith in orthodox religion has waned. Sartre's existentialism is perhaps the most popular of the French interpretations today.

To the inhabitant of the European wasteland, existentialism holds a positive attraction. For what mature person in western Europe could have avoiced, during the past decade, the experiences of despair upon which the philosophy dwells? And what European did not feel resentment toward the objectification which resulted in the loss of personal freedoms? The job of existentialism, as Mounier says,[7] is to rescue man from the inertia of things, from docile socialness, and to restore to him a sense of wonder, curiosity, responsibility. This philosophy strives to bring man back to the center of the philosophic universe. to give him choice, to call him individual. It is a personal philosophy which

[6] "Existentialism," in Vergilius Ferm, ed., *A History of Philosophical Systems*, Philosophical Library, 1950.

[7] *Op. cit.*, 69.

appears to be tailor-made for individuals living in a civilization which has been ravaged by war.

Europeans have witnessed the technological results of scientific rationalism coupled with the political results of Hegelian idealism. The combination has nearly destroyed European society. A madness which has stemmed from an absence of inwardness has all but engulfed a generation which sought to regard the world as Pure Manifestation. But the thinkers of Europe have seen the danger and have looked for a way out. They have sought a philosophy which is humanistic, and which asserts the value of inwardness. For many, existentialism is the way.

THE CIENTIFICOS: CRITICS OF THE DIAZ REGIME, 1892-1903

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The literature of the Mexican Revolution of 1910 generally has represented the *cientificos*--a group of philosopher-political scientists--as willing partners-in-crime to all the vices and excesses of the long administration of President Porfirio Diaz. Variously described as a party, an oligarchy, and a grafting clique, the *cientificos* have been accused of directing and supporting the Diaz regime in the interest of personal influence and private gain.[1] In fact, by 1910, the popular association of *Cientificismo* with *Porfirianismo* (a group composed of the followers of Diaz) was so widespread that the name carried a connotation of evil, sinister opprobrium. Capitalizing on this feeling, the Madero partisans successfully used "Death to the *Cientificos*" as their slogan to rally support for their revolutionary movement against the Diaz regime.[2]

Actually, however, a study of the origins of the *cientificos* reveals a background of criticism and opposition to the Diaz philosophy of government. This is a sharp contrast with the widely-held conception of a grafting and selfish oligarchy supporting an unpopular and decadent administration for personal gain. Much of the confusion concerning the true nature of the *cientificos* stems from a change about 1903 in the objectives, program, and composition of the group, and its relationship to President Diaz.[3]

In the years immediately following its inception in 1892, the *cientificos* were a small group of creative thinkers and reformers, strongly influenced by the currently popular Positivist philosophy. These thinkers made a significant contribution to Mexican political life through their opposition to Diaz. Then, about 1903, the group abandoned its reform program, absorbed itself into the administration, began to share in the spoils of the regime, and ultimately fell into the disrepute which is associated with its name. The *cientificos* provide, therefore, an excellent example of the transformation of a creative minority into a dominant minority. Abdicating their original position of constructive criticism and opposition, they assumed a new role as selfish defenders of a profitable *status quo*. Apparently, most of the critical evaluations of the group have referred to the period after it entered the Diaz fold. It is hardly surprising that the spectacular events of the revolutionary era should receive wide publicity. However, to assess properly the position of the *cientificos* in Mexican history, it also is necessary to focus attention upon the earlier and less understood period of their activity.

The group which came to be called "*los cientificos*" came into being in the months preceding the presidential election of 1892. Ironically, the impetus for the organization of the group came from President Diaz himself. The apathy and indifference with which the Mexican people accepted the constitutional reforms which made possible the indefinite re-election of the president caused considerable embarrassment, even to Diaz. The Chamber of Deputies and the Senate, like the general public, were convinced that all opposition would be futile. They approved the reform unanimously and without discussion.[4] Similarly, the routine

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[1] U. S. Congress, Senate, *Investigation of Mexican Affairs*. Preliminary report and hearing of the Committee on Foreign Relations, 66th Congress, 2nd. Sess., on S. Res. 106 (Washington: 1920, 2 vols.), II, 2864-2865. Henry Lane Wilson, *Diplomatic Episodes in Mexico, Belgium, and Chile* (New York: 1927), 196.

[2] Jose Fernandes Rojas, *De Porfirio Diaz a Victoriano Huerta, 1910-1913* (2nd. Ed.; Mexico: 1913) 129. *Papers Relating to the Foreign Relations of the United States, 1911* (Washington: 1918), 367-368.

[3] Jose Lopez-Portillo y Rojas, *Elevacion y Caida de Porfirio Diaz* (Mexico: 1921), 277. F. Vasquez Gomez, *Memorias Politicas 1909-1913* (Mexico: 1933), 11ff.

[4] Ricardo Garcia Granados, *Historia de Mexico, desde la restauracion de la republica en 1867 hasta la caida de Porfirio Diaz* (4 Vols. in 2, Mexico: 1911), II, 198.

manner in which Diaz was re-elected in 1888 without the slightest legitimate opposition became something of a scandal. Still, Diaz was anxious to impress foreigners with Mexico's progress in democratic government.[5] Consequently, as the elections of 1892 approached, Diaz felt that there should be at least a semblance of political activity. According to plan, this political activity would give rise to popular approval of his candidacy.[6] He wanted it to appear that he was not forcing his own return to office entirely through his power as chief executive.

The president's first attempts to "manufacture" a controlled political activity and an expression of popular enthusiasm were unsuccessful. The efforts of the Junta Central Porfirista, banquets in the national capital for *jefes politico* and municipal *alcaldes*, and suggestions that the press propagandize in the president's behalf, failed to generate the desired enthusiasm.[7] Failing in these attempts, Diaz was forced to organize a movement more political in nature. He accepted a suggestion of Rosendo Pineda, secretary to the Minister of *Gobernacion*, that Diaz employ a convention like those used in the United States to nominate a presidential candidate.[8] Recalling the failure of earlier attempts, Pineda and the supporters of Diaz decided to launch the new maneuver under a new name. A new organization, known as the Union Liberal, was created. Clubs were organized in many municipalities of the Republic, and they prepared for a national convention to open in Mexico City, April 5, 1892, to designate Porfirio Diaz as the candidate of the Liberal Party.[9]

On April 19, 1892, the convention dutifully nominated Diaz as its candidate but, significantly, it went on to name a commission to draw up a political program for the Union Liberal Convention. The convention's provisional president, Manuel Maria Zamacona, revealed the reformist temper of the group when he announced in his opening address that basic changes were needed in the pattern of Mexican government. Although aware of the auspices under which the convention met, he openly announced that true liberalism could not remain passive and inactive. "Despocism grows," he asserted, "from the inertia of [political] parties and the apathy and indifference of the people..."[10] Democracy could exist, he argued, only when "...expression of the national will through freedom of the press, freedom of assembly, and effective suffrage..." are assured.[11] In keeping with this note, a program was presented to the convention April 23, 1892, and approved. It was formulated by and carried the signature of 11 men. Five of these--Justo Sierra, Rosendo Pineda, Pablo Macedo, Jose Limantour, and Francisco Bulnes--became the nucleus of the *cientificos*.[12]

The formulators of the program envisioned reform along several lines.[13] They sought to improve the administration of justice in the republic by making the tenure of judges permanent and to prevent removal of the judges on the whim of the chief executive.[14] They proposed that the press be allowed to express political opinion, and they wanted this freedom stated in definite and liberal terms so that writers would know their political limitations. They urged the adoption of a new method of presidential succession, in the event of a temporary or permanent absence of the chief executive. This part of the plan was the origin of the establishment of a Mexican vice president. Diaz had opposed consistently

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[5] Henry Lane Wilson, "Errors with Reference to Mexico and Events That Have Occurred There," *Annals of the American Academy of Political and Social Science*, LIV (1914), 148.

[6] Ramon Prida, *De la dictadura a la anarquia; Apuntes para la historia politica de Mexico durante los ultimos cuarenta y tres anos* (El Paso, Texas: 1914), 94.

[7] Garcia Granados, *Historia de Mexico*, II, 199-201. Prida, *Dictadura a la anarquia*, 95.

[8] *Ibid.*, 95.

[9] Garcia Granados, *Historia de Mexico*, II, 201

[10] *Ibid.*, 202-203.

[11] *Ibid.*

[12] Luis Cabrera, *Obras Politicas del Lic. Blas Urrea: Recopilacion de escritos publicados durante los anos de 1909, 1910, 1911, y 1912* (Mexico: 1921), 382. Lopez, *Elevacion y caida*, 260.

[13] Cabrera, *Obras politicas*, 377-382. Garcia Granados, *Historia de Mexico*, II, 252.

[14] Prida, *Dictadura a la anarquia*, 97.

the creation of a vice presidency. The final proposal of the Union Liberal advocated the development of popular education, freedom of commerce from internal restrictions, and economy in the national administration.

The public was surprised at the frankly democratic ideas contained in the manifesto of the Union Liberal. The need for reform was evident, and it also was evident that Diaz had suppressed any manifestation of individual initiative that sought a democratic and liberal system. Clearly, the program represented the work of men whose political ideas contrasted sharply with those of the government of Diaz.

While Diaz accepted the proferred nomination with alacrity, he announced in his inaugural address December 1, 1892, that he planned no significant changes in his cabinet or in his policies. When Jose Limantour, Minister of Hacienda (Finance), was asked to present the *cientificos'* program to the president, he could get no assurance from Diaz that the president would consider the reform program.[15]

Despite this lack of official encouragement, the originators of the reform program, with Justo Sierra as their spokesman, presented their proposals to the Chamber of Deputies October 30, 1893. Insisting that the time had come to convert into reality the plans and promises of the convention, Sierra proposed that the Chamber turn its attention first to the proposal concerning an independent judiciary.[16] During the month of debate in the Chamber, the press aired the matter fully. Though the "great mass of the country remained inert," the proposals aroused intense interest in government circles.[17] In these discussions, the same small group which had planned the program of the Union Liberal party was the backbone of its defense. Finally, December 4, 1893, the Committee on Justice and Constitutional Points recommended the adoption of the measure.

The name *"cientifico"* originated during these debates. It was coined, and probably used derisively, by an opponent of the program.[18] In answering an objection of the opposition, Francisco Bulnes stated that the proposals had been prepared after a scientific investigation of the matter. To this statement, the rejoiner was that the members of the group, then, considered themselves *"cientificos."*[19] The name became more popularly and widely applied as the group continued to insist that scientific principles be applied to the problems of government.[20] Administration, they insisted, should not be merely pragmatic, but should follow the dictates of political science. Pleased with the name, the *cientificos* used the word science constantly. Government was to be scientific. The administration of finances was to be scientific; everything was to be scientific. The public, hearing the same word continually repeated, came to refer to them as *cientificos.*[21]

At the conclusion of the debate, the judicial reform measure was passed in the Chamber, December 12, 1893 and immediately sent to the Senate. Too little time remained for the Senate to act on the measure before the close of the session and it was left pending as unfinished business. At the next session, President Diaz ordered the matter shelved, and it was not acted on until the time of Madero.[22]

Here, finally, was an obvious manifestation of the fundamental differences between Diaz and the *cientificos.* It was clear that their program of reform did not carry unqualified official approval, even though it had been the result of a convention called with the express consent and approval of Diaz.

Thus Diaz dismissed the initial attempt to bring a democratic application of scientific principles to government problems. The failure, in this instance,

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[15] Lopez, *Elevacion y caida,* 259.

[16] Garcia Granados, *Historia de Mexico,* II, 252-253.

[17] Andres Molina Enriquez, *Los Grandes Problemas Nacionales* (Mexico: 1909), 306.

[18] *Investigation of Mexican Affairs,* I, 771.

[19] *"Cientifico"* is used here in the sense of a man learned in any branch of knowledge.

[20] Cabrera, *Obras Politicas,* 16.

[21] Lopez, *Elevacion y caida,* 261.

[22] Prida, *Dictadura a la anarquia,* 101.

did not mark the end of the *cientificos'* efforts. On the contrary, proof of the sincerity of the *cientificos* at this stage lies in the fact that they continued the struggle in spite of the formidable opposition of the president.

From this point until 1903 the *cientificos* were forced to promote their program and exercise their influence outside the administration. Except for one of their number, Jose Limantour, Minister of Hacienda, they had no direct contact with the government. Diaz did not yield to their influence, nor were they simply creatures of Diaz, as often is assumed.[23] He refused them any public or official recognition during this period and called on rival groups to promote his re-election in 1896 and in 1900.[24] The fact that Diaz encouraged the public to blame the *cientificos* for their many dissatisfactions, is an indication that no close political cooperation existed between them at this time.[25] Looking for a scapegoat, Diaz chose the *cientificos*. He charged they had fomented popular unrest by talking of reform and criticizing his procedures. Others took up the cry and the term *cientificos* became little more than a convenient tool for disparaging enemies.[26]

Although the *cientificos* never were organized formally as a political party, though erroneous references to them as a *partido* do exist, it is possible to establish with some accuracy the principle members of the group during its early period.[27] The composition of the group changed from time to time, but during its years of critical opposition to Diaz, 1892-1903, the years when its contribution to Mexico's social and political thinking was greatest, the group was small and select with probably no more than 15 members.[28]

What has been called the *"Partido Cientifico"* was simply a small group of Mexican intellectuals who had associated themselves with some of the original leaders of the Union Liberal convention of 1892. They were associated by conviction rather than convenience and held together by their belief that the well-being of the country depended on the development of its productive capacity and the improvement of its government along scientific lines.[29] This coterie, progressive and intent, attracted others of similar caliber.

They were men of exceptional ability, and they were able to exert an influence out of proportion to their numbers.[30] Even their enemies admitted that they were men of unusual talent, constituting a social force of great power and intellect in the old regime.[31] As opponents of Porfirianism, the *cientificos* placed their trust in *"la ciencia"* and visualized scientific government and development under the guidance of a talented oligarchy, as contrasted with government under the personal tyranny of a caudillo.[32]

[23] *Ibid.*, 108.

[24] *Ibid.*, 104.

[25] Manrique Moheno, *Partidos Politicos, Estudio Sobre su viabilidad y naturaleza de sus funciones en la Republica Mexicana* (Mexico: 1910), 146. Prida, *Dictadura a la anarquia*, 105.

[26] Trinidad Sanchez Santos, *Editoriales de "El Pais" en 1910, 1911, y 1912*, compiled by M. S. Sanches (Mexico: 1923), 317.

[27] Cabrera, *Obras Politicas*, 19. Roque Estrada, *La Revolucion y Francisco I. Madero* (Guadalajara: 1912), 25. Carlo de Fornaro, *Mexico tal qual es* (International Publishing Company: 1909), 123-130. Francisco I. Madero, *La Sucesion Presidencial en 1910* (3rd. ed.; Mexico: 1911), 25. *Investigation of Mexican Affairs*, I, 771.

[28] See *Ibid.*, I, 773, II, 2864; Cabrera, *Obras Politicas*, 6ff; Fornaro, *Mexico tal qual es*, 125. Despite the controversy involved in seeking to determine the peripheral membership of the group, it is clear that the word as originally used by the Mexican people applied primarily to the following men who were responsible for leading and directing the movement during the early or creative period: Jose Ives Limantour, Justo Sierra, Francisco Bulnes, Pablo Macedo, Miguel Macedo, Emilio Pementel, Rosendo Pineda, Joaquin D. Casasus, and Manuel Zamacona.

[29] Moheno, *Partidos Politicos*, 146.

[30] *Investigation of Mexican Affairs*, II, 2255. Mariano Cuevas, *Historia de la Nacion Mexicana* (Mexico: 1940), 1013. Roque Estrada, *La Revolucion y Francisco I. Madero*, 31. See the concept of the "creative minority" as developed in Arnold J. Toynbee, *A Study of History* (6 vols.; London: 1934-1939), III, 239ff.

[31] Cabrera, *Obras Politicas*, 3,8. Fornaro, *Mexico tal qual es*, 125.

[32] Cabrera, *Obras Politicas*, xv.

Distinctly Positivist in ideology, the *"ciencia"* to which they turned was the Positivist philosophy of August Comte. The majority of the *cientificos* were avowed Positivists and through their influence Positivism maintained its hold on the mind-life of Mexico during the Porfirian Era.[33] Under the spell of Comte, Spencer, Mill, and Durkheim, they sought to usher in a new era of scientific progress based upon the application of the methods and discipline of the natural sciences to the solution of pressing social and political problems.

The man who brought Positivism to Mexico was Gabino Barreda. In 1848 he had gone to Paris and in 1849 had attended Comte's classes. Returning to Mexico, he was instrumental in establishing in 1867 the National Preparatory School along the lines of Comte's ideology.[34] Inheriting his enthusiasm, Barreda's students, including the *cientificos*, were convinced that Positivism alone could replace anarchy with scientific progress.[35] The original manifesto of the Union Liberal in 1892 was the work of distinguished students of Barreda.[36] Viewed in the light of this philosophical orientation, it is easier to understand their sincere insistence that science was the key to Mexico's future.

The attitude of the *cientificos* toward the problems of government is shown in their writings. These works provide insights into their motivation, which in later years was open to serious question. Basic to all *cientifico* belief was their constantly reiterated faith in science and efficiency. The writings of Justo Sierra and Manuel Flores, like the original manifesto of the Union Liberal, are replete with tributes to science as the force which could accelerate Mexican progress.[37]

Second only to their belief in science was their desire to maintain uninterrupted peace for Mexico. Francisco Bulnes, often mentioned as the "high priest of Positivism in Mexico," gave frequent and eloquent expression to this desire in his public speeches.[38] Peace was so earnestly desired by the *cientificos* that it was almost a religion with them. Only the fact that the "Porfirian Peace" of Diaz had made possible a measure of political stability induced the *cientificos* to resign themselves to certain aspects of the *status quo*. The continuation of this stability was indispensable if Mexico expected to progress and consolidate its gains.[39] Hoping that the dictatorship would be merely transitional, they were persuaded to accept Diaz as the only alternative to anarchy. This decision, based on the best of motives, later opened the *cientificos* to widespread criticism in the revolutionary era and made them appear to be simply lackeys of the dictator.

As a corollary to their beliefs in science and political stability, the *cientificos* wanted to promote Mexico's material development. In a sense, their faith rested in a type of progress that could be measured by the output of mines and factories and the mileage of railway and telegraph lines. Actually, their thinking was based upon a more visionary and farseeing ideal. Mere industrialization was only a stepping stone to national economic independence and freedom. Expression is given to this facet of their ideology in the works of Justo Sierra:

> "Colonization, labor and capital to exploit our great riches, means of transportation to enable wealth to circulate, these were merely the social desiderata; what was important was for the Republic to pass from the military to the industrial stage of its development, and to make the passage quickly, for the giant who was growing at our side [the United States] was coming toward us...The weak have never been free."[40]

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[33] Samuel Ramos, *Historia de la Filosofia en Mexico* (1st. ed.; Mexico: 1943), 124. Leopoldo Zea, *El Positivismo en Mexico* (Mexico: 1943), 171-173, 177, 186.

[34] Antonio Caso, *Mexico, Apuntamientos de Cultura Patria* (Mexico: 1943), 76. Irma Wilson, *A Century of Educational Thought* (New York: 1941), 225.

[35] Ramos, *Historia de Filosofia en Mexico*, 119.

[36] Zea, *El Positivismo*, 186.

[37] Justo Sierra, *Evolucion Politica del Pueblo Mexicano* (Mexico: 1910), 414. See the "Manifesto" of the Convencion Nacional Union Liberal quoted in the appendix to Cabrera, *Obras Politicas*, 379.

[38] For a full account of this speech see Lopez, *Elevacion y Caida*, 249-253.

[39] *Ibid.*, 250.

[40] Sierra, *Evolucion Politica*, 416, 458.

Thus, to Sierra and the *cientificos*, industry alone was not enough. To them, industrialization and material progress meant strength, and strength meant freedom. They persuaded themselves that a peaceful Mexico under Positivist development could acquire the strength to protect itself from its neighbor on the north.

Another aspect of *cientifico* ideology is revealed in an essay by another of the original *cientificos*, Miguel Macedo, in which he outlines the respective obligations of the various social classes.[41] "In society," says Macedo, "all individuals have a determined role or position which determines their relation with others. The superiors, by virtue of their intellect, position, leadership, and resources, should work for the benefit and the progress of society. The inferiors, on the other hand, should follow and not impose resistance to the activities of the leaders."

Here is a disturbing attempt to justify the *cientificos* in their self-appointed role as an oligarchy of talent and intellect and as a directing minority in charting Mexican progress. This class conscious creolism, which would delegate to the mestizo and the Indian a secondary role of accepting and supporting the Positivist program of material development, caused the *cientificos* to be hated passionately in later years. The first Union Liberal convention in 1892 and the second in 1903 were both creole-dominated. In many respects the *cientificos* represent the ultimate expression of a not uncommon Latin American desire for creole supremacy.[42] In their impatience to achieve a material and scientific Utopia, they were led to depreciate and disparage the possible contribution of other elements in the Mexican nation, including its mestizo president.

It is ironic that the *cientificos*, disciples of Barreda, should share this attitude of their class toward the native population. They viewed Mexican progress in a coldly Positivist way--a mechanistic, scientific, material development which sometimes had to favor not all Mexicans, but only that "creative minority" in the vanguard of progress.

In their anxiety to build a well-governed and modernized Mexico, they succumbed to the attractive expedients of creole control and the encouragement of foreign techniques, institutions, and capital. It became increasingly difficult for the *cientificos* to achieve understanding and sympathy for the common people of Mexico.

This increasing emphasis on Europeanization and the ensuing lack of rapport with the masses was symptomatic of the change that was to take place in the fortunes of the *cientificos* after the turn of the century. This aspect of their ideology coincided more readily with the interests of Diaz, and by 1903 there was increasing evidence that the president would call off his anti-*cientifico* campaign and make use of their talents.[43] In that year he turned to the Union Liberal to promote his sixth re-election.[44]

This change in the policy of Diaz toward the *cientificos* is due in part to a significant change in the attitude of the *cientificos* themselves. Their critical, reforming impulses had been blocked by the dictator, and some of the *cientificos* forgot their original purpose, abandoned their ideal of social progress for the good of the nation, and turned their efforts to private interests. This shift in emphasis from political reform to the harmless concerns of routine business was more to the president's liking, and it explains in large measure his increasingly favorable attitude after the turn of the century. He saw them now as a group which could be useful to his administration without being a source of embarrassment. In a sense, this significant change in *cientifico* attitude represents an accomplishment for Diaz and a defeat for the original *cientifico* principles. Henceforth, the *cientificos* might participate more fully in the government, but it would be on the caudillo's own terms.

41 "Ensayo sobre los deberes recipricos de los superiores y de los inferiores." See Zea, *El Positivismo*, 171ff. for a discussion of this essay.

42 Molina Enriquez, *Grandes Problemas Nacionales*, 306.

43 Vasquez Gomez, *Memorias Politicas*, 11-14.

44 Lopez, *Elevacion y Caida*, 248-254.

The transition from a creative to a merely dominant minority was soon effected. It had a marked effect upon *cientifico* membership. The original group, whose ideas had been obnoxious to Diaz, had attracted those who shared their views and who were willing to support their program in the face of official opposition. After the *cientificos* made their peace with the dictator, and began to achieve a position of dominance in the government, they attracted many others, who came not from conviction, but because of personal convenience and ambition.[45] The name "cientifico" inevitably came to be extended to this larger group of opportunists whose personal affairs and intrigues were often credited to the original *cientificos*, a fact that blinded many to the real nature of the earlier *cientifico* program. Sharing in the spoils of the administration, they inherited also the opprobrium of the discredited regime when it was destroyed by revolution less than a decade later.

[45] Roque Estrada, *La Revolucion y Francisco I. Madero*, 31.

SOME OPTICAL PROPERTIES OF VAPOR-DEPOSITED FILMS OF ARSENIC, ANTIMONY, AND BISMUTH

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In the course of a study of vapor deposition of metal films it was noted that above a certain pressure the film deposited on a glass slide did not display specular reflection, but instead displayed a strong absorption of reflected light. These films had black velvety appearance.

It was attempted in this study to determine whether the production of the specularly reflecting and absorbing surfaces of films is a function of the gas pressure, and whether it can be correlated with certain physical and chemical properties of the film-forming metal.

A vacuum evaporation unit consisting of a (Central Scientific) megavac pump and a Distillation Products two-stage diffusion pump, type VWF 30-06, was used. An all-metal vacuum line led from the diffusion pump to a pump plate 18 inches in diameter and bell-jar (Central Scientific). The pump plate was equipped with four electrode connections (stand-off terminals), two of which were used to hold the tungsten filaments for the evaporation of the metals. The vacuum was measured with a Todd-McLeod gauge, which permits the measurement of vacuum between the pressures of 25 cm to 0.00005 mm mercury in three steps.

Chemically pure arsenic, antimony, and bismuth metals in pellets were placed in "baskets." The "baskets" were made by winding soft tungsten wire 0.4 mm in diameter around the conical part of a pencil and compressing the helix thus obtained until the individual windings were not more than 0.5 mm apart. This "basket" was connected with the stand-off terminals of the pump plate. Into this "basket" a few decigrams of the metals mentioned above were placed.

A glass slide (microscope pyrex glass slide) was placed in the bell-jar under an angle of 45°, 15 cm from the "basket." The slide was cleaned with potassium bichromate-sulphuric acid cleaning fluid, rinsed with distilled water, and dried in a vacuum drying oven at 105°C.

After covering the pump plate with the bell-jar, properly sealed with high vacuum silicone grease (Dow-Corning), the fore-pump (megavac) was switched on. After a vacuum of about 50μ was reached, the diffusion pump (silicone oil) was turned on. The replacement of air by helium, being an inert gas, was considered important to prevent chemical reactions of the metal, especially in vapor form at elevated temperatures with the constituents of air. Therefore, when the vacuum of 0.1μ was reached, helium was admitted into the vacuum system to the pressure of 100μ and again evacuated to 0.1μ. This "flushing" process was repeated four times, and after the ultimate vacuum of 0.05μ was reached, helium was admitted to the desired pressures. This process was repeated whenever the vacuum was broken.

After the desired vacuum was obtained, the tungsten filament ("basket") was heated electrically by using a variac-low voltage transformer combination to temperatures measured with an optical pyrometer. The vacuum was checked continually during the evaporation process with a Pirani gauge, and was spot-checked with the McLeod gauge.

In the preliminary measurements, the temperature of the "basket" within 800° to 1,500°C displayed no significant change of the optical appearance of the films, regardless of the metals used for the film deposition. However, at the lower temperature the film formation took more time to develop. Therefore, the measurements were conducted at the "basket" temperature of 1,000°C.

When arsenic was used as film material the transition from specular reflection to absorption of visible light was observed at a helium pressure of 298μ. A lowering of the pressure to 294μ produced specularly reflecting films in all the 20 trials performed, while a pressure of 305μ produced absorbing films in about 20 trials. At a gas pressure of 300μ, 19 or 20 trials showed absorption films. This transition pressure did not change when the "basket" temperature was varied.

NOTE: Research Paper No. 1105, Journal Series, University of Arkansas.

When antimony was used, the transition pressure from specular reflection to absorption was 95μ. Exclusively absorbing films (in all of the 20 trials) were showed at 3μ above, and 2μ below showed specularly reflecting films exclusively (20 trials). When the "basket" temperature was changed, no significant change of the transition pressure was observed.

When bismuth was used the transition pressure between specular reflection and absorption was observed to be 150μ. At 4μ above, and at 5μ below, 100 per cent absorption and specular reflection were shown respectively, in all 20 trials for each pressure quoted.

This indicates that at a well-defined gas pressure the transition from a specularly reflecting to an absorbing film occurs which is specific for the film-forming metal.

The transition pressures mentioned above for all the three metals were determined by interpolation from reflectivity measurements of the films obtained at lower and higher pressures. The method employed can be described as follows:

The reflectivities of films deposited at low pressure (specular reflection film) and high pressure (absorbing film) were determined photo-electrically. The films produced at low pressures (just less than the transition pressure) showed reflectivities of more than 80 per cent of the incident light. Films produced just above the transition pressure showed low reflectivity (between 5 and 12 per cent of the incident light). The transition pressures were calculated by taking the 50 per cent average of the differences of the reflectivities of the absorbing and reflecting films. Since the pressures at which specularly reflecting films and absorbing films were obtained are very close together (only a few μ pressure difference) this interpolation to determine the transition pressure seems permissible. (See Table I).

There seems to be a correlation between the atomic weight, as well as atomic number, and the transition pressure of the metal, although arsenic displays a high transition pressure (298μ). From similar measurements of transition pressures of other elements (Cu, Ag, Al), one can surmise that the higher the atomic number of the element, the higher is the transition pressure.

It would be interesting to continue this study by determining the transition pressures not only of the metals and their alloys, but of non-metals with the goal to verify the correlation suggested above.

Table I. The Transition Pressures, Specific Heat, Boiling Point, Melting Point, Density, Atomic Weight and Atomic Number of Metals Investigated.

	1	2	3	4	5	6	7	8	9
	Atomic number	Atomic weight	Density	Pressure for specific reflection (μ)	Pressure of transition (μ)	Pressure for absorbing film (μ)	Melting point °C	Boiling point °C	Specific heat at 100°C
As	33	74.91	5.727	290	298	305	814(38 at.)	615	0.0822
Sb	51	121.76	6.684	91	95	98	630	1380	.0515
Bi	83	209.	9.8	145	150	154	271	1470	.034

AN INVESTIGATION OF DIRECTIONAL ORIENTATION IN MAZES WITHOUT GOAL POINTING BLINDS[1]

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INTRODUCTION

The purpose of this study was to investigate the assumption that directional orientation--if it is a factor in maze learning by the white rat--facilitates a rat's learning of a maze in which the goals are directionally opposed, as compared with the learning of a maze in which the goals are not directionally opposed.

Although the effect of the spatial relation of the goal to the rest of the maze in the absence of extra-maze cues has received scant attention in recent years, the authors of several recent text books (1, 4, 6) have revived the goal or directional orientation hypothesis. Despite the acceptance of the directional orientation hypothesis by the authors of these books, the evidence remains inconclusive. This may be partly due to the use of entries into goal pointing blinds as a measure of the orientation factor. In order to clarify the picture, further experimental evidence is needed in which directional orientation is isolated from the anticipatory goal reaction.

GENERAL EXPERIMENTAL PROCEDURE

Apparatus. Two modified T-mazes were used, as shown in the floor plan in Figure 1. The same starting box and choice point were used for both mazes.

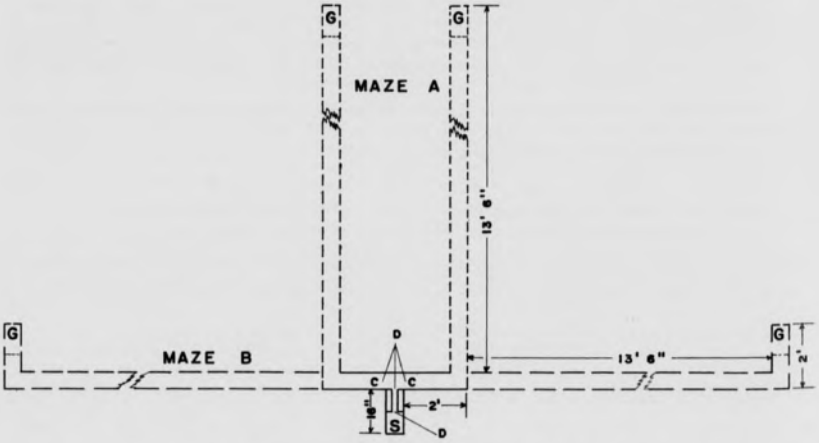

Fig. 1. Floor Plan of the Experimental Maze. C = Curtains, D = Guillotine doors, G = Goal boxes.

Constructed of white pine and painted a flat black, the maze alleys were 4 inches wide and 3½ inches high. They were covered with hardware cloth. The short alley leading to the choice point from the starting box was only 2½ inches wide in order to minimize the effects of following one wall up to the point of choice.

[1] The study reported in this paper was conducted by the writer in the Psychological Laboratory at the State University of Iowa. The writer wishes to express his gratitude to Dr. H. C. Wilcoxon for suggestions in the preparation of the manuscript.

NOTE: Research Paper No. 1106, Journal Series, University of Arkansas.

The goal boxes were 14 inches long, and sized to fit snugly inside the maze alleys. A hinged single-valve door, fastened on the front of the goal boxes, prevented retracing from the goal. The experimental room was lighted to provide uniform illumination over both paths.

Subjects and Training Procedure. The subjects were 22 female albino rats from the colony maintained by the Psychology Department of the State University of Iowa. At the beginning of the study, they were between 90 and 100 days old. The subjects were assigned at random to the two groups before the preliminary training began. After following a regular feeding schedule for one week, the animals were trained to run a straight alley 6 feet long within 5 seconds in 4 out of 5 successive trials. The food box in this straight alley contained a hinged single-valve door--the same as was employed in the maze used in the learning series. This helped the rats learn to open that type of door.

Learning Series. The learning series in the experimental mazes started the day after completion of preliminary training. Neither goal box contained a food reward on the first run, and the path chosen by each animal became the incorrect path for that animal for the remainder of the experiment. Each subject took four runs a day with 15 minutes between trials, until the criterion of 6 consecutive correct runs was reached. The non-corrective method was used throughout the study. A trial consisted of a run from the starting box to one of the two goal boxes. When an animal ran to the correct goal box, it was allowed to eat the small piece of food, and it was returned then to the carrying cage to await the next trial. If the animal ran to the incorrect goal box, it was removed after 30 seconds and returned to the carrying cage. Through such procedure, only one error could be recorded for each animal on each trial. A small pellet of the rat's regular diet was placed in the correct goal box as incentive. The pellets weighed about .15 gm. The animals were fed their daily ration, consisting of 8 gm. of Purina Dog Chow, immediately after the daily experimental period.

RESULTS AND DISCUSSION

The null hypothesis (that there is no difference between the groups) can not be rejected as the *t* for trials is .22 and for errors, .29. Thus, the results fail to support the assumption that directional orientation is a factor in maze learning by the white rat.

Table I. The Mean Number of Trials Required to Reach the Criterion and the Mean Number of Errors of the Two Groups with Respective Standard Deviations.

Group	Maze	Trials		Errors	
		Mean	Standard Deviations	Mean	Standard Deviations
I	A	10.27	6.27	5.82	3.32
II	B	10.82	4.91	5.45	2.28

The factor of goal or directional orientation has not been defined clearly. Most authors appear to imply that the rat actually learns the direction in which the goal lies, and further that the animal reacts to this "knowledge" from any point in the maze. Underwood (6, p. 426) has stated:

> Part of what a rat learns in a maze appears to be an orientation toward the goal. It is as if, after a few trials, the animal learns that the goal box is "over there."

If the writer correctly interprets this statement by Underwood, the maze designs used in this study were such that maze B should have been learned more readily that maze A, because the rat is capable of learning that the goal box is "over there." Although this learning of "over thereness" did not occur in this study, it "apparently" has been found in a number of previous studies. However, the complex design of many mazes used in studies of directional orientation

makes it difficult, if not impossible, to determine the variables which are influencing the learning of the rat.[2] In multiple T-mazes in which the last correct turn is the same as the turns leading into goal-pointing blinds, it is impossible to determine the influence of directional orientation, since the animal may be making anticipatory goal responses. For this reason the writer feels that Brogdon's definition (2, p. 601) is inadequate, since he defines directional orientation as the tendency to make more errors in goal-pointing blinds than in non goal-pointing blinds.

SUMMARY

Albino rats were run in two modified T-mazes in order to test the assumption that directional orientation would facilitate the learning of a maze in which the goals are directionally opposed, as compared with the learning of a maze in in which the goals are not directionally opposed.

There was no significant difference in the learning of the two groups when they were analyzed in terms of mean errors or in terms of the number of trials required to learn. Thus, the results failed to support the assumption that directional orientation is a factor in maze learning by the white rat.

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[2] It is possible that two different variables were operative in the present study, although the factor of anticipation of the last correct turn was removed from the maze situation. Both mazes had a forced turn for the animals after the choice was made. These turns may have gained secondary reinforcing properties, and therefore acted as sub-goals as described by Gilhousen (3). Spence and Grice (5), on the other hand, have presented evidence against the sub-goal effect in the type of maze used by Gilhousen. If sub-goals played a role in this maze situation, it would follow that arriving at them should have reinforced responses which led to them. In this study, the response at the choice point was the critical one to be learned. Thus, the problem is to deduce the possible differential effects of the sub-goals on the learning of this choice response. There are two important aspects of the present situation which must be considered: (1) the sub-goal in maze B should have had greater reinforcing properties since it was located much closer to the final goal, and (2) the sub-goal in maze A was achieved with shorter delay following the choice point and therefore should reinforce the choice response more strongly. As the effectiveness of the sub-goals appears to be equated, we may assume tentatively that they were not affecting differentially the learning of the rats in the two mazes. This, however, waits for an empirical test.

OBJECTIVE AND PROJECTIVE MEASURES OF WITHDRAWAL BEHAVIOR

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Current approaches to the appraisal and investigation of personality can be classified into subjective, objective, and projective methods. These three approaches can be distinguished for purposes of exposition, even though Rapaport (14) and Wechsler (18) have stressed the "projective hypothesis" in dealing with material obtained by measures which are classed usually as psychometric. A more useful way of regarding the three approaches is to emphasize the type of behavior--opinion, overt, or implicit--which each one yields. Both in clinical practice and in fundamental research, the appraisal and investigation of total personality demand a composite plan of attack evaluating opinion, overt, and implicit behavior in a complementary fashion.

STATEMENT OF THE PROBLEM

One specific manifestation of the more global personality structure--namely, withdrawal tendencies in human relationships--was selected for investigation. Opinion, overt, and implicit behavior attributed to this particular factor were elicited and evaluated. The following measures of withdrawal behavior were selected for study:

(1) The Picture Arrangement Subtest scores from the Wechsler-Bellevue Intelligence Scale, Form I.

(2) The Picture Arrangement Subtest scores from the Wechsler-Bellevue Intelligence Scale, Form II.

(3) Factor S scores from the Builford-Martin Inventory of Factors STDCR.

(4) Human, or H Scores, and Human detail, or Hd Scores, from the Rorschach Technique.

(5) Quantitative measures from a Rating Scale.

Rappaport (14) and Wechsler (18) emphasize the interpretation of Picture Arrangement Scores as an indication of social intelligence, or social alertness, or ability to deal with social situations. If an individual is lacking in the ability to get along in social situations, he will be uncomfortable in them and will tend to withdraw from them. Guilford (5) states that if a person receives a high score on the S. factor--social introversion--it indicates that he is shy and seclusive. In regard to H and Hd responses on the Rorscach, Rappaport (14) says: "...These responses are generally considered to reflect the presence of interest in human beings...It appears that interest in, and/or free contact with, other persons results in a wealth of observations and experiences relative to human form, postures, and expressions; the lack of such interest or contact results in a lack of such observations."

In order to pursue this study it was necessary to obtain scores on the measures listed above from a number of individuals whose behavior manifested marked withdrawal tendencies. It was decided to use schizophrenic and neurotic individuals because in such individuals' behavior, impressive evidence of withdrawal tendencies frequently is found. On the basis of reported studies (2, 3, 4, 6, 10, 11, 13, 16) no consistent differences between normal, neurotic, and schizophrenic groups on Picture Arrangement scores would be anticipated. The reported studies (7, 8, 17) on intellectual deterioration in schizophrenia and the neuroses are conflicting. Therefore, differences in total test scores between normals, on the one hand, and schizophrenics and neurotics, on the other, would not be expected solely on the basis of diagnosis. Likewise, reported studies (1, 12, 15) on the use of the Rorschach with clinical groups would not lead to the expectancy of differences in the factors under investigation.

The aims of this investigation were to test the following hypotheses:

(1) Individuals who are rated as withdrawn receive lower scores on the Picture Arrangement Subtests of the Wechsler-Bellevue Intelligence scale than individuals who are rated as outgoing.

(2) Individuals who are rated as withdrawn receive lower H and Hd scores on the Rorschach technique than individuals who are rated as outgoing.

(3) Individuals who are rated as withdrawn receive higher scores on Factor S of the Guilford-Martin Inventory of Factors STDCR than individuals who are rated as outgoing.

SUBJECTS AND PROCEDURE

Subjects who manifested withdrawal behavior were selected and appraised, along with a group of individuals characterized by absence of withdrawal tendencies. Schizophrenic and psychoneurotic patients--30 of each--in a Mental Hygiene Clinic were selected as the withdrawn groups. Thirty normal subjects were selected as the outgoing or control group. A Rating Scale on which the subject's typical behavior was checked against behavioral descriptions for each of six characteristics (such as seclusiveness, shyness, detachment) was the instrument for selection of the subjects. Agreement among the independent ratings of a psychiatrist and two psychologists was required for selection of each subject. All subjects were American-born, white, male veterans of World War II, and the groups were matched for age, intelligence, and educational level. The age range was from 20 to 45 years. The IQ range was from normal to superior.

The tests were administered to each subject in two sessions about a week apart. The method outlined by Klopfer and Kelley (9) was used in administering and scoring the Rorschach tests.

RESULTS

The statistical results served four purposes: (1) determining differences between the means of the outgoing group and each of the withdrawn groups on the various measures and testing the significance of the differences by use of the "t" test, (2) analyzing the total variance into that among and within the three groups, and testing the significance of the ratio of these two variances by means of the F test, (3) determining differences among the groups after the effects of intelligence and education are accounted for, and (4) finding the optimum combination of measures to predict withdrawal behavior.

The general conclusion derived from an analysis of the data was that the hypotheses were supported. The specific conclusions were as follows:

(1) The mean of the scores for each of the withdrawn groups (neurotics and schizophrenics) was significantly lower than the mean of the scores for the outgoing group (normals) on the Picture Arrangement Subtests of the Wechsler-Bellevue, Form I and Form II.

(2) The mean of the scores for one of the withdrawn groups (neurotics) was significantly lower than the mean of the scores for the outgoing group on both H and Hd factors of the Rorschach Technique. The mean of the scores for the other withdrawn group (schizophrenics) was significantly lower than the mean of the scores for the outgoing group on the Hd factor of the Rorschach Technique, and lower on the H factor, but not significantly so.

(3) The mean of the scores for each of the withdrawn groups was significantly higher than the mean of the scores of the outgoing group on the S inventory, which is in the expected direction.

(4) When the effect of education and intelligence on the differences among the three groups is accounted for, significant differences among the groups remain on all measures and in the direction expected for the withdrawn groups.

(5) Neither of the two withdrawn groups was significantly different from the outgoing group in respect to the number of individuals who gave no H responses or to the number who gave no Hd responses.

(6) The relationships between actual scores on the Rating Scale and scores on the Rating Scale predicted from the other measures were higher for each of the two withdrawn groups than for the outgoing group, and higher for the total group than for any of the three groups.

(7) For the total group a team consisting of Picture Arrangement Scores from the Wechsler-Bellevue, Form II, and the S Inventory, gave almost

as good prediction of scores on the Rating Scale as did the team consisting of all measures.

The results of the study indicate that psychological test results vary with certain aspects of personality functioning. Furthermore, if the Picture Arrangement Subtests of the Wechsler-Bellevue Scales are measurers of intelligence, then this study shows that intellectual functioning varies with certain aspects of personality functioning. The study, then, lends evidence in support of some commonly accepted theoretical formulations. The results of the study offer an effective measure of withdrawal to the clinician.

SUMMARY

This study deals with various objective and projective measures described by different authors as measures of withdrawal behavior. The measures used were: (1) The Picture Arrangement Subtest of the Wechsler-Bellevue Scale, Forms I and II, (2) S Inventory, which consisted of the Factor S items of the Guilford-Martin Inventory of Factors STDCR and other similar items, (3) the Rorschach Technique, of which only H and Hd scores were considered. In addition, a Rating Scale designed to measure withdrawal tendencies, or lack of such tendencies, was included.

The subjects included 30 schizophrenics, 30 psychoneurotics, and 30 normals. Three independent ratings and anecdotal material on each subject were used as a basis for inclusion in the study.

Statistical analysis of the test data provided evidence that:

(1) The Picture Arrangement Scores on both forms of the Wechsler-Bellevue Scale, and the scores on the S Inventory, distinguished withdrawn subjects in both abnormal groups.

(2) The scores on the H and Hd factors distinguished withdrawn subjects in the neurotic group.

(3) The scores on the Hd factor only distinguished withdrawn subjects in the schizophrenic group.

(4) Scores on Picture Arrangement from the Wechsler-Bellevue, Form II, and the S Inventory gave almost as good prediction of scores on the Rating Scale as did the consideration of all the measures.

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