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TRANSACTIONS

OF THE

ILLINOIS STATE ACADEMY OF SCIENCE

VOL. 26 | SEPTEMBER, 1933 | NUMBER 1

Announcement
Twenty-seventh Annual Meeting

Officers and Committees, General Program
Section Meetings, Junior Section
Instructions to Authors
General Information

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JUL 11 1934

Friday and Saturday, May 4-5, 1934
Decatur, Illinois

Department of Registration and Education
State Museum Division, Centennial Building
Springfield, Illinois

Entered as second-class matter, December 6, 1930, at the post office at Springfield, Illinois, under Act of August 24, 1912.

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V. O. GRAHAM, 4028 Grace Street, Chicago.

GENERAL PROGRAM

All Addresses and Section Meetings Are Open to the Public

THURSDAY, MAY 3

7:30 p. m. Meeting of the Council *(Room 119, James Millikin University).*

FRIDAY, MAY 4

8:00 a. m. Registration by all members and guests. Secure tickets for luncheon at Aston Hall and for the annual banquet at First Presbyterian Church. Register for Saturday field trips *(Lobby of James Millikin University).*

8:00 a. m. Meeting of the Council with local committee and delegates from affiliated societies *(Room 119).*

8:30 a. m. Preliminary business meeting of the Academy. Appointment of committees on nominations and on resolutions; adjournment until 11:45. *(Chapel.)*

9:00 a. m. Address of the retiring president—*Recent Developments in the Chemistry of the Rare Earth Group*—B. SMITH HOPKINS, University of Illinois.

9:40 a. m. Symposium: Conservation of Illinois agricultural and human resources. Addresses to members of the Academy and students of James Millikin University:
The Significance of the Conservation of Land Resources—H. W. MUMFORD, Dean of the College of Agriculture, University of Illinois.
The Relationship Between the Standard of Living and Natural Resources—SIMON LITMAN, Professor of Economics, University of Illinois, Urbana.

10:30 a. m. Addresses to members of the Academy:
Classification of Illinois Lands—RAYMOND S. SMITH, Professor of Soil Physics, University of Illinois, Urbana.
Soil Erosion Control Projects—F. A. FISHER, Soil Erosion Service, U. S. Department of the Interior.
Utilization of Illinois Lands for Forestry, Wildlife, and Recreation—T. H. FRISON, Chief, State Natural History Survey, Urbana.
Objectives of the Illinois Planning Commission—COLONEL H. L. KELLOGG, State Planning Commission, Springfield.

11:45 a. m. Annual business meeting of the Academy. Reports of officers and committees; other business; adjournment until 5:00 p. m.

12:00-1:00 p. m. Luncheon, Aston Hall *(Women's Dormitory)*, 40 cents.

1:00 p. m. Visit to Library of James Millikin University.

1:45 p. m. Section meetings. Election of section chairmen for 1934-35; papers, demonstrations, discussions *(James Millikin University).*

5:00 p. m. Final business meeting of the Academy *(Chapel).* Reports of committees; election of officers for 1934-35; appointments to standing committees; other business; adjournment.

7:00 p. m. Annual banquet (informal), *(First Presbyterian Church).* Reservations should be made in advance by mail to J. H. Ransom, 1357 W. Wood Street, Decatur, and tickets secured at time of registration. $1.00 per plate.

7:45 p. m. Annual public lectures *(First Presbyterian Church).*
Address of Welcome—O. W. SMITH, Mayor, Decatur.
Address—JESSE H. WHITE, President, James Millikin University.
Response—B. SMITH HOPKINS, President, Illinois State Academy of Science.
A Three-Year Windjammer Cruise to the Islands of the South Atlantic—GEORGE FINLAY SIMMONS, University of Chicago, Chicago.

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SATURDAY, MAY 5

8:00 a. m. Meeting of the new Council *(Room 119, James Millikin University).*

9:00 a. m. Inspection trips leave from James Millikin University. The local committee will arrange for transportation for those having no cars if reservations are made in advance. Register for trips at the time of the general registration.

Industrial trip—a visit to the Decatur Sewage Disposal Works and the Water Purification Plant; trip through the Staley Starch Factory. To be conducted by William D. Hatfield and R. E. Greenfield.

Geological trip—a visit to observe the Shelbyville moraine, the buried Sangamon soil, the Wisconsin valley-train, Wisconsin loess, intraglacial gravels in the Shelbyville drift along Sangamon River valley, and relations of the Shelbyville moraine to the older Illinoian drift plain to the west. The trip will be under the direction of M. M. Leighton, Chief, Illinois State Geological Survey, and will require the morning and early part of the afternoon.

Coal Mine trip—a trip through the coal mine in the City of Decatur. To be conducted by D. W. Beggs and G. H. Cady.

PROGRAM OF SECTION MEETINGS

FRIDAY, MAY 4—1:45 P. M.

JAMES MILLIKIN UNIVERSITY

AGRICULTURE

H. W. MUMFORD, University of Illinois, *Chairman*

The Agriculture section is joint sponsor with the Economics section of the Symposium presented at the morning general session, and will not hold a separate section meeting.

ANTHROPOLOGY

Room 119

THORNE DEUEL, University of Chicago, *Chairman*

Election of chairman for 1934-35.

Symposium: Certain Aspects of Mississippi Valley Archaeology and Their Relation to Illinois.

1. Prehistoric timetables (lantern slides)—JOHN VOSS, Peoria.
2. Certain bluff mounds in Western Jersey County, Illinois—P. F. TITTERINGTON, St. Louis, Missouri.
3. Certain Carolina sites and their affiliations, northern and southern—J. D. JENNINGS, University of Chicago, Chicago.
4. Physical types in aboriginal Illinois—GEORGE K. NEUMANN, University of Chicago, Chicago.
5. Basic cultures of the Mississippi Valley and their Illinois representatives—THORNE DEUEL, University of Chicago, Chicago.
6. Archaeological reconnaissance work in southern Illinois, 1933—BRUCE W. MERWIN, Southern Illinois State Normal University, Carbondale.
7. The tree-ring method of chronology and its application in Illinois—J. H. MACGREGOR, Museum of Northern Arizona, Flagstaff, Arizona.

BOTANY

Room 215, Main Stairway

E. L. STOVER, Eastern Illinois State Teachers College, *Chairman*

Election of chairman for 1934-35.

1. New methods in paleobotanical micro-technique (lantern slides)—A. C. NOÉ, University of Chicago and Illinois State Geological Survey.
2. Rock ledge vegetation in southern Illinois (lantern slides)—A. G. VESTAL, University of Illinois, Urbana.
3. Mosses from the Illinois Ozarks—STELLA M. HAGUE, University of Illinois, Urbana.
4. Some Bryophytes from Macon County, Illinois—GLADYS C. GALLIGAR, University of Illinois, Urbana.
5. Barberry eradication in Illinois (lantern slides)—ROBERT W. BILLS, United States Department of Agriculture, Bureau of Plant Industry.
6. A Stratigraphical study of the Manito Swamp (lantern slides)—JOHN VOSS, Manual Training High School, Peoria.

CHEMISTRY

Room 240, West Stairway

FRED A. DYKINS, Division of Highways, Springfield, *Chairman*

Election of chairman for 1934-35.

1. The use of ceric sulphate for the determination of cuprous oxide obtained by the action of reducing sugars on Fehling's solution—D. T. ENGLIS with R. A. STEGEMAN, University of Illinois, Urbana.
2. A few suggestions on the teaching of fuels in elementary chemistry—G. T. FRANKLIN, Lane Technical High School, Chicago.
3. Some metathetic reactions of iodine mono-chloride—H. W. HORRABIN, Western Illinois State Teachers College, Macomb.
4. The occurrence of a pectin material in artichoke syrup—D. T. ENGLIS with H. A. HARRISON, University of Illinois, Urbana.
5. Micro-methods in qualitative analysis—J. H. REEDY, University of Illinois, Urbana.
6. Lysis and hydration of serum proteins as general features of disease—K. SCHULHOF, Chicago.
7. A new method for whipping cream—G. F. SMITH with C. A. GETZ, University of Illinois, Urbana.
8. The effect of potassium cyanide upon amylase activity—D. T. ENGLIS, with J. O. PAGE, University of Illinois, Urbana.
9. The mechanism and application of the Fries isomerization—V. C. SEKERA, Northwestern University, Evanston.
10. The explosive reaction of perchloric acid with bismuth—D. G. NICHOLSON with J. H. REEDY, University of Illinois, Urbana.

ECONOMICS

ERNEST F. BOGART, University of Illinois, *Advisory Member*

The Economics section is joint sponsor with the Agriculture section of the Symposium presented at the morning general session, and will not hold a separate section meeting.

GEOGRAPHY

Room 116, West End Corridor

ALFRED W. KASEL, Moline High School, *Chairman*

Election of chairman for 1934-35.

1. Decatur, Illinois, a study in urban geography—E. MURIEL POGGI, University of Illinois, Urbana.
2. Points of emphasis in the geography of Illinois (lantern slides)—W. O. BLANCHARD, University of Illinois, Urbana.
3. Growing broomcorn in Coles County, Illinois (lantern slides)—ROSE ZELLER, Eastern Illinois State Teachers College, Charleston.
4. The relation of topography and drainage to farm-type regions of Illinois—WILLIAM E. POWERS and EDWARD C. DAPPLES, Northwestern University, Evanston.
5. The southern Wisconsin tobacco region (lantern slides)—H. O. Lathrop, Illinois State Normal University, Normal.
6. Items in the Haitian pattern of occupance—R. S. PLATT, University of Chicago, Chicago.
7. Patterns of the port of Vancouver, British Columbia—LEAH STEVENS, Eastern Illinois State Teachers College, Charleston.
8. The retarded development of Alaska—EMMA AYRS, Northwestern University, Evanston.

GEOLOGY

Room 221, Main Stairway

CHARLES H. BEHRE, JR., Northwestern University, *Chairman*

Election of chairman for 1934-35.

1. Subsurface stratigraphy of the Devonian of western Illinois—L. E. WORKMAN, Illinois State Geological Survey, and JOHN HUNER JR., University of Illinois, Urbana, (5 minutes, lantern slides).
2. On the reproductive habits of *Turritella alumensis* Mansfield—A. H. SUTTON, University of Illinois, Urbana, (8 minutes).
3. The age of the so-called Permian beds near Danville, Illinois—H. R. WANLESS, University of Illinois and Illinois State Geological Survey, Urbana, (10 minutes).
4. Research on Paleozoic formations in Virginia—ARTHUR BEVAN, Virginia State Geological Survey, (to be read by title).

5. The Port Byron (Guelph) fauna in Illinois—T. E. SAVAGE, University of Illinois, Urbana, (8 minutes, lantern slides).
6. The subsurface stratigraphy of the Decatur region—L. E. WORKMAN, Illinois State Geological Survey, Urbana, (12 minutes, lantern slides).
7. The glaciology of the Decatur region—M. M. LEIGHTON, Illinois State Geological Survey, Urbana, (12 minutes, lantern slides).
8. Effects of barometric pressure and winds on the level of Lake Michigan—W. E. POWERS, Northwestern University, Evanston, (12 minutes, lantern slides).
9. Boundaries of Pennsylvanian cyclothems—J. M. WELLER, Illinois State Geological Survey, Urbana, (10 minutes, lantern slides).
10. New American plants from the Pennsylvanian period as preserved in coal balls—A. C. NOÉ, University of Chicago, Chicago, and Illinois State Geological Survey, Urbana, (10 minutes, lantern slides).
11. The gelogical and biological significance of coal beds—L. C. MCCABE, Illinois State Geological Survey, Urbana, (10 minutes, lantern slides).
12. The integration of sciences required for logical study of coal constitution—GILBERT THIESSEN, Illinois State Geological Survey, Urbana, (12 minutes, lantern slides).
13. Clay veins in the Springfield (No. 5) coal—W. B. ROE, Northwestern University, Evanston, (10 minutes, lantern slides).
14. Migmatization in the Sawatch Range, Colorado—J. T. STARK, Northwestern University, Evanston, (12 minutes, lantern slides).
15. Rock wool, an Illinois resource—J. E. LAMAR, Illinois State Geological Survey, Urbana, (10 minutes, lantern slides).
16. Structural control of ore deposition in the Wisconsin-Illinois lead-zinc district—E. R. Scott and C. H. BEHRE, JR., Northwestern University, Evanston, (10 minutes, lantern slides).
17. Silurian Echinoids—PAUL H. DUNN, University of Chicago, Chicago, (5 minutes, lantern slides).
18. A four-hundred acre lake disappears—CLARENCE BONNELL, Harrisburg Township High School, Harrisburg, (5 minutes).

MEDICINE AND PUBLIC HEALTH

HARRY F. FERGUSON, State Department of Public Health, Springfield, *Advisory Member*

No program has been planned for this section for the 1934 meeting.

PHYSICS

Physics Lecture Room, Main Stairway

JAKOB KUNZ, University of Illinois, *Chairman*

Election of chairman for 1934-35.

1. A compact vacuum gauge for measuring pressures ranging from .2 mm. down to .0001 mm. of mercury—CHARLES T. KNIPP, University of Illinois, Urbana, (demonstration, 10 minutes).
2. Renewed activity of radium bromide after heating as revealed in a Wilson Expansion Chamber—CHARLES T. KNIPP, University of Illinois, Urbana, (demonstration, 10 minutes).
3. Model of a storage cell, simulating ion and electron flow—CHARLES T. KNIPP, University of Illinois, (demonstration, 10 minutes).
4. Electron oscillations—J. T. TYKOCINER and A. E. ABEL, University of Illinois, Urbana.
5. The flow through submerged orifices—JAKOB KUNZ, University of Illinois, Urbana.
6. Electron diffraction and the physics of solids—LESTER I. BOCKSTAHLER, Northwestern University, Evanston.
7. The present crisis in theoretical physics—JACOB KUNZ, University of Illinois, Urbana.

PSYCOLOGY AND EDUCATION

Room 237, West Stairway

RALPH W. PRINGLE, University High School, Normal, *Chairman*

Election of chairman for 1934-35.

1. Cultural value of courses in psychology and education—GEORGE D. WHAM, Southern Illinois State Normal University, Carbondale.
2. Contributions of psychology to education—E. H. CAMERON, University of Illinois, Urbana.

3. Psychology and juvenile crime—M. L. REYMERT, Mooseheart Laboratory, Mooseheart.
4. Psychiatry and the modern child—PAUL L. SCHROEDER, Institute for Juvenile Research, Chicago.
5. Education and the present reorganization of life—JORDAN CAVEN, Rockford College, Rockford.
6. A study of certain rural teacher activities and the adequacy of training for performance—TED RAGDALE, Southern Illinois State Normal University, Carbondale.
7. Relation of scholarship during college career to success in teaching as judged by salary—H. A. PETERSON, Illinois State Normal University, Normal.
8. Out of school activities that contribute to professional success of the teacher—B. W. MERWIN, Southern Illinois State Normal University, Normal.

ZOOLOGY

Room 235, West Stairway

W. C. SPOONER, Eastern Illinois State Teachers College, *Chairman*

Election of chairman for 1934-35.

1. Animals killed by automobiles on Illinois highways—W. P. FLINT, Illinois State Natural History Survey, Urbana.
2. Thomas Say, early American zoologist of the middle west—H. W. MAUNTEL, Mendota High School, Mendota.
3. Notes on the environmental relations of the crayfish *Cambarus propinquus* Girard —W. C. VANDEVENTER, University of Illinois, Urbana.
4. Winter habits of land snails on a Sangamon River floodplain—T. D. FOSTER, University of Illinois, Urbana.
5. Abnormalities in the uterine young of the snail *Campeloma rufum*—N. T. MATTOX, University of Illinois, Urbana.
6. A study of characters for the differentiation of two species of minnows of the genus *Notropis*—W. C. STARRETT, University of Illinois, Urbana.
7. Seasonal life history of a snail of the genus *Fossaria*—H. J. VAN CLEAVE, University of Illinois, Urbana.
8. Swimming of the muskrat—J. D. MIZELLE, University of Illinois, Urbana.
9. Skeletal modifications in river catfishes of Illinois—W. F. HOHEISEL, University of Illinois, Urbana.
10. The changing states of some Illinois birds—C. W. G. EIFRIG, Concordia Teachers' College.
11. The Florida Gallinule—C. K. CARPENTER, Morgan Park.
12. Sexuality in the Prosobranch mollusks—C. L. FURROW, Knox College, Galesburg.
13. Entomophagus parasitism among beetles—W. V. BALDUF, University of Illinois, Urbana.
14. Biological principles underlying the field of education—C. E. MONTGOMERY, Northern Illinois Teachers College, DeKalb.
15. Changes in abundance of birds in the Chicago area during the past twenty-five years —C. B. COURSEN, General Biological Supply House, Chicago.
16. Living vs. Dead—SISTER M. STANISLAUS, Mercy High School, Milwaukee, Wisconsin.
17. An ecological study of rapids communities—H. E. GEARHART, Grand Tower, Illinois.
18. Observations on the stream life of the Charleston, Illinois, region with notes on the food ecology of fishes—T. L. HANKINSON, Michigan State Normal College.
19. Moth proofing and moth proof materials—C. L. METCALF, University of Illinois, Urbana.

ILLINOIS STATE ACADEMY OF SCIENCE

JUNIOR SECTION

HIGH SCHOOL SCIENCE AND CLUBS

LOUIS A. ASTELL, 137 N. Evergreen Avenue, Kankakee, *Chairman*

MARY BROCK, Decatur High School; CHARLOTTE MEYER, Decatur High School in charge of local arrangements

FRIDAY, MAY 4

8:00 a. m. Registration *(James Millikin University, East Corridor, first floor).*
8:00-11:00 a. m. Arrangement of exhibits. *(East Corridor, Rooms 100 and 103.)* Scientific equipment exhibited by scientific companies.

12:00 m. Luncheon, *(Westminster Church, two blocks west of University)*, 35 cents.
12:45 p.m. Visit to James Millikin University Library.
1:30 p.m. Annual business meeting of official delegates of Junior Section *(James Millikin University Chapel)*.
Formal initiation of new clubs.
Geological Adventures—T. T. QUIRKE, University of Illinois, Urbana.
Sound films: (1) *The Molecular Theory of Matter;*
(2) *Oxidation and Reduction.*
Talks and demonstrations by student delegates.
3:45 p.m. Presentation of awards. B. SMITH HOPKINS, President, Illinois State Academy of Science.
6:30 p.m. Annual banquet, First Presbyterian Church, 65 cents.
7:45 p.m. Address.

SATURDAY, MAY 5

9:00 a.m. Choice of inspection trips as listed under general program.

INSTRUCTIONS TO AUTHORS OF PAPERS PRESENTED AT SECTION MEETINGS

Summaries suitable for publication and not longer than 500 words should be handed to the section chairman at the time of the section meetings. The reduced State appropriation for the publication of the *Transactions* this year will make it impossible to publish longer articles or illustrations.

HEADQUARTERS OF THE ACADEMY
JAMES MILLIKIN UNIVERSITY
DECATUR, ILLINOIS

Registration Desk in Lobby

Telegrams and other messages may be sent to individuals in care of J. H. Ransom, James Millikin University, Decatur, Illinois, and called for at the registration desk.

Changes of schedule or program and other special announcements will be posted in the lobby at the registration desk.

Secure tickets for banquets and register for trips at the registration desk.

Members and guests of the Academy expecting to attend the Annual informal Banquet and the Luncheon at Aston Hall, Friday noon, May 4th, are asked to notify the Local Chairman previous to May 4th.

Junior Section Headquarters: East Corridor, James Millikin University.

Housing facilities for out-of-town guests attending the Junior Section are being arranged as follows: For boys in the fraternity houses of James Millikin University; for girls in Aston Hall and at the sorority houses. The rate for those who can be accommodated in this way will be about 50 cents for bed and breakfast. Sponsors of science clubs wishing these accommodations should communicate before May 1st with Miss Mary Brock or Miss Charlotte Meyer, Decatur High School.

Hotel Rates

Orlando Hotel:
Single room with bath, \$2.50; without bath, \$2.00.
Double room with bath, \$4.00; without bath, \$3.50.

St. Nicholas Hotel:
Single room with bath, \$2.00, \$2.50; without bath, \$1.50, \$1.75.
Double room with bath, \$2.75, \$3.25; without bath, \$2.25, \$2.50.
Room with 2 beds for 4 people, with bath, \$1.50 per person; without bath, \$1.00 per person.

Ladies Entertainment, Friday, May 4

Luncheon at Aston Hall.
2:30 p.m. Drive to points of interest in and around Decatur.
4:00 p.m. Tea at home of Mrs. Jesse H. White.

TRANSACTIONS

OF THE

ILLINOIS STATE ACADEMY OF SCIENCE

VOLUME 26 DECEMBER, 1933 NUMBER 2

Papers Presented in General Sessions at the Twenty-sixth Annual Meeting

Memoirs

EDITED BY DOROTHY E. ROSE

Printed by authority of the State of Illinois.

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STATE MUSEUM DIVISION, CENTENNIAL BUILDING

SPRINGFIELD, ILLINOIS

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TRANSACTIONS OF THE ILLINOIS STATE ACADEMY OF SCIENCE

Volume 26 December, 1933 Number 2

CONTENTS

PAPERS PRESENTED IN GENERAL SESSIONS AT THE TWENTY-SIXTH ANNUAL MEETING, EAST ST. LOUIS

ADVANCEMENT IN THE SCIENCE OF PUBLIC HEALTH*

BY

FRANK J. JIRKA, M. D.

State Health Director, Springfield, Illinois

The public health movement is still very young. Compared in age with such institutions as the church, the monetary system and the military, public health service is at best only a youth. Like a healthy, vigorous human, the public health movement has grown rapidly during its early life.

Within the first year of life a healthy infant doubles in weight. Then he settles down to a less rapid but steady increase in height and weight until about twelve years of age. At that, as though the youngster had just seized upon a glimpse of the richness of life and the rare privileges of human existence upon the earth, he begins to grow in height and weight and in breadth of intellect and vision at a rate far beyond any previous experience since the first twelve months. During about four years of that period known as adolescence, a child grows with such amazing rapidity that his parents are taxed to the limit to keep him supplied with clothes that fit, food that meets his needs and a thousand things which are required to satisfy his expanding physical and mental horizon. It requires, furthermore, the closest observation on the part of acquaintances and friends of the family to recognize and keep informed about the changes that take place in growth and habits of an adolescent.

It appears that the public health movement is now in the midst of its adolescent growing period. During its infancy, the period prior to 1900, it suffered from inanition. Having survived that hazardous and critical period, the public health movement then settled down to a reasonably steady growth that continued until about the opening of the World War. That conflict gave a tremendous impetus to public health service. It demonstrated on a large scale the infinite possibilities of controlling disease and maintaining health through the application of scientific knowledge. Since then the growth of public health service in this country has been phenomenal. It has enjoyed a healthy adolescence, expanding and spreading out in all directions. The results have been astonishing. A study of appropriations by municipal and state legislative bodies indicates that this youthful activity may suffer somewhat from a lack of nourishment during the immediate future. It requires more than a short ration, however, to seriously discourage a robust adolescent.

An omnivorous appetite is characteristic of youth. Food in great quantities for body and mind is drawn from a multiplicity of sources if healthy development results. So it is with the public health movement. No one science and no one profession can provide this service with a program

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worthy of the name. Indeed, public health work depends upon knowledge and skill drawn from the fields of medicine, engineering, bacteriology, epidemiology, biometry, biology, zoology, geology, psychology, psychiatry, sociology, chemistry, dentistry, eugenics, physics, nutrition, education and numerous others. Advancement in any of these fields is at least a potential advancement in the public health movement. A delineation of advancement in public health must therefore be limited to a broad vision of progress along the whole sweeping front of this significant movement. So able a scientist as Dr. H. Levy, the mathematician, declares that no scientist would claim to know all about tobacco-growing, let alone the other factors that enter into the manufacture of a cigarette. How much less would an administrator profess to know all about all of the sciences involved in public health.

The most important advancement in respect to public health is doubtless the change in popular attitude toward the meaning and significance of this movement. Only 27 years ago an impetuous president of the United States entertained grave doubts in his own mind as to whether or not he should retain as chief sanitary officer of the Panama Canal Zone a man who spent, as he had been informed, all of his time in trying to kill mosquitoes. About two weeks ago a nationally known educator (Dr. Robert K. Speers) roundly upbraided health education instructors for being too gullible in the acceptance of fads and half truths. Among these he cited "a clean tooth never decays" and "a daily bath for positive health" as examples.

These two illustrations show that within thirty years the best popular attitude has changed from skeptical to critical in respect to preventive medicine. From the mountain peaks to which he has swiftly climbed the well informed public health specialist looks back upon the valley of limited knowledge that he used as stepping stones to higher altitudes. The knowledge he used for tools then, he now recognizes were crude and simple. These tools served well their purpose, however. Now the public has reached those valleys and are already striving to climb the higher grades. This is proved by the critical attitude of mind.

The shift from skepticism to confidence in preventive medicine made possible the improvement that has taken place in the public health. It made possible appropriations to health departments and contributions to the many voluntary public health agencies throughout the country.

The next step, according to J. B. S. Haldane, is to bring about a popular attitude so that both the electorate and the lawmakers will think in terms of human biology. Popular thought today is almost wholly in economic channels. Tariff walls are built up and torn down chiefly for economic reasons. If thought were redirected into biological channels the basis for tariff and other laws would shift to human instead of monetary values. Suppose the steel industry petitioned Congress for a protective tariff. The death rate from pneumonia is much higher among steel workers, particularly those subjected to strenuous labor and radical changes in temperature, than among employes in any other industry. With this knowledge at hand the biologist-politicians would say to the steel magnates, "We cannot protect your industry until you protect more adequately the health of your employes."

Lead poisoning, silicosis, and asbestosis are three important hazards involved in various manufacturing, industrial, and commercial employment. The lawmakers who think in terms of human biology would grant no favors in the form of protective tariffs or other legal advantages to any of these industries until all reasonable precautions were taken to protect the employes. This is the next great step in the advancement of public health. The prevailing popular tendency to criticize the shortcomings of health education encourages the belief that progress is being made in that direction.

Record Keeping

Next to the change in popular attitude toward preventive medicine the next most important advance in public health service is probably the collection, classification, and utilization of records. It is an astonishing fact that reliable records of mortality, the prevalence of diseases and of births date back only to 1918 in Illinois. Prior to that time the mortality records in only 27 states were acceptable to the United States bureau of the census as reliable. Mortality records are now accepted by the bureau from all of the states except Texas and South Dakota. These records, which are constantly being more refined and accurately executed, are the very foundations upon which the public health structure is built. They show what diseases are most hazardous, what age groups fall victims most easily to this or that danger. They show the results of efforts at disease control and the gains and losses in the public health program. We know from the death records, for example, that diphtheria killed one thousand, one hundred forty-two people in Illinois during 1918 and only two hundred forty last year. We know that mortality from tuberculosis fell from 8,579 in 1918 to 4,273 in 1932. We know also that the greatest risk of diphtheria is to the child between two and five years of age while the hazard of tuberculosis is three times as great as that from all other health dangers to young women between 14 and 35 years of age.

The statistics, moreover, show that improvement in public health protection has advanced at an uneven rate from a geographical standpoint. This is true when considered on a state, national or international basis. Smallpox, typhoid fever and malaria are as prevalent and fatal as ever throughout a large portion of Mexico. Within the United States both typhoid fever and diphtheria have been practically eradicated in some commonwealths while in others these two diseases are still problems of large magnitude. Last year, for instance, typhoid fever was responsible for only 1 death or less per 100,000 people in New York, Connecticut and Wisconsin, while diphtheria was charged with less than 3 deaths per 100,000 people in California, Iowa, Massachusetts, Michigan, Minnesota, New York and Wisconsin.

In Illinois two counties last year experienced death rates from diphtheria of a magnitude comparable with those prior to the discovery of antitoxin and toxoid or toxin-antitoxin while 58 counties suffered no loss of life whatever from that disease. When grouped together the 34 counties that make up the extreme southern third of Illinois have a mortality rate from typhoid fever that is fifteen times greater than that of the 33 counties in the extreme northern third of the State. The death rate from diphtheria is three times as great, and the infant death rate is 30 per cent higher in the southern than in the northern third of this State. In the southern third the death rate from tuberculosis is 20 per cent greater than in the central third.

Statistical records bring out, moreover, that a tremendous shift is taking place in the age level of the population. At the turn of the century nearly one-half of all mortality was among children under five years old. Now less than 10 per cent of the mortality is in that age group. This means that a much larger percentage of the population is reaching maturity and the upper age levels than at any previous time in history. Fully 40 per cent of the population of Illinois are over 35 years old now whereas about 30 per cent of the people in the State had reached that age in 1900.

This aging of the population brings to the fore a host of problems. Instead of diarrhea, diphtheria, typhoid fever, tuberculosis and other hazards of infancy, childhood and early maturity, such health risks as cancer, heart disease, diabetes and nephritis dominate the picture. In addition to this, industry, commerce, and the government find themselves with an increasingly large percentage of leaders who have reached three score years of age. Although still physically vigorous and mentally alert these men experience great difficulty in adjusting their point of view to the swiftly changing conditions brought about by scientific development. The records at least make us aware of a problem that grows daily in complexity and magnitude.

Sickness records have likewise marked an important advance in public health service. Not only are case reports required for a constantly increasing number of diseases but sickness surveys have brought to light some astonishing knowledge. No one suspected until recently, for instance, that chronic rheumatism is the greatest single cause of all chronic illness. This opinion is based upon a study of one per cent of the population of Massachusetts which indicated that fully 145,000 people are suffering from chronic rheumatism at any one time in that state. The Committee on the Cost of Medical Care brought together a mass of valuable records in respect to the prevalence and cost of sickness and medical care.

Activities which stimulate the collection and study of records constitute a tremendous contribution to the advancement of public health. They point the way toward better adjustment in a rapidly changing world.

Mental health is by all odds the most important problem of the future. Advancement in application of mental hygiene has not progressed very far but there has been a tremendous growth in knowledge concerning this subject on the one hand and a recognition of the problem on the other.

The sheer magnitude of the problem compels serious thought and stirs up apprehensions. Nearly one-half million hospital beds in the United States are filled with nervous and mental patients. The ratio of feebleminded and epileptic patients per 10,000 people in the United States has increased from 2 to 5 since 1904. In Illinois the patients in State hospitals for the mentally defective (insane, feebleminded and epileptic) have increased from 27 to 40 per 10,000 population since 1914. While the entire population increased 30 per cent the institution population increased 48 per cent. The actual number of mental defectives under the care of the State has increased from 16,402 in 1914 to 31,367 on the first of April of this year.

Turner points out that more children are headed for the insane asylum at the present rate of commitment than for college. Birth reports filed by the Illinois State Department of Public Health show that reproduction among the best stock has declined far more rapidly than among the less desirable. The number of children born to mothers of mental defective and retardates is almost twice the number born to mothers of children who are sufficiently intelligent to attend high school and college.

Statistical studies indicate that about 11 per cent of the feebleminded in any generation come from the mating of feebleminded parents while 89 per cent come from the mating of carriers. The latter are people, who though normal themselves, carry over to their offspring the mental defect. This is an illustration with the Mendelian recessive type.

Another phase of the mental health problem is that of maladjustment. Mental illness is frequently functional rather than pathological. Bad training and lack of adjustment to modern conditions can destroy usefulness as completely as biological incapacity. Fully 40 per cent of the crime in this country is committed, according to newspaper reports, by boys under 25 years old. Perhaps three-fourths of these youngsters have sound minds biologically. They are badly trained.

These are disquieting symptoms. They constitute a distinct advancement in public health if they stimulate action in the right direction. The extension of sound eugenics, programs and the employment of psychiatry in our schools are the ways in which to attack the problem. The great store of technical knowledge that makes possible the maintenance of community and individual health at a high favorable level depends upon an intelligence high enough to apply the knowledge.

Technical Advancement

Recent advances in the field of nutrition and food values are voluminous and remarkable. These relate principally to the vitamins. Probably the most far reaching development is the perfection of a method for impregnating milk with vitamin D. This can be done economically and practically in three ways. The fluid milk may be irradiated with ultra-violet rays from a carbon arc lamp, the cows may be irradiated in this way, or yeast may be added to the ration of the dairy herd.

These processes yield a milk that has a high anti-rachitic value. It will prevent rickets in babies and children who have no cod liver oil or other vitamin D concentrate. Even when less than a quart per day is given the children show no more evidence of rickets than do those under the care of competent pediatricians who prescribe cod liver oil or other anti-rachitic preparations.

The cost of irradiating milk by the carbon arc lamp is above 15 cents per 100 gallons under quantity production methods. Thus an economical method capable of almost universal application has been opened up for the control of rickets. Advantage of the opportunity has been seized upon by forward looking dairymen, especially in New England where anti-rachitic milk is a regular market product.

Perhaps the newest trend of thought in the field of nutrition is that a balanced ration of vitamins is required to yield satisfactory results. Thus a concentrate of vitamin A, for example, would not produce the desired results unless the patient has a proportionate volume of vitamin B, vitamin C, etc.

Another refinement of knowledge in this field is a recognition of the fact that humans are born iron-rich and calcium poor. This is a natural condition which has, as Sherman points out, important survival value but it creates a health problem that must be solved by the intelligent use of artificial methods. Poverty of calcium makes the bones of an infant at birth much softer and more pliable than those of an adult. This reduces the hazards of birth to both infant and mother. It also reduces the chances of acquiring sound, durable teeth and sturdy bones. This deficiency must be met by a dietary regimen rich in calcium and phosphorus.

Early this year the Agnews announced that they had succeeded in controlling caries by adding vitamin D and phosphorus to the diet. During recent years Mrs. Mellanly reported that pyorrhea could be produced or prevented at will in puppies by withholding or giving vitamin D in appropriate quantities.

These fragmentary references suggest how rapid have been the advances in the knowledge of nutrition and food values during the last decade or two and indicate the importance which diet is assuming in respect to public health.

Refinement of technique and the adjustment of old ideas to meet new situations has marked the practical advancement in immunology and epidemiology. Knowledge has reached the point where practically all of the gross disadvantages of quarantine can be eliminated under ideal circumstances. With an adequate health service, for instance, it would not be necessary to quarantine at home or prohibit from school the children who have been exposed to measles until the ninth day after exposure. In the face of a scarlet fever outbreak it is a more scientific course to keep open the schools under medical supervision than to close them. The isolation of patients suffering from communicable diseases is now considered a measure that results more in benefit to the patient than in protection of the public.

Under prevailing conditions the carrier is now recognized as a more important source of infection to others than bedfast patients.

Of outstanding importance because of the magnitude of the problem is the refinement of epidemiological methods concerning tuberculosis. The skin test which shows whether or not a person has been infected, together with x-ray pictures of the chest, make possible the almost complete control of this disease. The procedure is based upon the principle that no person can have tuberculosis without being infected with the tubercle bacilli. An individual might slowly starve to death or gradually waste away on stale air and a shortage of sunshine but he would never suffer from tuberculosis unless the germs of that disease get into his body. The source of those germs, moreover, is nearly always a human being. The skin test shows whether or not the tubercle bacilli have gained access to the body.

Children under school age have a narrow range of human contacts. Opportunity of infection is limited to family members, servants, close friends and perhaps nursery school and kindergarten teachers. Thus a positive tuberculin test on a young child indicates a nearby source of infection. Meyers points out that 60 nursery school children were tested under his observation. The test was positive on four children. A search for the source led to the discovery that one of the teachers was tuberculous. Her removal saved the other children from infection. In Massachusetts the source of infection of school children is found to be a member of the family in more than one-half of all cases. Frequently these sources of infection are people who do not know that they are tuberculous. They are all the more dangerous for that reason.

A positive tuberculin test indicates infection only. It does not necessarily mean active disease. Indeed, only about 1 in each 100 children with positive tests is found to be suffering from the disease. Diagnosis in these early and minimal cases can be established only by the x-ray.

This refinement in procedure with respect to tuberculosis must be rated as one of the larger advancements in public health service. It has great potentialities. Tuberculosis still heads the list of fatal communicable diseases with the possible exception of pneumonia.

Methods of scarlet fever control have reached a point of advancement which makes practicable the complete elimination of this disease from institution populations. At least two Illinois schools, that at Mooseheart with an enrollment of some 1,500 and the soldiers' orphans school at Normal with about 700 have succeeded in eradicating scarlet fever. All children are given the Dick susceptibility test. Those who show a positive reaction are given a series of immunizing doses of scarlet fever toxin. A similar course was followed before it closed, a victim of the depression, by the Durant Hospital for Contagious Diseases in respect to candidates for training as nurses. Experience in all three places showed that the test is thoroughly reliable as an index to susceptibility or immunity. In no case did any pupil or nurse who had been vaccinated and thereafter showed a negative Dick test experience an attack of scarlet fever. All three institutions remained practically free from the disease over a period of years although scarlet fever was frequently epidemic in the communities round about.

While it seems impracticable to attempt general vaccination against scarlet fever in the way employed with respect to diphtheria and smallpox, the use of the Dick test might be employed to great advantage especially among school children in the lower grades. The Dick test applied to school children in the fall would show which ones are susceptible. Not more than one-third would fall into this group and they would be mostly in the lower grades. If scarlet fever appeared in the community during the year all efforts at control could be concentrated on the susceptibles. Even in the face of an epidemic the use of the Dick test and the observation of susceptible children is a far more scientific, practicable and economical procedure than closing the schools.

A particularly promising advancement is the development of serum treatment for patients with lobar pneumonia. An experimental demonstration of this procedure has been underway in Massachusetts since 1931. Progress reports indicate that serum treatment, when given to patients suffering from types I and II prior to the fourth day of the disease, reduces mortality to about one-third of that in non-serum treated patients. This trial in Massachusetts is being observed with the greatest interest. Lobar pneumonia of types I and II is the form which the disease most frequently takes among young and middle aged adults. The perfection of the serum treatment method would be of the greatest significance to public health. Pneumonia usually ranks second or third among the leading causes of death in Illinois. Importance of control is therefore manifest.

Very recently Sauer has reported significant success in preventing whooping cough by vaccination. He used a vaccine prepared under his own direction. A fairly large number of vaccinated children who were undoubtedly exposed to repeated infection escaped sickness entirely. While the procedure may be regarded as still experimental it undoubtedly has value and can be utilized by experts to advantage.

Health problems associated with industry have come to the fore very rapidly in recent years. To cope with these medical knowledge has progressed as rapidly as the need has manifested itself and more rapidly than it has been applied. The McCord test for lead poisoning, for example, seems to be a reliable means for controlling that growing hazard. Some people are much more susceptible to lead poisoning than others. More and more manufacturing processes involve an exposure of employes to this risk.

The McCord test indicates by changes in the blood whether or not an individual exposed to the danger is reacting unfavorably to the risk. Blood changes pointing toward disabling illness can be observed long before definite clinical symptoms of poisoning manifest themselves. The McCord test is, therefore, of significant value in controlling lead poisoning among employes.

The medical examination of candidates for employment in various occupations has become routine practice in a number of industries. These include railroads, bus companies, steel corporations, aeronautics and many of the public services such as policemen, firemen, military, etc. This precaution is a service to both the employes, the public and the industry concerned. Individuals of unstable nervous systems and those with disqualifying physical defects are in this way prevented from undertaking functions that might endanger both themselves and others.

A substantial number of industries have created medical departments through which the growing volume of knowledge concerning industrial hazards are applied. On the other hand, there is room for great expansion in this direction. The chief problem concerns small industrial units. In some localities, as in Philadelphia, this situation has been met through the organization of a medical group the cost of which is pro rated among the industries served on the basis of employe population.

In the field of sanitary engineering the methods of sewage disposal have progressed to the point where it is possible to obtain from the outlet of sewage treatment plants clear, sparkling water that is perfectly purified and safe for drinking. Our esthetic sense would doubtless rebel at drinking water obtained from that source but the sanitary quality of the water is unquestioned.

This sketchy outline of the more noticeable developments and trends in the public health field suggest how rapidly knowledge of a practicable character has come to light. Advancement has taken place along the whole broad front. The gains in end results have been solid and durable. This is proved by the fact that health conditions have been maintained at unusually favorable levels throughout the current economic depression. Under the pressure of prevailing financial conditions no scandals of consequence have come to light in health departments.

These are significant observations. The public health movement is built upon solid ground. Its achievements are a monumental tribute to scientific thought. The methods employed in extending its benefits are a beacon to guide activities in other departments of life.

MEDICAL SCIENCE, ITS PAST, PRESENT AND FUTURE*

BY

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In agreeing to speak upon this subject I accepted a large order, but I assure you that I have never entertained serious notions of filling it. In these days when defaults are so common on everything from such trivialities as teachers' salaries to such important things as bankers' dividends, I felt sure that I would not be held strictly to my bargain. What I really propose to do is to touch some of the high points of medical history, recent and remote, germane to my theme, which might perhaps better be stated as "The Road to Medical Progress".

The art of medicine had its beginnings in the earliest dawning of human development, since the practice of medicine is the inevitable consequence of the existence of disease. It is natural that the attempt to practice the art should be as old as man, since disease in general is not a special product of civilization but is an integral part of the picture of life from its earliest beginnings. The earliest man had the problem of illness to beset him, according to evidence from fossil and other relics. Studies of the pathology of the remains of our remote ancestors are largely confined to those aspects of disease which are apparent from changes in the bony framework of the body and the teeth. The fossil remnants of some of our earliest men give clear evidence of the prevalence of disease of various types. For example, the Rhodesian man found at Broken Hill, which seems to be dated as early Pleistocene or late Pliocene, according to Dr. Hooton, shows, among the fifteen teeth which were found, ten with rather characteristic dental caries. The surrounding bone changes gave indication that there were alveolar abscesses. In the femur which was found with this skull there were abnormalities characteristic of rheumatism. And in the skull itself there is also a peculiar perforation about one-fourth inch in diameter in front of the orifice of the left ear indicating a discharging abscess. In this man one sees the same sort of picture of disease that is prevalent today. His tooth decay could scarcely have been due to abuse of cooked and prepared soft foods, for he lived somewhat prior to the era of oatmeal and corn meal mush. He lived on nuts, raw meat, crude cereals and fresh greens, if evidence from other sources does not lead us astray. But he suffered from the same sort of illness that our more pampered civilization finds itself heir to.

When primitive man began to think about the ways of combating disease in himself, his methods were those of the empiricist. He tried one and another of the means that occurred to him in attempting to rid himself of pain and weakness, and to forestall the death which he had seen his fellows suffer under similar circumstances. Whether his first approach to therapy was through an appeal to mysticism and to the supernatural by the medium of the witch doctor, or whether his earliest attempts were by the

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use of herbs and strange concoctions of rare and oftentimes repulsive substances, one can only speculate. This much is certain, that he struggled with this meagre grasp of the facts to find a remedy for his ills whether it was through incantation or medication. What the earliest man lacked was not a desire to be healed or the willingness to use his best reasoning in finding a way to be healed. Rather it was a dearth, or one might say total absence, of knowledge concerning the causes of disease that frustrated him in his attempts at cure.

Furthermore, the methods employed in attempting to solve the problems of disease and its treatment were not promising. The attempt to cure disease without a knowledge of its cause could scarcely be called scientific. Healers became known as fakirs because of the obvious chicanery and fraud which they practiced. The spirit healers and the witch doctors inevitably failed except when the real nature of the complaint of their patient was nervous and could be affected by the emotional state of the individual. So too, after the herb doctor by trial and error found amongst the plants certain ones which had powerful effects upon the animals or men who happened to eat them, he discovered to his sorrow that for the most part his potions were fruitless. The art of healing in the absence of knowledge of the cause of disease was as apt to be productive of results as the search for the needle in the hay stack. In the almost infinite complexity of types of disease and the equally great variety of procedures for their control or cure the likelihood that by random chance successful measures would be happened upon is extremely small.

The science of medicine may be said to have begun when man began to accumulate knowledge concerning the intimate mechanism of disease, and to try to apply that knowledge to the search for ways and means of curing it. There is no date in history that one can set as the beginning of medical science, because it began very gradually. Knowledge applied to medicine did not become important, however, until late in the recorded history of human civilization, and in truth one may say that a really producitve medical science dates only from the Renaissance. The early Egyptian civilization gives definite evidence of an attempt having been made to study human disease by somewhat exact methods. The Greeks made further progress, but not until after the end of the Middle Ages can it be said that any notable applications were made of the knowledge of physiology and pathology to the treatment of disease. This is largely due to the fact that not until the rebirth of learning in recent times has there been widespread use of the experimental method in biological science.

What are the exact methods by which progress has been achieved in the medical sciences in recent times? How has the treatment for thyroid disorders been discovered? How were the methods developed for the control of Addison's disease, diabetes mellitus, diabetes insipidus, pernicious anemia, syphilis, small pox, diphtheria, to mention only a few of the many diseases with which medical science is now able to cope? I should like to be allowed to sketch hastily the methods by which several important discoveries were achieved. A recent discovery about which nearly everyone knows, is that of insulin for the control of the metabolic disorder, diabetes mellitus. Most of you know that Frederick Banting and J. J. R. McLeod were awarded the Nobel prize for the discovery of insulin, but probably few know how it came to be discovered. Banting and McLeod are credited with this achievement, and they were not, to be sure, without great merit for the part they played in it; but they are no more solely responsible for it than it was "the medical corps that won the war". About a half century before Banting, McLeod and their co-workers put the finishing touches on the job, Minkowski and von Mering found that removing the pancreas from animals produced diabetes. The story is told that these experimenters came upon this knowledge by accident. They had removed the pancreas from animals for another reason and noticed by chance that insects were unusually attracted to the urine of these animals, which they found on examination contained great quantities of sugar. For the next forty years workers tried to extract a substance from the pancreas which would control diabetes. Time after time the attempts failed, largely because the pancreas also produces in great quantity the proteolytic enzyme trypsin which is extremely toxic to living matter. Then one day a young pathologist at the University of Minnesota, whose name I feel rather sure you have not heard in this connection, Dr. Barron, found that by ligating the external secretory duct of the pancreas and allowing the animal to recover, all the enzyme secreting cells degenerated and left only the cells in the islets of Langerhans. Since no diabetes resulted it became apparent that these islet cells elaborated the substances necessary for proper carbohydrate metabolism. When Banting began to think about curing diabetes he knew of the discoveries of Minkowski and von Mering, and of Barron. He merely took the next step and with the help of a young graduate student whose name is now a household word, Charles Best, he made extracts of such islet tissue, which they found to their satisfaction were not too toxic to be used, and did control diabetes. But they were not chemists, and the problem of extracting the material, which they called insulin, from the islet tissue, was too intricate a problem for them to master completely. So they called in the biochemist J. B. Collip to complete the trick for them. And what did Professor McLeod do? Aside from accepting a share in the Nobel prize, history will record that he judiciously discouraged his ardent young assistants from expecting results too easily. The real story of insulin is a drama of scientific progress, of human foibles, and a beautiful illustration of the place of step by step progress of knowledge in the arrival at practical fruition of scientific results. Insulin required Minkowski and Mering, it needed Barron, McLeod, Banting, Best and Collip, to contribute their small part each to the sum total of scientific fact that now forms the basis for the treatment of diabetes.

Another important recent advance in applied medical science has been the development of our knowledge of the accessory food substances, or vitamins. The knowledge of vitamins had a romantic beginning, because the first definite evidence that substances important to nutrition were absent in certain diets, thought to be adequate with respect to the known nutritional requirements, came from observations of sailors making long voyages without supplies of fresh food. Some very interesting clinical observations were made on the relation of dietary inadequacies to the occurrence of beriberi in seamen. Beriberi is a disease of the peripheral nerves. Its victims become easily fatigued and depressed, their skin becomes sensitive, there is swelling and edema, and the mortality in the disease is very high. It was the scourge of seafaring men in the early days of ocean sailing and not until a scientific analysis of its cause had been made was its occurrence brought under control. Empirical methods of treatment instituted in the years around 1880 pointed the way for a thoroughgoing investigation of the problem, and today there is no longer any reason why sailors or others living upon highly refined and restricted diets need suffer from beriberi. The classical proof of the role of an accessory food substance or vitamin in this disease was made in 1897 by Eijkman, who was medical officer to a prison in Dutch Java. Beriberi was common in that prison and Eijkman noticed that the poultry which were fed on the garbage of the hospital died with a disease picture very similar to that of his own patients. He was therefore led to investigate this problem thoroughly and fed pigeons some rice in the natural condition, with the husk on the grain, and others on rice from which the husk had been removed, but still retained the outer layer or silverskin, and the embryo or germ. Still others were fed on polished rice from which these latter parts had been removed. He found that all the pigeons fed on polished rice died of polyneuritis or beriberi, while those fed the whole grain or the grain still retaining the outer layer and the germ did not develop the disease. He therefore proved that the absence of the material removed in milling and polishing rice was responsible for the disease. He thought erroneously that it was the silverskin itself which contained the substance which protects against beriberi, whereas, as a matter of fact, we now know that this substance is in reality concentrated in the germ of the seed which he removed with it. His practical deduction, however, was correct, that rice polishings, when fed, protected against beriberi. At the time of his studies two-thirds of the people in the large cities of the East Indies suffered from beriberi. Among prisoners as many as eighty per cent showed symptoms of the disease in institutions where polished rice formed the main article of the diet. The disease has all but disappeared since unmilled rice has been substituted in institutions, and the incidence in the population at large is diminishing rapidly with the dissemination of popular information concerning the cause and cure of the disease.

The antiberiberi substance is now known as vitamin B. More recent work by McCollum and Hopkins showed that the lack of vitamin B causes a retardation of growth and it has been indicated by chemical studies that there are really at least two substances included in what was thought to be vitamin B, the absence of one of which leads to the human disease beriberi, another leads to inadequate growth, while a third may be related to the disease pellagra.

The development of knowledge concerning the vitamins presents a story of the application of the experimental method in biology and medicine which is scarcely excelled in any other instance. Knowledge has been acquired by painstaking observations of apparently inconsequential details. In these times when the scientific method as a whole has been attacked by persons in high places in academic life, it may not be amiss to point out that we would not have any of our important knowledge of the vitamins if scientists had disdained to spend months, and even years, of their lives studying carefully the minute details of the nutritional requirements of common laboratory animals.

The scientist has been accused of being anti-intellectual in that he places his reliance on observations rather than logic. If it is true that placing reliance on observed facts, instead of abstract logic, is anti-intellectual, then I, for one, wish to challenge the significance of the word intellectual. If intellectualism requires blindness to reality in subservience to logic, then certainly intellectualism is a sterile formula. I suspect that those persons who have criticized the experimental method as the sine qua non of progress in science have confused intellectualism with pedantic scholasticism. A further surmise may be permissible that the modern pedantics who rail at the "blizzards of facts" which modern science has contributed to knowledge, find themselves in a "state of bewilderment" because they themselves are incompetent to grasp the true meaning of the observations which experimental science has placed in the hands of humanity.

Nor is it a new complaint for scientists to hear that the experimental method is essentially anti-intellectual. The dark ages were full of such talk, and the rebirth of learning, with its general acceptance of the experimental method, did not in itself endow the entire human race with enough intelligence to be able to appreciate its significance.

The question may be asked as to why the use of the experimental method in biology has been so tardy in coming to fruition. In the biological sciences there are numerous serious difficulties standing in the way of experimentation. In the first place, analytical study requires the use of living animals and frequently requires that changes in their environment and their make-up must be produced in order to permit controlled observations of individual phenomena. In order to experiment on animals effectively, means had to be developed for producing anesthesia. Before the discovery of anesthetics, experimentation on animals was confined largely to those observations which could be performed without inflicting pain. It can truthfully be said that the advent of anesthesia was the greatest single advance ever made in the development of tools for biological research. It should be noted, in passing, that the development of anesthesia, which was itself a result of animal experimentation in pharmacology, was also one of the greatest boons to mankind directly that science has ever accomplished. For us to consider the practice of medicine and surgery today without the use of narcotics and anesthetics is to consider a practice so archaic as to be absurd. The possibility of safe anesthesia is undoubtedly as important to mankind as any other result of modern science.

After speaking at length of the importance of animal experimentation, it seems necessary to consider briefly the problem of the ethics of the use of animals in this way. Living in such a homocentric civilization as we do, it may seem to some that there could be no room for argument concerning the propriety of taking the lives of the lower animals for the furtherance of human welfare. Of course, in the history of mankind there seems never to have been any very strong sentiment against the use of animals for man's purposes. Long before animals were domesticated our savage ancestors employed animals of all sorts for their food, just as we, as a matter of fact, do to large extent today. In other words, man has collectively always felt justified in using the lower animals for his food, as his beasts of burden, and even, one may add, for his enjoyment in hunting, fishing, racing and fighting. It is a strange paradox that in our civiliation, which has never questioned the right of man to slaughter animals for his food and enslave them for his convenience, there should actually grow up a strong sentiment amongst a small minority against the use of animals for the furtherance of knowledge and of health. Surely there can be no logical grounds for denying the right of men to employ animals for the highest good known to man—that is the furtherance of knowledge, particularly in relation to problems of health—when the propriety of almost wanton destruction of animal life in hunting and fishing, to say nothing of the orderly business of slaughtering animals for human food, is accepted as correct. There are, as a matter of fact, many experimental biologists who are perfectly willing that animal life should be sacrificed for the real good of mankind in connection with the provision of food and with the increase in knowledge who are strenuously opposed to the destruction of animals by relatively cruel methods in hunting and fishing. It seems, to the mind of one who believes that scientific research in biology and medicine has been of great value to human welfare, that so long as the thesis that animals may be used for human welfare at all is maintained, there can be no question about the propriety of animal experimentation.

The opponents of animal experimentation attempt to prejudice the issue by referring to it as vivisection. There is a certain emotional reaction aroused by the idea of cutting up live animals that is unwarranted by the actual facts of the case. The serious scientist does not conduct experiments which are apt to produce pain without the use of anesthetics, except when it would be absolutely impossible to obtain valuable information in any other way. In almost all experimental work, whatever cutting of tissues is to be done is carried out under adequate anesthesia. Even if it could be shown that in rare instances a scientist has been known to carry out experiments in an unnecessarily painful manner, either by error or by intention, there is no ground for criticizing all experimental biologists by the same token. It is, undoubtedly, true that occasional instances have occurred where a scientist has not observed all due precaution to avoid pain and suffering. These instances are exceedingly rare, however, in proportion to the number of experiments performed by biologists as a whole; and what one should do is perhaps to criticize the individual scientist for his indiscretion; but to condemn the whole practice of animal experimentation on the basis of occasional abuse is as intelligent as it would be to criticize the whole practice of civil government because an occasional officer of law enforcement is unreasonable in his application of law to specific instances. No sane person denies the necessity and value of an ordered society simply because certain agents of an organized society abuse their privileges and power. Neither should one criticize the practice of animal experimentation in the welfare of humanity simply because an occasional individual has been known to carry on unnecessarily painful experiments. It should be emphasized at this point that instances of such indiscretions on the part of biologists are as a matter of fact exceedingly rare, but it cannot be too strongly insisted that there is no one who regrets their occurrence at all any more fully than do the rank and file of biologists themselves.

The activities of the organized groups opposed to animal experimentation are a menace to the progress of science because they would make it impossible for biologists to do any effective experimental work. One is led to inquire as to the motives that prompt the so-called antivivisectionists in their fight against biological work. The antivivisectionists include three major groups. The first are the antimedical bloc; the second are the professional agitators interested in the movement because it affords them a living; and the third are a group of very well intentioned, but misguided, people who support the movement because it claims to be humanitarian, and they are opposed to anything that could be considered to be inhuman or cruel, as the first two groups have portrayed animal experimentation as being.

The antimedical group are the Christian Scientists, the chiropractors, the osteopaths, naturopaths, and those following the other "paths" that are not quite straight and narrow. They are attempting to embarrass medical science by every means, legal and extra-legal, at their command and are using this as one method of achieving their ends. The sane portion of the population will surely never allow this unbalanced group of people to deprive humanity as a whole of the benefits which are accruing and will undoubtedly still accrue in the future from observations on animals.

The second group of professional agitators comprise the paid officials of the various propaganda organizations against biological research. These persons are supported, some of them rather lavishly, by the first group mentioned, and, unfortunately, also by some of the well meaning people in the third group, to be discussed in a moment. Many of these agitators have admitted that they have no interest other than a commercial one in antivivisection propaganda. These paid propagandizers are the most vicious element in the group. They are the lobbyists who attend every session of the state legislature and even of the National Congress, having bills introduced, pulling wires, and altogether exerting as much influence as they can in a political way, to embarrass legitimate biological research.

The third group amongst the rank and file of antivivisectionists is the large number of well meaning, but misinformed, individuals who are led by those who have an axe to grind. It is of this group that we should be particularly solicitous. They are largely people who have simply never been informed about the real situation. They have listened to an inaccurate or exaggerated account of scientific experiments on animals out of the mouths of the promoters, the quacks, and the mentally unbalanced. What these people need is information concerning the realities of the situation. They should be taken to see experimental laboratories. They should be told of the benefits of animal experimentation to mankind. They should be reassured that animal experimentors in science are probably as solicitous of the welfare of animals as any other group of people in the community. The checking of the growth of the power of the antivivisectionist movement depends upon winning these misled people away from their biased, bigoted, and unscrupulous leaders.

Finally, a word should be said about the possibilities for the future of medical science. It would be futile to attempt to predict exactly what lines of investigation will prove fruitful within any specified period of time. There is only one point that it is really worth while to make concerning the future of medical science, namely, that progress is possible only by the further application of the experimental method to its problems. We shall not achieve new successes in the field of medicine comparable to the discovery of insulin, to the conquest of rabies, to an understanding of the methods of control of smallpox and typhoid fever by arm chair research. We have a vast amount of information in the biological sciences which is, at present, uncorrelated, to be sure, but its correlation does not wait for a master mind to put two and two together. Rather, it waits for the filling in of missing links in the structure of our knowledge. It is incomprehensible to scientists who are working in the field that the discoveries which have already been made and applied for human welfare could have been accomplished in quiet contemplation without the use of the experimental method. To be sure, a well reasoned experimental approach is the secret of practical success in scientific work. No scientist would be so blind as to deny the value of logic in the planning of experiments, but anyone who insists upon the superior importance of *a priori* reasoning over observation is simply entirely blind to the whole history of scientific progress. We can look for a ripening of the fruits of scientific labors only by continuing assiduous cultivation of the experimental method.

In summary, I should like to review the ground that I have tried to cover. I have attempted to show, by what has necessarily been a very meager group of examples, the methods by which achievements have been made in biology and medicine. I must apologize for having drawn all of my examples from the realm of physiology. I have chosen to do so only because of my greater familiarity with that field. Equally important examples could be drawn from the field of bacteriology, from pharmacology, or from anatomy. It has seemed obvious that in all of the instances cited the addition bit by bit of observational knowledge has been the basis of scientific progress. I have tried to show that all of this progress has depended upon the use of animals in experimental work, that the sacrifice of animal life to this end is justifiable for the welfare of humanity. Since, in general, the human race has insisted that its interests are paramount to the interests of any other species of animal life, there seems to be no question but that a sacrifice of animals for the increase of scientific knowledge is entirely justifiable on ethical grounds. Until the population at large becomes vegetarian and forgoes the use of animals for all domestic and commercial uses, the scientist should not be required to justify his use of animals for the welfare of humanity. I have tried to call attention to the menace of the organized vivisectionist movement, and I have pointed out the ulterior motives animating a large share of the people back of this movement. Finally, I have stressed the importance of continued animal experimentation in furthering medical discovery. I hope that I have made clear how intimately the progress of biological knowledge is connected with the employment of the experimental method which is in jeopardy by virtue of the activities of the antivivisectionists. The future of animal experimentation is the future of biological science, and it behooves those who are interested in the latter to foster, encourage and protect the former.

PSYCHIATRY IN THE CRIMINAL COURTS OF COOK COUNTY*

BY

HARRY R. HOFFMAN, M. D.

Director, Behavior Clinic of the Criminal Court of Cook County

Report for the Fiscal Year, 1933

Organization.—The Behavior Clinic of the Criminal Court of Cook County, which came into existence April 1, 1931, is essentially a diagnostic clinic, giving advisory psychiatric service to the Judges of the Criminal Court. The Clinic is disinterested in the legal aspect of the cases referred for examination. Its aim is the intensive study of the individual offender—his mental, physical and emotional make-up—his environment, and the interaction of that individual and that environment. It is hoped that such a scientific study will make for a better understanding of criminals and the forces motivating anti-social behavior and thus help to combat the menace of crime to society.

Scope and Method.—A psychiatric examination may be availed for any offender whom the presiding judge sees fit to have examined. Requests for examinations are made for numerous reasons, the most frequent of which are: 1) to determine the sanity of the individual; 2) to determine his intellectual capacity; 3) to determine his suitability for probation.

Every patient referred to the Behavior Clinic is given several types of examination: 1) a psychological examination by the psychologist to ascertain his mental ability and to determine what can be expected of him in terms of social and industrial adjustment; 2) a comprehensive social history of the patient from relatives, friends, other agencies and individuals who have had contact with him, to learn all the pertinent facts concerning his family background, early life history, later experiences, and a detailed study of his environment in an effort to arrive at a more thorough understanding of the patient in view of his background; 3) a physical examination with special attention to constitutional and neurological defects when such an examination appears necessary; 4) a psychiatric examination by the psychiatrist: (a) to evaluate the personality manifestations of the person; (b) to coordinate all findings and from them make a report to the judge for use in determining the disposition of the case.

Before the hearing copies of the psychiatric examination and conclusions are sent simultaneously to the presiding judge, State's Attorney, and attorney for the defense. After legal disposition of the case copies of the psychiatric, psychological and social service reports are sent to the institution to which the patient is committed or sentenced, or to the Adult Probation Department should he be granted probation.

Referrals.—Since the Clinic's inception 790 cases have been referred for examination, of which 316 were referred during the fiscal year of 1933, an increase of 3 per cent over the number of referrals in 1932. Of these, 302 cases received the routine psychiatric and psychological examinations and

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* Presented before the Twenty-sixth Annual Meeting of the Illinois State Academy of Science, East St. Louis, Illinois, May 5, 1933.

intensive social service investigations; 2 were given physical examinations only upon order of the presiding judge; 10 either refused examination or were discharged before the psychiatrist could see them; 2 have not yet been examined.

Diagnoses.—Sixteen per cent of those examined were found to be actively psychotic and were committed to hospitals for mental diseases. Ten per cent were found to be mentally defective to an extent warranting commitment to an institution for the feebleminded. An additional 6 per cent were mentally defective (borderline), but not sufficiently low for commitment. It happens that heretofore in the majority of these cases our findings of feeblemindedness have had necessarily to be disregarded by the Court because of the danger of escape from a hospital for the feebleminded (such as Dixon or Lincoln), and the offender, if found guilty, sentenced to Pontiac or Joliet. However, since the establishment of an institution for the defective delinquents and the passage of new laws by the State Legislature permitting the commitment of such individuals to the Department of Public Welfare, the defective delinquents, so diagnosed by the Behavior Clinic, are being committed to the Department of Public Welfare at the Joliet Penitentiary and from there are transferred to the proper institution. Our findings obviously expedite matters for the Diagnostic Institute at Joliet, for the psychiatrists there accept our findings without further examination and dispose of the prisoners accordingly.

About 8 per cent of those patients examined were found to be suffering from some mental or nervous disturbance or personality defect (psychopathic personality, drug addiction, neurosis, emotional instability, inebriety, epilepsy, ambulatory automatism), but not sufficiently serious to warrant commitment by the Court to a hospital for mental diseases. In most of the cases treatment has been recommended. The remainder were found to be negative, that is, no evidences of organic or functional nervous or mental disease were ascertained.

Sources of Referral.—The cooperation of the Judges and every division of the Criminal Court has not only continued but increased. Despite the change in the judges sitting in the Criminal Court, orders for examination originating directly from the judges has increased. In 1932 approximately 35 per cent of the cases referred to the Behavior Clinic for examination were requested by the judges themselves. In 1933 approximately 50 per cent were requested by the judges. Most of the judges sitting in the Felony Court have referred cases to the Behavior Clinic for examination, and several of the judges from the Boys' Court. A judge of the South Chicago Court referred a boy for examination who was being held in the County Jail awaiting trial in his court. The Public Defender's office has requested examinations in approximately 16 per cent, and the State's Attorney's office about 5 per cent. The public at large seems to have become more aware of the Clinic's service for 10 per cent of the private counsels for defense have referred cases to us as against 5 per cent of last year. Referrals by members of the patient's family, or friends, has shown a slight increase from 3 per cent of last year to 4 per cent of this year. The jail authorities (the Warden, Assistant Warden, and Jail physician) have referred 6 per cent; other social agencies, including the Bureau of Public Welfare, Criminal Court division, Rural Service and Veterans Service divisions, and the Juvenile Court, about 7 per cent; the Adult Probation Department 2 per cent. In one instance a Federal Probation Officer referred a female drug addict for examination; the Parole Officer of Pontiac Reformatory asked for examinations of two boys on parole whom he had incarcerated in the County Jail for the purpose of examination. (In both instances the boys were found to be psychotic.)

Charges.—Individuals charged with every type of offense from disorderly conduct and vagrancy to incest and murder, have been referred to us for examination. Of the cases referred the largest number were those indicted on sex crimes (32 per cent), including rape (10 per cent of the total number referred), crime vs. children (14 per cent of the total number referred), crime vs. nature, incest, indecent liberties, and contributing to the delinquency of minors. The next largest group were those charged with robbery, (17 per cent), 15 per cent of the cases referred were charged with murder, 13 per cent with burglary, 9 per cent with larceny and 4 per cent with "white collar crimes", such as embezzlement, forgery and confidence game. Among the offenders referred for examination were individuals serving sentence at the County Jail for violation of the Municipal Code on such charges as disorderly conduct, soliciting, vagrancy and non-support. In five instances individuals held in the County Jail for safekeeping while awaiting transportation to Federal prison or other institutions were referred for examination.

Stage of Referral.—Though it was intended that examinations by the Behavior Clinic be made after an individual was convicted of a crime, but not yet sentenced, the majority of the cases (80 per cent) have been referred after indictment, but before conviction; 12 per cent were referred after arrest and before indictment; 3 per cent referred were already serving sentence in the County Jail. The remainder were in the County Jail either on habeas corpus writs, for safekeeping for parole officers, or were prosecuting witnesses.

Additional Services.—The Behavior Clinic performs many services to the Court incidental to its work proper. Sometimes emergency physical examinations have to be made and patients treated. On a few occasions the psychiatrist has had to make home or hospital visits to determine the fitness of an individual to appear in court. Occasionally the psychiatrist is called into court to answer questions involving psychological phenomena.

(1) *Expert Testimony.*—The psychiatrist is called into court to testify regarding a patient's mental condition in cases where a diagnosis of a psychosis (insanity) or feeblemindedness has been made warranting commitment to a State hospital. Thus the Court is saved the expense of paying outside psychiatrists for their testimony, and even more important, eliminates the so-called "battle of alienists", for the findings of the Clinic are, in nearly every case, accepted by the State and the Defense as impartial unbiased conclusions.

In many instances where a patient is found to be suffering from a mental disease he is committed at once to a State hospital upon testimony of the Clinic psychiatrist. Thus, not only are matters expedited, but the County is saved the expense of a trial, the impaneling of a criminal jury, the time of the judge, the prosecution and the defense. And the patient is spared the ordeal of a trial until his sanity is recovered.

The psychiatrist has on several occasions been called by the State's Attorney's office to examine a suspect in a murder case at the time of the inquest, especially where it is anticipated that insanity will be used as a defense. (In the recent Wynekoop case Dr. Hoffman, besides making psychiatric examinations of the chief suspects, Dr. Alice Wynekoop and her son, was present during every interview with all the suspects in the case. During the initial investigation in the State's Attorney's office the psychiatrist was called in to make a psychiatric examination of the Touhy gangsters suspected in a pending kidnapping case).

(2) *Education.*—Frequent informal conferences are held between the psychiatrist and judge or attorney concerning medico-legal problems. It is very encouraging to note the growing interest among the practitioners of

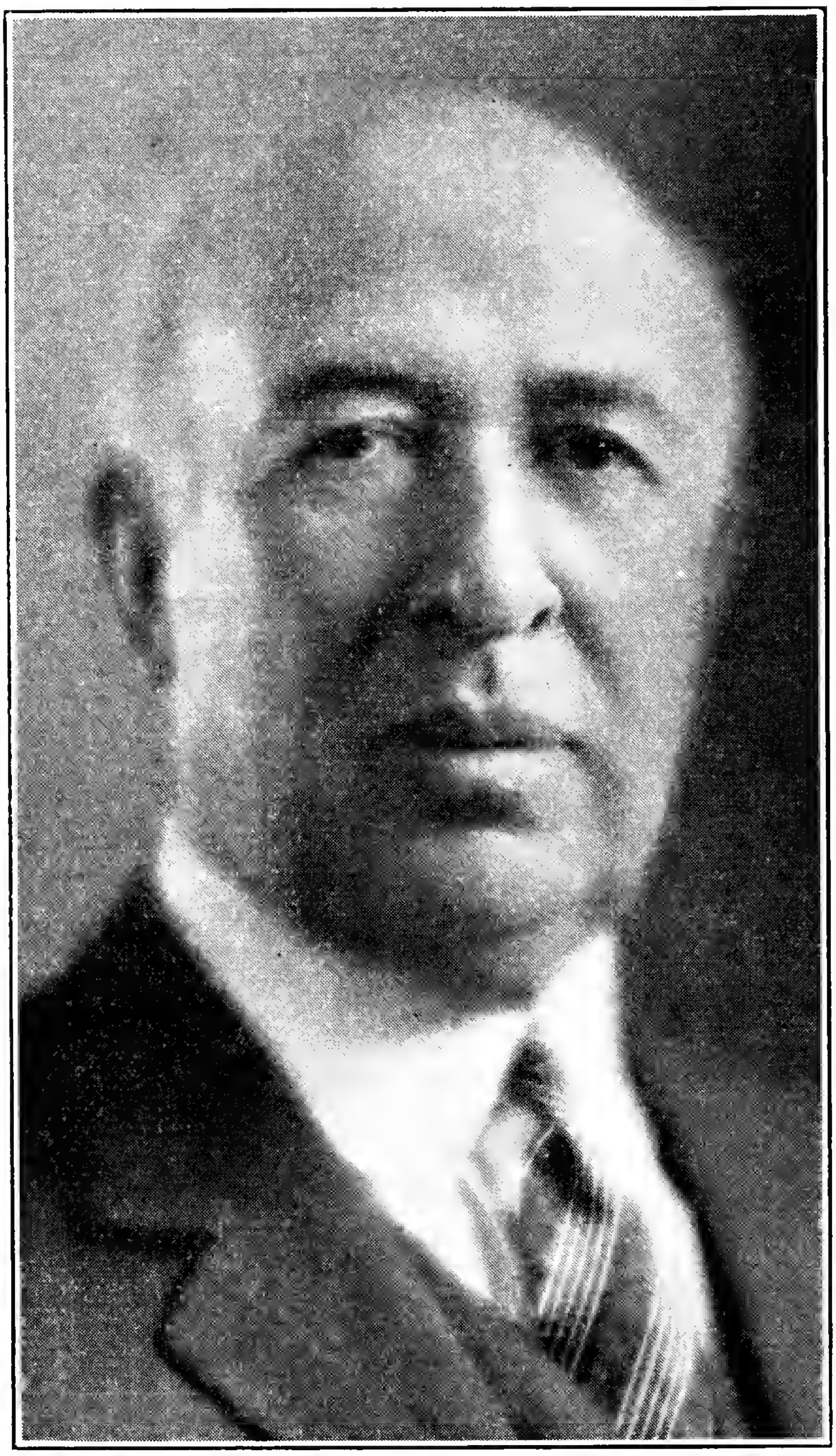
law in the causes of criminal behavior and its treatment, to note the veering away from the old conception of a set punishment for a set offense—a step, we feel, in the right direction.

(3) *Reform.*—Just as after years of discussion in medical, legal and academic circles the Behavior Clinic finally emerged, so too, after much discussion and finally through the concentrated efforts of the Behavior Clinic, an institution for defective delinquents and a radical change in the commitment of that type of offender, have been evolved. Though the need has been long standing, it was not until Dr. Harry R. Hoffman cohesed the general agitation into concrete meetings, committees and potent propaganda, that an amendment to "An Act to better provide for the care and detention of feebleminded persons", was finally passed by the State Legislature. In September, 1933, a theory became an actual reform. By this law defective delinquents are committed directly to the State Department of Public Welfare who in turn, after receiving an intensive psychiatric study at the Diagnostic Depot in Joliet, are classified and committed to the proper institution. In those instances where a patient has been examined by the Behavior Clinic the findings of the Clinic are accepted without further examinations; thus the time and expense of the psychiatric group at the State Penitentiary are saved.

Personnel.—It is intended that all the members of the staff will eventually be placed under Civil Service. Thus far only the supervising psychiatric social worker falls in this category. The psychiatrists were selected by the Chicago Institute of Medicine; the psychologist and medical stenographers were appointed by the Director of the Clinic. The staff as it was originally conceived, consisting of two half time psychiatrists, a full time psychologist, a resident physician, two psychiatric social workers and stenographic service, was barely adequate. With the depleted budget, effective since March, 1932, which eliminated entirely the services of the resident physician and one social worker, and cut the psychologist's services to half time, the Clinic has been working under a handicap, despite which the case load has increased and the service widened, especially since the Courts have become acutely aware of its existence and dependent on its services.

The Behavior Clinic has now been in existence for 32 months. We feel that it has well justified its establishment not only for its work as an advisory psychiatric service to the Courts, nor as an economy measure effecting a savings to the County, but more important, for its inculcation into the spirit of the law and the philosophy of those practicing it, the conception of the offender as a mentally sick individual in need of study and treatment rather than a pariah to be punished according to the heinousness of his offense.

MEMOIRS



Ulysses Sherman Grant

ULYSSES SHERMAN GRANT

1867–1932

Ulysses Sherman Grant, one of the founders of the Illinois State Academy of Science, died in Evanston, Illinois, September 21, 1932. He was then Professor and Head of the Department of Geology and Geography of Northwestern University, a position he had accepted in 1899. He was Vice-President of the State Academy of Science during 1914–1915, and its President in 1915–1916. He was the temporary chairman of the group that founded the Academy in 1907, invariably attended its sessions, and participated in its business and programs with constant energy and interest. In like manner he maintained an active membership in the Chicago Geographic Society, was its First Vice-President for a term of years, and was a member of its Board of Directors at the time of his death.

Professor Grant was born in Moline, Illinois, February 14, 1867. During his undergraduate years at the University of Minnesota he developed an interest in the field of zoology, and in this he held a fellowship there after his graduation in 1888. During later post-graduate work at Johns Hopkins University, however, he transferred his major interest to geology. Attaining his doctorate in 1893, he returned to Minnesota to serve as Assistant State Geologist from 1893 to 1899. During that time he taught in the University of Minnesota for one year. After coming to Northwestern University he was actively associated with the Wisconsin Geological Survey, the United States Geological Survey, the Illinois Geological Survey, and the Oregon Bureau of Mines and Geology. From 1897 to 1904 he was one of the editors of the American Geologist.

Professor Grant's contributions to geological science have ranged over a wide field, but first in his interests was the study of the crystalline rocks. Some of his field studies were made along the International Boundary and in the region lying north of the west end of Lake Superior. It is noteworthy that this same area later became the scene of some of his most effective teaching of field geology. During this early period of creative labor between fifteen and twenty reports appeared in the publications of the Minnesota Geological Survey, the culmination of his studies in this field appearing in Volumes IV and V of the final reports of that Survey.

In 1900, and in closely following years, his studies were directed in part to ore bodies, particularly the lead and zinc ores of southwestern Wisconsin. His mapping of the ore bodies and the accompanying reports are embodied in the Bulletins of the Wisconsin Geological Survey, and in the Lancaster-Mineral Point Folio of the United States Geological Survey. For the latter Survey he was detailed to make an investigation of the ores and crystalline rocks of the vicinity of Prince William Sound and the Kenai Peninsula in Alaska. He visited these regions during three summers and three Bulletins of the United States Geological Survey incorporate the results of his studies.

At Northwestern University Professor Grant's large intellectual caliber and broad sympathies brought him into close relationships both with his colleagues and with students. He served the University on many advisory and administrative committees. On two occasions, one of them during the World War, he was drafted to act as Dean of the College of Liberal Arts. His interest in his students did not terminate with the completion of their classroom work but followed them into later life. None recognizes more keenly than they the value of his competence in teaching and the worth of his friendship.

John Paul Goode

JOHN PAUL GOODE

1862–1932

John Paul Goode died on August fifth, 1932, at his summer home at Little Point Sable, Michigan. His brief illness came shortly after the publication of the revised edition of his School Atlas, and his last days were enlivened by letters of congratulation. He remained to the end the happy, enthusiastic personality known to hosts of students and friends.

Professor Goode was born on a farm near Stewartville, Minnesota, November 21, 1862. He graduated from the University of Minnesota in 1889 and accepted a position at the newly-opened normal school at Moorehead where he remained for nine years, doing graduate work at Harvard in 1894 and at the University of Chicago in 1896–97. In 1898 he went to the State Teachers College at Charleston, Illinois, and two years later to the University of Pennsylvania where he received his Ph. D. in geography in 1901 and remained two years as instructor.

In 1903 the University of Chicago established a department of geography under the headship of Rollin D. Salisbury who promptly invited Dr. Goode to an assistant professorship. The presence of these two brilliant scholars and teachers soon attracted a following of both undergraduate and graduate students, and the department grew rapidly. Dr. Goode was advanced to an associate professorship in 1910 and to a professorship in 1917.

Dr. Goode's activities extended far beyond the classroom. He was one of the founders of the Geographic Society of Chicago, served as president for two years and as a director for more than two decades. He was co-editor of the Journal of Geography from 1901 to 1904. In 1908 he made a study of the principal European ports for the Chicago Harbor Commission. In 1909 he was appointed one of the government escorts to the Honorable Commissioners of Japan in their transcontinental tour. Two years later he lectured for the Philippine Government at the Baguio Assembly.

In his later years Dr. Goode gave increasing attention to research and writing. He brought out a set of desk maps and a significant series of physical and political wall maps of the world and of each continent. For years he wrestled with the baffling problem of a map projection of the world on an equal-area basis. He advanced the solution in 1916 with his interrupted homolographic projection and solved the problem in 1923 with his interrupted homolosine projection. These projections represent a basic advance in cartography. In the brief interval since their appearance, they or projections based on them have been used in technical publications of several governments and by practically all important map-making institutions of the world. The climax of Dr. Goode's work is represented in his School Atlas, first published in 1923 and recently revised and enlarged. In it he combined the long experience of a mature geographer with the technical ability of a master cartographer. As a result the Atlas has both scientific and educational distinction.

Professor Goode received many and varied recognitions of his work. His outstanding ability on the lecture platform brought him invitations to speak before Chambers of Commerce, geographic societies, state educational associations, and many other organizations. He served a term as general secretary for the American Association for the Advancement of Science. In 1923 the Geographic Society of Chicago awarded him its Helen Culver Gold Medal for "distinguished achievement in cartography." He was a charter member of the Association of American Geographers, serving as vice-president in 1916 and as president in 1926.

Many students and scientists are indebted to Dr. Goode. He truly was a pioneer in geography, a leader in cartography, and a stimulating influence to his fellow men.

Charles C. Colby

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OF THE

ILLINOIS STATE ACADEMY OF SCIENCE

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Extract From the Report of the Section Chairman

The program of the Agriculture Section was devoted to a symposium of six papers on the general subject, "Problems of the Soybean Industry."

The paper by Otto Eisenschiml, Scientific Oil Compounding Company, Chicago, entitled "The Use of Soybeans in Industry," was not presented for publication.

Average attendance at the meeting was seventeen, maximum was twenty-five.

The acting chairman was reelected for 1933-34.

(Signed) H. W. Mumford, *Chairman*

HISTORY OF SOYBEAN DEVELOPMENT IN THE UNITED STATES

BY

C. H. OATHOUT

Western Illinois State Teachers College, Macomb, Illinois

ABSTRACT

The soybean has been known in most of the countries of the Orient since prehistoric times. Over fifty different names have been listed by Piper and Morse, United States Department of Agriculture, thus showing its great antiquity. It is said to have been mentioned by the Chinese Emperor Chen Nung in the ancient Materia Medica in the year 2838 B. C. It is also described in several ancient Chinese dictionaries under different names, one of which was *sou* from which, these authors suggest, our recent names *soi, soy, soja* and *soya* are probably derived. DeCandolle says it is doubtless the plant called *shu* in the Chinese writings of the time of Confucious; that the species was wild in Cochin-China to the south of Java when the ancient people of this region began to cultivate it at a very early period.

A good deal of confusion seems to have prevailed for many years concerning the correct botanical name. However, after much study of the subject Piper and Morse concluded that the correct name must be *Soja max.*

The soybean found its way into Europe near the close of the eighteenth century, its culture having been recorded in England in 1790. It was introduced into the state of Pennsylvania in the United States in 1804, but for many years received only occasional notice. Morse, in Farmers' Bulletin 1520, states that since 1890 nearly all of the state experiment stations in the United States have conducted experiments with it.

It has been only during the last twenty to twenty-five years that the farmers of the United States have given attention to the crop, though a report read by W. H. Stoddard of Macoupin County, Illinois, at a farmers' institute in 1898 shows that the farmers of that community had a good deal of practical knowledge concerning it. No figures showing the acreage produced in the United States are given until the year 1917 when 460,000 acres were reported from seventeen states. In 1924 there were 2,500,000 acres grown of which 613,000 acres were harvested for seed. In 1930 the acreage grown for seed was 1,105,000 of which 843,000 acres were grown in seven states. Illinois led with 321,000 acres, followed in order by North Carolina, Missouri, Iowa, Ohio, Tennessee, and Oklahoma.

Probably the most important by-product of the soybean is oil which is used in the manufacture of paint, varnish, linoleum, oilcloth, artificial leather, etc. In the year 1922-23 9,528,000 pounds of soybeans were used in producing 1,482,000 pounds of oil. By 1929-30 this had increased to 95,676,000 pounds of beans producing 12,482,000 pounds of oil.

Experiment stations in the United States have done much in improving varieties. This is notably true in Illinois, where, under the direction of Dr. C. M. Woodworth, the Illini, an early variety of great merit has been developed.

SOYBEAN PRODUCTION IN ILLINOIS

BY

W. L. Burlison

University of Illinois, Urbana, Illinois

ABSTRACT

Six hundred and seventeen thousand acres of soybeans were produced in Illinois in 1932 with a crop that amounted to over 6 million bushels. Because of the potential importance of the soybean in Illinois, the Illinois Agricultural Experiment Station has conducted through more than a quarter of a century investigations on the production and utilization of this crop. The present paper is intended as only a very brief resumé of certain phases of our studies.

Varieties.—Definite studies on soybeans in Illinois were first made by the Illinois Agricultural Experiment Station in 1897. From that day to this, literally scores of varieties and types have been under observation and trial. Superior varieties have been discovered from time to time which, naturally, have largely supplanted those of earlier domination. For example, varieties of outstanding promise recommended in 1923 were Manchu and Virginia, and in 1932 were Illini, Dunfield, and Mansoy.

It is interesting to note the range in yield of the varieties. They vary upward from 16 bushels per acre to approximately 35 bushels. Yield has always been considered an important factor in choice of variety, but present-day industrial requirements have shifted emphasis to quality as well as yield.

A selection by the method of plant breeding made by Doctor C. M. Woodworth of the Department of Agronomy here at this Station, called the Illini, was distributed in 1928 and has averaged 40 bushels per acre for a period of ten years. About half of the beans now grown in Illinois for commercial purposes are of this new variety.

Date of Seeding.—Experiments carried on for the past six years have brought out the fact that date of seeding soybeans is an important matter in production, especially when quality is considered. Varieties have been seeded at ten-day intervals from May 1 through and including June 20, and the results show that there is practically no difference in the yield of the first three seedings; namely, May 1, May 10 and May 20, but from the June 1 planting yields declined until the last seeding June 20.

Rate of Seeding.—Five years' results on the effect of rate of seeding on yield have changed opinion in regard to this matter. Years ago, when seeded in rows, it was thought that 30 pounds an acre were quite sufficient. Now a larger amount (50 to 70 pounds) is commonly used. In seeding beans "solid," as in the case of planting with the 8-inch grain drill, a higher rate of seeding is required than where the beans are seeded in 24-inch rows. The yields, however, from the solid seedings were distinctly lower than the yields for the 24-inch rows. The labor item and available equipment are of considerable importance in determining this practice.

Longevity and Storage.—The matter of storage and longevity, as it affects yields are, of course, closely related. Studies on longevity of seed of five varieties stored under favorable conditions show that there is a steady loss in the yield of beans when stored for a period of from one to five years. Rapid deterioration in the germination for the first year is not necessarily true. After a two-year period, however, there was a distinct loss in germination and yield although varieties differ materially in the length of time they remain viable and in the ability to produce vigorous plants when seeded.

THE USE OF SOYBEANS AS HUMAN FOOD

BY

EVERETT E. ROQUEMORE

Allied Mills, Inc., Chicago, Illinois

ABSTRACT

Although the soybean has been referred to as the meat and milk of the Orient, the average American knows little if anything regarding the value of products of this plant in the human diet. The possibilities in the use of the soybean as a food for humans as well as for livestock should be of great interest to the thousands of farmers who have become interested in producing this crop, but who now are directly confronted with the problem of widening the market outlet for the soybean.

History tells us that soybeans have constituted the principal source of protein in the Chinese diet for more than 100 generations. Scientists in different countries, particularly Italy, Germany, England, and France as well as our own country, have been interested in investigating the soybean for human nutrition and the facts regarding the value of the soybean as a source of food supply are gradually gaining recognition.

The medical profession has recognized the soybean as a valuable food for diabetics on account of its freedom from starch. It also carries an unusual amount of those peculiar nitrogenous compounds, designated collectively as "protein", which play such an essential role in the nutritive processes.

In the Orient where the soybean to a large degree takes the place of milk in the diet, a cheese-like material is prepared by a well known process and extensively used.

The chemical composition of the soybean as compared with that of our ordinary grain products is extremely peculiar. Not only does it analyze as high as 35 to 40 per cent of protein but it also carries 17 or more per cent of oil, besides 5 or 6 per cent of minerals. Moreover, it is found to be very rich in vitamins, so that altogether the soybean represents the most concentrated, natural, common foodstuff available.

A soybean flour is now coming into use. It is prepared by dehulling the beans, extracting the surplus oil, and bolting the pressed cake into a fine flour. This product has a pleasing nut-like flavor. The flour is used in making breads, cakes, pastries, ice cream and other food materials.

A substance of special value extracted from soybeans is lecithin, formerly prepared largely from yolks of eggs. Lecithin is a phosphorus compound useful in building up nerve tissues.

Soy sauce is another oriental preparation that is now being made in this country under sanitary regulations.

Soybean sprouts are prepared by soaking the beans for a period in water in a warm place and permitting them to sprout through a period of four to six days. The sprouts are then kept in a cool place until served as salad, in stews, and in other ways.

The Chinese prepare soybean milk by grinding with water between millstones, filtering through cheesecloth, and boiling. This material will coagulate, forming a curd which resembles cheese.

When used as a binder for meats in the making of sausages and meat loaves, Soya Flour improves the flavor and appearance of products in which it is blended without increasing cost.

Soybean oil, properly refined, makes an excellent table oil.

Thus with all these various products for human consumption it would seem that the extension of the utilization of the soybean can well be encouraged, thus creating a wider market outlet for this valuable farm crop.

THE FEEDING OF SOYBEANS TO LIVESTOCK

BY

C. W. HUDELSON

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ABSTRACT

The soybean is a native of southeastern Asia and has been grown in China, India, and Japan for more than 5000 years. It is the most important legume of those countries. Although the soybean was first introduced in this country in 1804 it is only within the last three decades that it has found an important place in American agriculture.

Summarizing, types of soybean feeds are as follows:

Soybean Pasture.—Soybeans as a pasture crop are not comparable to other legumes, rape, peas and oats or the grasses. The most satisfactory use as a pasture crop is for utilization when the crop is nearly mature and the beans are starting to harden.

Soybean Silage.—Soybeans can be made into silage successfully if allowed to dry in the field until the moisture content is reduced to 60 per cent. A more successful method is to mix alternate loads of soybeans and corn. Legumes, at best, however, do not make as satisfactory silage as corn.

Soybean Hay.—Soybean hay is about equal to alfalfa in feeding value and is ready to harvest the same season it is planted. A good grade of hay can be made from it at almost any time in its growth, but as the best hay comes from a small stemmed leafy plant, soybeans can best be cut not later than when the pods are small.

Soybean Straw.—Soybean straw in analysis seems to be only slightly lower in feeding value than timothy hay, containing five pounds less digestible nutrients per hundred pounds of feed. The nutritive ratio of the two feeds is about the same. Timothy hay is finer, of course, and usually will be eaten up cleaner.

Whole Soybeans.—Soybean grain contains about 36 per cent protein, 5 per cent ash and 17 per cent oil. The beans are not palatable to pigs and their protein and ash do not supplement the common farm grains well. If the beans are fed in sufficient amounts to balance a ration of corn for fattening hogs (about 20 per cent), the oil of the beans causes a soft pork.

Ground Soybeans.—Ground soybeans have been found slightly superior to cottonseed meal for milk production. In one instance where soybeans formed one-half the concentrate mixture for dairy cows, a soft unsatisfactory butter was produced. A smaller proportion should produce satisfactory results.

Soybean Oil Meal and Soybean Oil Cake.—Soybean meal is greatly esteemed by western dairymen and is an excellent protein-rich feed for swine. Soybean oil meal cake is fully equal to high grade linseed meal as a protein-rich concentrate.

Conclusions.—Soybeans furnish home grown protein feed which is an urgent need on every livestock farm. They yield well, therefore they are an economical feed.

Of the several forms in which a part or the whole plant may be offered the most popular and generally used are the hay and the oil meal. The classes of livestock that make the best returns on certain types of soybean feeds are: Dairy cattle, beef cattle, and fattening hogs on oil meal and cattle and horses on hay. The one main caution to observe is to take proper steps to avoid production of soft pork.

ECONOMIC BASES FOR PRESENT AND FUTURE PRODUCTION OF SOYBEANS IN ILLINOIS

BY

R. C. Ross

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ABSTRACT

The farmer's decision on soybean acreage focuses upon two economic considerations—relative profitableness, and the place of the crop in the farming system. During recent years improvement in varieties, cultural practices and harvesting methods have markedly increased yields, and the building up of a marketing organization has put the crop on a commercial basis.

The acreage of soybeans grown in Illinois has increased from 1,000 in 1914 to a peak of 771,000 in 1931. While some soybeans are now grown in all parts of the State, approximately 85 per cent of the acreage is located in a belt running east and west across the State, 175 miles in width from north to south. In the northern three-fifths of this belt, the part lying north of the Shelbyville Moraine, the acreage devoted to seed or grain production exceeds that used for hay, while the reverse situation is true in that part of the belt lying south of this line. Economically, the method of utilization is significant, since it marks the difference between use on the farm where grown and disposal through commercial outlets. As a grain crop, soybeans compete with other grain crops; as hay, with other hay crops. Relative profitableness of soybeans with other grain crops is shown by comparing the amounts of income above operating costs and taxes for various periods (Table 1).

Table I

Average Incomes per Acre Above Operating Costs and Taxes for Various Crops and Designated Periods Champaign and Piatt Counties[1] [3]

	10-year average 1923-1932	5-year average 1928-1932	3-year average 1930-1932	1-year 1932
Corn	$11.27	$7.95	$2.16	$—3.00
Winter wheat	9.52	6.75[2]	2.25	3.45
Soybeans (threshed)	6.83	5.49	— .18	.71
Soybeans (combined)	-------------	9.03	2.70	4.86
Soybeans (hay)	-------------	5.70	2.97	—1.72
Oats	4.43	3.33	1.26	.15

[1] Unpublished data and annual mimeographed reports, Department of Agricultural Economics, University of Illinois.

[2] Four-year average, 1929-1932. No records for 1928 due to winter killing.

[3] Incomes based on average market values for month of harvest.

Under recent price relationships, soybeans have an evident advantage which, however, is less obvious in the longer periods during which more normal price relationships prevailed. These figures also show one reason for the shift from binder and thresher to the combine in harvesting soybeans.

During short periods when economic conditions force every possible economy it is likely that the difference between direct cash outlay and cash returns becomes the immediate criterion for crop adjustments. Cash outlays

in growing corn, wheat, oats, and soybeans differ but little, hence the tendency is to favor the crop with the largest cash income. For the three-year period 1930-1932, cash incomes in Champaign-Piatt counties were corn, $14.13; wheat, $12.72; soybeans—threshed, $12.58, combined $13.37; and oats, $7.93. From the standpoint of profitableness, soybeans are bidding strongly for second place among grain crops.

In the farm organization, soybeans are widely adaptable. Their place as a direct income-producing crop has been shown; as an emergency crop they may replace winter-killed wheat as grain, or clover failure as hay. As a hay crop the operating costs are relatively high, yet with good yields, ton costs are not excessive. The present tendency to use home grown feeds and to defer liming programs favors expansion of hay production to meet farm needs. Commercial outlets for soybean hay have been but little developed.

Even in the heaviest producing areas of Illinois the ratio of soybean acreage to other crops suggests the possibility of much further expansion through replacement of lower profit crops. The much wider extension of the present commercial areas not only in Illinois but in other important producing areas indicates the possibilities of increasing the supply if prices warrant.

As yet, the demand is predominantly on the farms where grown. For the entire country, of the 1929 and 1930 crops, 56 per cent was cut for hay, 15 per cent grazed, and 29 per cent harvested for beans. Development of feed uses depends largely upon numbers of animals and feeding methods. Harvested beans have several outlets—crushing, seed, feed, export, and human food. While all of these may be expected to provide for expansion, the greatest possibilities doubtless lie in the broad and varied field of industrial utilization. The economic problem of determining the extent to which the potential physical production will be carried is that of developing commercial uses in sufficient variety and volume and an adequate marketing mechanism in order to return to the grower remunerative prices for the beans produced for market.

Papers In Anthropology

Extract From the Report of the Section Chairman

Six papers were presented before the meeting of the Anthropology Section. The following were not presented for publication:

"Pictorial Survey of Archeology in the Mound Area," by Thorn Deuel, University of Chicago, Chicago, Illinois.

"An Archeological Survey of Cahokia Creek East of Collinsville Bluffs," by W. H. Hunter, University of Illinois, Urbana, Illinois.

"Projected Research in the Archeology of the Ohio-Mississippi Confluence in Southern Illinois," by Bruce Merwin, Southern Illinois State Normal University, Carbondale, Illinois.

Attendance averaged twenty at the Friday afternoon meeting. Approximately seventy persons attended the field trip to Cahokia Saturday morning.

Mr. Thorn Deuel, University of Chicago, was elected chairman of the section for 1933-34.

(Signed) A. R. Kelly, *Chairman*

SUGGESTIONS FOR THE QUANTIFICATION OF POTTERY STUDIES IN THE LABORATORY

BY

FREDERICK R. MATSON, JR.

University of Illinois, Urbana, Illinois

As it is felt that objective descriptions would prove of value in describing the pottery of a district and would aid in the comparative study of pottery, the following suggestions are offered:

Body Composition.—The study of a thin section or a powder of a representative sherd with the aid of a petrographic microscope would not only indicate the physical composition of the body which, with most primitive pottery, approximates that of the unfired ware, but would also aid, together with the study of State Geological Survey bulletins, in the identification of the clay beds used. With this information it could be determined whether or not the non-plastic tempering material occurred naturally in the clay. The nature of the non-plastic material, the percentage present in the body, and the range of grain size might be determined either by means of the thin section or by an X-ray photograph of the sherd.

Texture.—The determination of the porosity of a ware would furnish a means of describing its texture, the coarsèr ware having the higher porosity. In reporting the surface texture of the sherds, a hard needle might be drawn over the surface under controlled conditions with its vertical motion amplified and recorded, the resulting curve then being mathematically analyzed.

Hardness.—Among the methods for determining hardness are scratching, grinding, boring, and pressure and impact tests. For pottery studies, Moh's scale of hardness which is used by mineralogists seems to be quite satisfactory. Where necessary, some intermediate minerals can be added to this scale to further limit it. As the "skin effect" of the surface of the pottery may greatly influence the hardness, the tests should be made on undamaged surfaces of sherds. The hardness of the sherd will give some indication as to the temperature to which the clay was fired.

Color.—There are many methods which might be used to define color or color variation in a sherd series, such as Munsell's color sphere with its three variables—hue, value, and chroma; a book of standard color shades; a color top; or a recording photo-electric analyzer which will automatically plot a color curve in less than a minute showing the amount of each wave length of light reflected from a surface when illuminated from a standard source. Although the analyzer would be the most accurate, the book of colors would probably be the most practical to use in studying sherds. A series of sherds selected from those found at a site might be used to illustrate the color variations in the pottery of that place, and to determine the percentages of the different colors found.

Density.—A statement as to the bulk density of the sherds would be a useful addition to a report.

If a series of objective standards were adopted by archaeological laboratories studying primitive pottery, the resulting uniformity of reports would greatly aid workers in this field.

A CLASSIFICATION OF CAHOKIA PROJECTILE POINTS

BY

P. F. TITTERINGTON

St. Louis, Missouri

ABSTRACT

The material here classified is from the surface of the camp sites which are located between the mounds. It represents the combined collections of three men over periods of twenty, fifteen, and twelve years respectively, and material secured from local farmers.

The 2523 arrowheads that can be classified range from ⅝ to 2⅜ inches in length; 1020 (40.4 per cent) are triangular and 1503 (59.6 per cent) are notched. Of the 1020 triangular points, 672 (65.8 per cent) have slightly convex sides, 252 (24.7 per cent) have straight sides, and 96 (9.5 per cent) have slightly concave sides; 958 (93.9 per cent) have straight and 62 (6 per cent) have concave bases.

Of the 1503 notched points, 1284 (85.4 per cent) are side notched and 219 (14.5 per cent) are corner notched; 1217 (94.7 per cent) have straight and 67 (5.2 per cent) have concave bases. In the side-notched points the head is rather wide. The group of corner-notched points includes all that do not have wide heads. Some of these should doubtless be classed as side-notched but since the heads are not rectangular, they are not included in the predominating group.

Of the total number of arrowheads, 211 (8.3 per cent) have a notch at the center of the base; 208 are side-notched. They are worthy of special note on account of the materials and workmanship. Fifty-one are translucent, a few being made of highly colored almost transparent agate, and the chipping is of the finest, the arrowheads being thin, well made and regular, most of them completely chipped on both sides. Only a few are made from flakes.

Most of the base-notched points (177) have one pair of side notches and are known locally as three-notched points. A few have more than one pair of notches. In the multiple-notched points the primary pair of notches is considerably deeper than the more shallow secondary pair or pairs. There are seventeen five-notched points with one pair of primary and one pair of secondary notches; five seven-notched points with one pair of primary and two pairs of secondary notches; two nine-notched points with one pair of primary and three pairs of secondary notches; and seven points so closely notched that they are classed are serrated.

Twenty-one points which have no base notch have one pair of primary and one pair of secondary notches (four-notched); four have one pair of primary and two pairs of secondary notches (six-notched). In all multiple-notched points, the secondary notches may be above, below, or above and below the primary notches.

Fifty-five of the triangular and twenty-five of the notched points (3.1 per cent of the total) are serrated. Ten points have a highly polished strip down the center of one side. This polish is the same as that seen on bits of agricultural implements and suggests that they might have been made from chips from these implements.

The number of arrowheads is being increased each year. The collection is open for study and it is hoped that some time an archeologist will make a more scientific classification.

ON THE INVESTIGATION OF THE SECOND POWELL MOUND

BY

R. H. BRAY

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ABSTRACT

This report discusses briefly an attempt to apply soil chemistry to the study of the mound structure of the second Powell Mound. The work was done in cooperation with Doctor Kelley of the University of Illinois.

The main feature of this mound was a dark-colored, fine silty clay soil material making up the bulk of the mound which rested on a natural sand base. This was covered by a shallow sandy material, not included in the investigation because of its disturbed condition. The soil material has been undisturbed since it was laid down, except in the dyke formations found cutting through the mound. Vertical samples from the top to the base of the undisturbed soil material were taken for study. A slight columnar structure had developed in the upper part of the soil material.

The replaceable base content of the whole profile varied from 20 milliequivalents per hundred grams of soil in the surface to 22 in the soil just above the sand floor. The pH for the whole profile was around 7.0. This shows no leaching profile but is evidence for the original uniformity of the whole soil material. This uniformity makes possible the interpretation of the organic-matter study.

The organic nitrogen content showed a variation with depth from 0.086 per cent nitrogen in the top of the soil material to 0.113 per cent in the bottom of the soil material. The organic carbon varied similarly.

This is the reverse of a regular soil profile and is chemical evidence that the mound was built up by man and has since weathered to form the organic-matter curve found. This organic-matter curve is a result of many factors, among which time is of greatest importance. Although no definite length of time can be associated with this one curve, there is a possibility that relative age can be established on mounds built of fairly uniform material by comparing the nature of the curves obtained. The careful vertical sampling of mound material as a regular part of mound study is recommended.

The question as to whether the dyke formations were recent or not has been raised. If recent, the organic matter curve for a vertical sampling of the dyke material would be erratic. If they were cut through the mound shortly after the mound was built this curve would follow the curve of the undisturbed portion of the mound. Unfortunately no dyke samples were taken.

This emphasizes the importance of taking vertical samples from all structural features within the mound.

PAPERS IN BOTANY

EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN

Twenty-two papers comprised the program of the Botany Section. A number were withdrawn from publication, some being of such a nature that they did not lend themselves readily to abstracting and others requiring illustrations. They are as follows:

"Additions to Flora Peoriana," by V. H. Chase, Peoria Heights, Illinois.

"Rust Observations in the Illinois Winter Wheat Areas in 1932," by Kenneth Wright, Bloomington, Illinois.

"A Comparison of the Size Range and External Characteristics of the Spores of Modern and Fossil Lycopods," by Orrin J. Henbest, University of Illinois, Urbana, Illinois.

"Pollen Analysis of Some Water-deposited Sediments," by P. K. Houdek, Robinson, Illinois.

"*Primula mistassinica* in Illinois and the United States," "Unique Plant Distribution," and "Apple River Canyons," by H. S. Pepoon, State Natural History Survey, Urbana, Illinois.

"The Skunk Cabbage in Winter," by Jesse L. Smith, Highland Park, Illinois.

"Forest Distribution in Crawford County," and "Tree List for Crawford County," by S. Ray Bradley, Robinson, Illinois.

"False Indigos of the Mississippi Valley," by J. M. Greenman, Missouri Botanical Garden, St. Louis, Missouri.

"Three Fungal Species Parasitic Upon Algae," by Myrtle M. Burk, University of Illinois, Urbana, Illinois.

"Development of Zinnia under Soil Moisture Control," by Charlotte L. Grant, University of Illinois, Urbana, Illinois.

Average attendance at the meeting was forty, maximum was sixty.

Mr. E. L. Stover was elected chairman for 1933-34.

(Signed) H. S. PEPOON, *Chairman*

RESISTANCE OF FUNGOUS SPORES TO LOW TEMPERATURES

BY

CONST. J. ALEXOPOULOS AND J. DRUMMOND

University of Illinois, Urbana, Illinois

The study of the effects of very low temperatures on lower plants has been mainly limited to bacteria and yeasts. In 1902, Macfayden and Rowland (*1*) exposed some yeast cells and several types of bacteria to liquid hydrogen temperatures (about -252° C.) for a period of six months. In no case was the vitality or the physiological properties of the micro-organisms impaired by such treatment. Tanner and Williamson (*3*) and Tanner and Wallace (*2*) cite other experiments in which the resistance of bacteria and yeasts to low temperatures was shown. Experiments by Tanner and Wallace (*2*) with *Clostridium botulinum* indicated that spores of this organism are able to withstand freezing at -16° C. for a period of fourteen months. On the other hand, Tanner and Williamson (*3*) have shown that prolonged action of freezing temperatures destroys certain yeasts and bacteria.

The writers undertook experiments to determine the resistance of fungous spores to liquid air temperatures (about -185° C.). The organisms used were: *Melanconium fuligineum* isolated from Grape, *Coniothyrium* sp. isolated from Elm,[1] *Eurotium herbariorum*, culture obtained from C. V. S., Baarn, Holland, and *Cytospora chrysosperma*, isolated from Willow.

Several methods of subjecting the spores to liquid air temperatures were employed: 1) A suspension of spores in sterile water was placed in a test tube and the latter immersed in liquid air; 2) spores were inoculated on a corn meal agar slant and the tube immersed in liquid air; 3) a sterile glass rod was dipped into a sterile water suspension of spores and after the water was allowed to evaporate the glass rod was immersed directly into the liquid air. All three methods were employed with each of the organisms used and controls were maintained in each case.

After an hour's exposure to -185° C. the spores were brought to the laboratory and inoculations were made on corn meal agar with spores taken from the water suspension and from the glass rod. In all cases, germination of the spores and normal growth took place, the colonies resulting from frozen spores being in all ways similar to those resulting from untreated spores.

There were some indications that the mycelium of certain fungi was fatally injured by exposure to liquid air temperatures, transfers made from treated mycelium failing to grow. Experiments will be continued with both spores and mycelium and the results will be reported later.

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(*3*) TANNER, F. W., and WILLIAMSON, B. W., The effect of freezing on yeasts. Proc. Soc. Exp. Biol. and Med., 25:377-381, 1928.

[1] Isolated by Mr. H. Harris of the Illinois Natural History Survey, whom the writers wish to thank for supplying them with a culture of the organism.

SCIENTIFIC BOTANICAL DESIGN

BY

EMMA C. CRUMMER

Chicago, Illinois

Scientific Botanical Design is a three-fold subject: science is classified and established knowledge—comprehensive information; botanical pertains to plants and trees; design means to plan, to purpose. Then scientific botanical design must be something upon which we may depend as being true facts from the field of botanical research, and as designers we find our patterns for designing purposes.

It is one of the erroneous beliefs that there is always a conflict between science and art. One of our great masters in science has taught us that "Science leads—Art follows."

The designer's job is to create something beautiful. The field of scientific botanical research is wide open to the artist who is indeed welcome, because he has demonstrated that he has found what he was seeking in science, and is using it in art.

It has been said by some of our scholarly educators that "some day we shall be looking for God in our laboratories." That "some day" is here now. Out into the field we go, among the things which God has created—to find the Creator. There we shall learn that the Creator is greater than the thing created.

How may we use this new discovery? It is to be the foundation of a new school of scientific art and industry where students are free to experiment in science and art.

The old masters in art experimented in doing things in new ways, hence they became masters; and a master is one who has mastered something for human use and enjoyment. Moreover, he must be a pioneer, who can give convincing proof that he has worked out a method, a system, and a course of procedure, all in obedience to natural laws which he has learned from diligent study from the pages of "Nature's Book of Ornament" giving logical reasons for certain rules which are to be followed whereby the designer may create something original and scientifically beautiful.

It is very important where the patterns are obtained in nature as this, in a large degree, determines the quality and value of the design.

The author has learned by experimenting that fundamental laws will guide the designer in testing his work, which can only be gained by systematic training and a workable knowledge of his subject, namely, the internal plant morphology, from the viewpoint of the two-fold mastery, which must be both Botanist and Artist.

Here, too, is a wide field for the geologist and the chemist in experimental research to discover more truth in color harmony; seeking scientific ideas and how to use them.

FLOWER VARIATION IN ZINNIA

BY

CHARLOTTE L. GRANT

University of Illinois, Urbana

During an experimental investigation on the development of Zinnia under three soil moisture ranges—wet, moist and dry—certain flower variations were observed.

According to catalog description the Red Riding Hood variety of Zinnia possesses double flower heads with scarlet rays. This description should certainly apply to the terminal head of the main stem, and according to reported observations to branch flowers as well. In twenty-three greenhouse plants of this variety none showed scarlet rays in the axial head (at the top of main stem), and only two plants gave consistent orange color in all the flowers developed on one plant. In all other plants, different flower heads had different colors although never more than one color to a particular flower head. As many as four different colors have been found among the flowers of a single plant. Fourteen colors have thus far been found on the twenty-three plants.

Microscopic examination of freehand sections of the rays showed a distribution of color in the following manner: orange or yellow chromoplasts in the upper papillose epidermis, red pigment dissolved in cell sap, present in varying amounts or entirely lacking in the upper epidermal cells; chloroplasts abundant or few in the mesophyll. Thus, yellows with a greenish cast were due to an abundance of chloroplasts in the mesophyll. Scarlet ray color results from a combination of red sap (apparently dilute spectrum red) with orange chromoplasts. Apparently the influence of the chromoplasts is less than might be expected. The various shades of orange depend upon abundance of chromoplasts in the upper epidermis and chloroplasts in the mesophyll.

Some variation in doubling was apparent and in six heads disc flowers were wholly lacking. But excluding from consideration these variations one is puzzled to account for the presence of differently colored flowers on a single plant. Is this an inherent variation involving genetic differences originating in the buds which produce the several axillary branches with their terminal flower heads? Can it result from the rather peculiar environmental conditions? Can it be an expression of difference in carbohydrate nutrition for the several branches on a plant? Or can it be a combination of several of suggested influences?

The lack of uniformity in color of heads on the same plant, and among plants of the same environmental series together with absence of correlation between sequence of development of heads on one plant with change in color are indications of inherent variation within the individual plants. On the other hand the frequency of color variation is many times higher than is characteristic for somatic mutations.

The soil used, a sandy loam of pH 5.3 was found low in phosphates and nitrates. This might be considered a possible environmental influence on flower color. But if soil conditions are unfavorable to normal color development why should not all the flower heads of a plant develop alike?

CONSERVATION OF WILD FLOWERS AND SHRUBS A MUNICIPAL DUTY

BY

L. F. GUMBART

Macomb, Illinois

Our native wild flowers are fast becoming extinct because people who love them will not let them grow and mature seed. Native shrubbery is fast following the flowers, in spite of the fact that brush holds the hillsides and stops erosion. Encourage the hazel, the wild-crab, plum, the red and black haw, persimmon, sassafras, the prickly, aromatic, and paper ashes, the service bush and red-bud, the wahoo or spindle bush, the gooseberries and blackberries and the wild roses in the draws and washes and plant hickory, walnut, pecan, oak and the conifers on washed off knobs and give nature a chance to take care of some of her own flood control problems.

Just now when the early wild flowers are blooming we must not forget that many varieties are fast disappearing. As a general rule, of the early spring flowers only the violet and cranesbill should be plucked or transplanted in town. Most of the summer and fall flowers seed freely and so may be picked generously. Following is a list of some of the flowers which we should encourage in our wild parks by carefully planting such as are not already there: Hepatica, anemone, wind-flower, spring-beauty, buttercup, blood-root, yellow-puccoon, wake-robin, purple trillium, blue-bell, dutchman's breeches, may-apple, sweet-william, dogtooth violet, shooting star, jack-in-the-pulpit, pansy, hare-bell, solomon's seal, lady's slipper or moccasin flower—all spring flowers—and I must not forget the old prairie or Turk's cap lily, now seldom seen.

May we not all go back to our home town and if there is no wild park, check up on some available rough land, say twenty to a hundred acres, buy it as a community or induce someone to buy or donate it for the town! Clear a few level spaces for picnic, ball, and tennis grounds. Turn it over on honor to the boy and girl scouts or high school to rule and regulate. Give continued instruction and care toward developing a real nature's garden of ground flowers, tangled vines and shrubbery for the birds. When available, a good spring or brook is an added attraction, but good potable drinking water must be provided. A good substantial fence is the next consideration, then clean toilet arrangements and an open building of steel construction with sheet steel corrugated roof large enough to cover a good sized crowd should a storm arise. If the town has no large auditorium, consideration might be given the possibility of using this building for Chautauqua, politics, young folks conventions, 4-H work, etc. By all means, do not combine it with a tourist park.

Uncle Sam has national parks, Illinois has state parks, Cook County has forest preserves and beautiful parks and playgrounds. Why not a wild park and playground near every city and town in the State to help perpetuate the many beautiful native plants, shrubs, and trees and aid us all to know and appreciate the outdoors and what nature reveals to us of God and His wonderful works for the children of men.

LATE WINTER INJURY OF SOME COMMON TREES AND SHRUBS

BY

HUBERT A. HARRIS

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ABSTRACT

During the latter part of February, 1932, temperature conditions throughout Illinois were so mild that growth activities were initiated precociously in different kinds of trees and shrubs. Early in March, however, a sudden freeze occurred which seriously injured vegetative growth.

In the Champaign and Urbana vicinity the effects of winter injury ranged from slight to very severe. Among those woody perennials most seriously injured were elm, pussy willow, poplar, and privet.

The most conspicuous and common symptom associated with winter injury was the presence of numerous dead, bare twigs or small branches protruding either from the tops of injured trees and shrubs or occurring at the ends of lower lateral branches. Quite frequently portions of larger branches manifested the same dead and leafless appearance. The extent of dying back ranged from only a few inches to as much as several feet, in accordance with the particular species of plant.

Another common and striking characteristic of the winter-injured plants was the presence of much enlarged or partially opened buds killed by freezing. Buds of the most precocious trees and shrubs were fully opened when killed. Those woody perennials characterized by a more retarded growth showed only swollen or partially unfolded buds, while buds on other plants with a still more prolonged period of dormancy, were only slightly enlarged and had been killed, apparently, just as growth activities were being initiated.

The American elm (*Ulmus americana* L.) commonly suffered winter injury during the spring of 1932. The occurrence of an exceptionally dense or compact foliar growth immediately below the winter-killed twigs and branches was a conspicuous character manifested by severely injured elms. Such leafy growth originated from the premature development of buds normally developed at the bases of already expanded leaves. Ordinarily these buds would have remained dormant until the following spring.

The cultivated pussywillow (*Salix caprea* L.) was so commonly injured that very few instances were observed in which no serious effects of freezing were evident. Injury was most noticeable among the flower branches though some lower laterals were also injured.

Winter injury to poplar was also quite general and extensive. The Lombardy poplar (*Populus nigra* L. var. *italica* Du Roi) was more extensively injured than the White (*P. alba* L.), Carolina (*P. canadensis* Moench.), or Simon (*P. simonii* Carr.). Greater injury to the Lombardy poplar was due not only to its more general cultivation, but also to the fact that the tree is usually grown singly, or in rows, quite isolated from other trees, and left unsheltered.

The common privet (*Ligustrum vulgare* L.) suffered extensive, though only moderately severe, winter injury. In most instances no large portions of the plants were killed, but instead, it was of more common occurrence for numerous small twigs scattered throughout the bush to be killed.

Most noticeable among those trees and shrubs injured to a lesser extent was the hard maple (*Acer saccharum* Marsh.)

MATERIALS FOR DEVELOPING THE TECHNIQUE OF CONSUMPTION FOR FOODS

BY

M. FAITH MCAULEY

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The studies that have been made of our food crops have been concerned chiefly with problems of production and distribution. Techniques of production have been worked out for all of our leading crops and the technical information is available to anyone interested. In distribution, too, techniques have been developed.

The consumptive activity has received little attention to date. The consumer has only recently been recognized as an important factor in our economic scheme and production and distribution considered in terms of consumption. The education of the consumer is still left almost wholly to competitive commercial interests and is accomplished through the medium of modern advertising. This method is expensive, characterized by half truths and economic shortsightedness.

The intelligent buying of food is not only important, it is also difficult. Our food stuffs are many and varied and their purchase presents more difficulties than does the purchase of materials satisfying other human needs, such as clothing and shelter. Much technical knowledge covering a wide range of products is needed.

Many of our food products, even the most perishable, are raised in distant producing regions, brought to us by special transportation such as fast freight, express, and refrigerator car. They are held for delayed consumption in cold storage or are preserved for indefinite periods by drying, canning, freezing. Each new process leaves the consumer less well-informed concerning his food products and makes acquiring of new knowledge necessary.

Materials for developing the techniques in food consumption should furnish, as a background, information concerning the methods of production or manufacturing which have a bearing on consumption and the marketing machinery which brings the product from distant producing regions. Certain specific information concerning the product is needed such as: the chief producing regions; the volume of production; the peak of production; the season when available and when most abundant; varieties with quality; grades and the brands descriptive of such grades; standard packages with volume or weight; quality and value as distinct from appearance and price; and the special uses for which the product is suited.

The importance of definite information in regard to the season can be illustrated by cauliflower. Cauliflower, the variety *botrytis* of the cabbage group, is a plant requiring abundant moisture and cool temperature for the production of marketable stock. It shows a definite climatic response with the heaviest production in January, a lesser production in the Fall and Spring and a very small production in June, July and August. The intelligent placing of consumer demand is therefore very clear.

Spinach is another crop with clearly marked seasonal availability. The four chief producing regions are Texas, Virginia, Maryland and South Carolina, with Texas and Virginia the heaviest producers. The three winter months are the months of heavy production with no shipments in June, July and August. The ecological factor of temperature is well shown; spinach, heat intolerant, is produced in the winter in the truck gardens of Texas and the South Atlantic states. In the northern states, the summer season is too hot for the production of spinach, and the period suitable in Spring and Autumn is too short to produce more than a small and uncertain supply. Spinach is, therefore, a vegetable to be used when most available, namely in January, February, March, rather than in June.

Materials of this nature the writer feels, would, if made more generally available help in developing a technique of consumption.

ANATOMY OF THE XYLEM OF *SCIADOPITYS*

BY

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ABSTRACT

This investigation was undertaken with the intention of presenting a complete anatomical study of *Sciadopitys,* from which it is hoped new light may be thrown on its phylogenetic affinities. The anatomy is revealed as being quite simple, with but two notable exceptions: the absence of a resinous system is paralleled only in five species of *Abies,* and the absence of end-wall pitting in ray cells is not known in other conifers. The presence of resin canals and resin cells in tissues of the cone axis other than xylem suggests interesting corroboration of Jeffrey's theory concerning the evolution of these organs. Extremely primitive manifestations are found together with others equally advanced. Taking a phylogenetic view of the sum of anatomical characters, it is assumed that *Sciadopitys* is not closely related to any known conifers. Its evolution apparently involves somewhat remotely both the Abietineae and Taxodineae, but not the heterogeneous Cupressineae.

PERSISTENCE OF SUBSPECIFIC TYPES OF *XANTHIUM* IN THE FIELD

BY

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ABSTRACT

Attention is called to the unhappy situation in the taxonomy of the genus *Xanthium* caused by the disagreement between recent monographs on this group. Evidence is presented to show that some of the forms which are considered of sub-specific rank by the monographers are capable of maintaining themselves as distinct entities under field conditions.

The species described some years ago as *X. globosum* and included under this name in Millspaugh and Sherff's[1] monograph, was grown a number of years, and maintained itself as a distinct form. Widder[2] considers this species a form of *X. pungens*. Evidence in regard to variability in seed size in *X. globosum* and *X. pungens* indicates that the two are quite distinct. In length, breadth, and weight of seeds, color of seed coats, time of blooming, color and armature of burr these two are distinct enough to retain *X. globosum* as of species rank.

Another form of sub-specific rank, *X. chinense globuliforme*[3] has been maintaining itself under field conditions for six years, and seems capable of becoming an independent and permanent multiple seeded form of *Xanthium*. There has never been any apparent tendency for it to split up into other forms. It is very prolific, and all plants are fertile. Volunteer plants propagate it year after year without difficulty. In nature it could become a very persistent weed.

A third sub-specific type is *X. pennsylvanicum laciniatum*[4] which was discovered by the late Mr. Crevecoeur of Onaga, Kansas, several years ago. These laciniate forms have been maintaining themselves by volunteer propagation, and 100 per cent of the offspring came true to type in a test embracing nearly 400 individuals. There was no evidence of hybridization, and the laciniate type of leaf seems fixed in this form.

The origin of these sub-specific types is not known. They have arisen suddenly as if by mutation, although the multiple seeded form may be of hybrid origin. But they are apparently not any less stable than those forms that are regarded as true species, and can maintain themselves unaided in the field. Such forms raise the question as to what constitutes a species, and as to what constitutes good taxonomy, that which concerns itself only with dried herbarium specimens, often immature, or that which gathers evidence of stability and presistence in nature on the basis of breeding and field tests. Certainly those forms that cannot persist and remain stable in character should not be called species; those that arise in nature, which can and do persist, and remain permanently stable seem worthy of consideration as true species.

[1] Millspaugh, C. F., and Sherff, E. E., Revision of the North American species of the genus Xanthium. Field Museum of Natural History Pub. no. 204. 1919.

[2] Widder, F., Die Arten der Gattung Xanthium. Repertorium specierum novarum regni vegetabilis. Beih. Bd. XX Berlin. 1923.

[3] Millspaugh, F. C., and Sherff, E. E., Xanthium. North American Flora 33:37-44. 1922.

[4] Sherff, E. E., New or otherwise noteworthy Compositae. Bot. Gaz. 92:202-209. 1931. (See pp. 208-209.)

GRASSLAND IN THE FLOODPLAIN OF ILLINOIS RIVERS

BY

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The occurrence of grassland in the floodplain of the larger rivers in or bordering Illinois has been discussed by Brendel (1887), Gleasan (1910), Imlay (1797) and Sampson (1921). The relationship of this type of grassland to bottomland forest and other vegetation types in the Mississippi and Illinois river valleys seems to be as follows: the customary floodplain forest is commonly confined to a belt or zone from a few hundred yards to a half mile in width paralleling the river channel or surrounding ponds and lakes. The landward side of this forest type merges into a grass association, at first on the hydric side of mesophytism, but giving way in turn, as the elevation of the floodplain increases, to a mesic grass association.

Two such areas were studied in the summer of 1930, in the Mississippi floodplain near Hillview, and the Illinois River floodplain northeast of Kampsville. An analysis of the site factors of these situations did not reveal striking differences between these areas and similar prairie areas in the middle western states, except for occasional flooding.

The spring floral aspect of these areas is characterized by the early vegetative phase of the grasses and the few sedges that will later dominate the situation. In addition are a number of early blooming spring flowers as Cerastiums, Veronicas, Stellaria, Specularia, Amsonia, Ranunculus, Myosurus, Erigerons, Potentilla, Apocynum, Sisymbrium and Arabis. Two grasses, Alopecurus and Festuca are identifiable and Eleocharis is fairly common.

Midsummer finds the following plants important in the habitat: *Spartina Michauxiana*, Bidens species, Cassia, Ambrosias, Iva, Apocynum, Steironema, Vernonias, Oxalis and Euphorbias. By this time Spartina, *Panicum virgatum* and *Calamagrostis canadensis* have attained such size as to be the dominant, conspicuous plants.

A statistical survey, conducted in early September revealed the following floristic character of the prairie: *Spartina Michauxiana* is conspicuously dominant in both areas. *Panicim virgatum*, although having a spotted distribution is locally important to the point of dominance. *Elcocharis palustris* and Carex species are relatively important. Both areas have also a representation of dicotyledonous plants, as *Lythrum alatum, Cassia Chamaecrista, Bidens trichosperma, Ambrosia bidentata, Iva ciliata, Eupatorium serotinum,* and *Oxalis corniculatus.*

In many ways these areas resemble some of the stages in prairie succession as occurring in the Mississippi floodplain near Savanna, Illinois (Sampson, 1921). However, in this instance clear-cut steps in succession were not discernible, conversely there occurred an abundance of overlapping of stages.

The method of statistical analysis employed was that derived by Raunkiaer (Raunkiaer, 1918). The frequency curve of the areas in question essentially coincided with the curves derived by other investigators elsewhere. However, the results obtained more nearly approximated Kenoyer's curve

(Kenoyer, 1927) in the Chicago region, than other areas described by other investigators.

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Brendel, Frederick, 1887:
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Imlay, G., 1797:
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Kenoyer, Leslie A., 1927:
A study of Raunkiaer's Law of Frequency. Ecol. Vol. VIII. No. 3.
Raunkiaer, Christian, 1918:
Recherches statistiques sur les formations vegetalis. Det. Kgl. Danske Videnskabens Selskab. Biologische Middel, 1:3. Kobenhaven.
Sampson, Homer C., 1921:
An ecological survey of the prairie vegetation of Illinois. Bulletin of the Illinois Laboratory of Natural History. Vol. XIII, Art. XVI.

Papers In Chemistry

Extract From the Report of the Section Chairman

The Chemistry and Physics sections held a joint session at which three lecture-table demonstrations and two papers were presented, after which the groups separated for their section meetings.

Of the eight papers on the Chemistry program, only five are here represented. The others were:

"Activity Coefficients of Hydrochloric Acid," and "Pressure in Bubbles," by T. F. Young, University of Chicago, Chicago, Illinois.

"The Value of Valence and When to Teach It," by E. E. Rademacher, Nokomis.

Mr. Fred A. Dykins, State Highway Division, Springfield, was elected chairman for 1933-34.

(Signed) George C. Ashman, *Chairman*

LECTURE TABLE DEMONSTRATIONS

BY

CHAS. T. KNIPP

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LIQUID OXYGEN

Abstract.—This paper has to do with the liquefaction of oxygen as a lecture table experiment. The apparatus consists of a single bulb (pyrex) and the operation need last but 30 seconds and yet results in the formation of 2 to 3 cc of liquid. The process may be projected on a screen.

A NEW EXPERIMENT SHOWING THAT CATHODE RAYS LEAVE THE CATHODE SURFACE NORMALLY

Abstract.—This fact is so well established that a suggestion of an experiment to show it seems trite. The cathode is a cylinder around which are placed a number of rings of wire equally spaced. These wires are conductors yet they cast distinct shadows on the walls of the discharge tube. The experiment is novel and at first perplexing yet easily understood. To make the phenomenon visible throughout the room the vessel is primed with helium.

A RECTIFIER HAVING COLD ELECTRODES

Abstract.—When one refers to rectifiers we at once think of discharge tubes having a hot cathode. This new rectifier makes use of the principle, established years ago by Hittorf, that in order for a current to pass through a discharge tube the electrodes must be so located that the Crookes dark space can form freely. By preventing this in the case of one of the electrodes, in a simple discharge tube, and placing this tube in series with the secondary of, say, a ½ kilowatt transformer, the resulting high potential alternating current may be rectified. Experiments showing an alternating and a rectified discharge through a vacuum tube will be performed.

THE MAGNETO-OPTIC METHOD OF ANALYSIS

BY

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ABSTRACT

The magneto-optic method of analysis which has been devised by Professor Fred Allison depends upon the fact that when a water solution of an inorganic salt is subjected to a magnetic field it rotates the plane of polarized light (Faraday effect). When the magnetic field is applied there is a brief time interval before the Faraday effect can be detected. The length of this lag depends on the nature of the material in solution. If it is possible to measure the extremely short spaces of time which represent the differences in the lag, then it ought to be possible to use these differences as a means of chemical analysis.

The apparatus includes a light source such as a metal spark. This light is polarized by a Nicol prism and passes through two tubes which are surrounded by oppositely wound coils of wire. Behind the second coil is placed another Nicol prism, the two prisms being "crossed" so that a minimum of light emerges at the zero position. The two tubes are filled with different liquids, and the second coil is moved a short distance away so that the light is compelled to travel a slightly longer path and hence delay for a fraction of a second the effect of the magnetic field. By careful adjustment the delay caused by the increased light path may be made to coincide with the Faraday lag and at this point a minimum of light emerges. By noting the position of these minima, it is found that each inorganic salt has a minimum for each of the isotopes of the metal. This apparatus is therefore a device for measuring the time required for light to travel a distance of a few millimeters.

The method is extremely sensitive since the minima persist even when the solution contains only a slight trace of solute. Roughly, it should be possible to detect a single drop of brine in 100,000 barrels of pure water.

It is to be expected that any method which is so extremely sensitive might easily mislead an observer. Accordingly results on the magneto-optic apparatus have been carefully checked against standard methods such as the arc spectra, the absorption spectra and X-ray spectra with satisfactory checks in every case. We believe that in the hands of a careful, well trained observer the method can be depended upon to give accurate results.

Its advantages are: (a) extremely small quantities can be detected; (b) complex mixtures can be analyzed without separating the constituent materials; (c) the analysis is possible with a minute sample; (d) there is almost no loss of material; (e) the apparatus is moderate in cost; (f) the method may be adapted within limits to both qualitative and quantitative work.

The great weakness in the method under present conditions is the uncertainty on the part of various observers in detecting the minima. If a photoelectric cell could be brought into use or a photographic record made the large personal equation would be eliminated and the method would find many useful applications.

A STUDY OF BOILER WATERS IN HIGH PRESSURE PLANTS*

BY

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ABSTRACT

The occurrence of calcium sulfate scale in ordinary boiler operations, the common practice of treating the water in order to prevent the formation of this particular compound, and the conditions of its formation in the ordinary boiler operating at 250 pounds pressure is well known.

High pressure boilers up to 2,000 pounds pressure have been recently constructed in this country and abroad. The higher efficiency of operation has caused considerable interest in these particular plants. Unfortunately, no data are available on the solubility of calcium sulfate under the new conditions, the solubility of many other salts present in ordinary boiler waters, or the effect of one soluble salt on another. The problem of operation at these high temperatures and pressures becomes a serious one. Work was started in the Chemical Engineering Division at the University of Illinois some years ago in order to ascertain the solubility of all these salts under these new conditions, and the effect of one upon the other.

It is realized that scale formation under high temperature conditions is likely to materially retard heat transfer and cause a hot spot in the metal and the failure of the tube or drum due to the high pressure. Such failures are likely to be disastrous, not only from the standpoint of property damage but also from the standpoint of loss of life.

The preliminary results of these tests, as far as calcium sulfate scale is concerned, indicate that the use of a small amount of soda ash will prevent the formation of calcium sulfate scale at high temperatures and pressures, and at the same time sufficient sulfate ion can be maintained to prevent embrittlement of the boiler plate.

In conclusion, it may be said that solubility studies at high pressure and high temperature will not only be valuable from the standpoint of the power plant operator but should supply data which will be of real use to everyone who is attempting to remove salts from water solution and who can utilize both high pressure and high temperature.

* This work was done by Professor F. G. Straub of the Chemical Engineering Division, Engineering Experiment Station, University of Illinois. The work has had the financial support of the Utilities Research Commission Incorporated, of Chicago, Illinois. Further details of the work have been published in the Transactions of the American Society of Mechanical Engineers, *54*, (21) 221, Nov. 15, 1932.

EVALUATING A HIGH SCHOOL CHEMISTRY COURSE

BY

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Since the ultimate effect of the teaching upon the student is of most importance, the student's opinion of what is interesting and valuable in his general education should be considered.

To obtain the student's evaluation of what he studies, a questionnaire was prepared which listed 46 different learning elements, achievements and activities commonly included in the high school chemistry course. Each student in ten different high schools of cities having populations from 1000 to 100,000 was asked to judge each item as to whether it was interesting and as to whether it was of general educational value in later life.

Abstract ideas, it was found, are not interesting and are usually not recognized as of much value, especially if they are difficult to comprehend. For example, the theory of atomic structure and its relation to chemical activity was rated very low in both interest and educational value. How laws are derived was considered of interest by only 30 per cent and of educational value by 23 per cent of all the students. Determining the weight of a metal that would replace one gram of hydrogen ranked 32 per cent in interest and 42 per cent in educational value.

The data showed that what appealed most either applies to life directly, provides purposeful activity, or explains the nature of chemical activity. The students considered it very interesting and still more valuable to learn of the elements and compounds essential to plant and animal life, to learn of some of the chemical processes in the animal body, and to learn of the chemistry related to the home. Taking trips to local industries was considered very interesting by 94 per cent of all the students, and 89 per cent considered it of great educational value. Doing projects was interesting to 80 per cent of all the students, while 62 per cent thought it educationally valuable.

Learning that clarifies the nature of chemical action is also desired by students. For example, 68 per cent of the students were interested to know that when two elements were united chemically, the compound formed has entirely different properties from either of the two elements thus uniting, while 58 per cent believed it of educational value. Again, 74 per cent thought it was both interesting and valuable to know that matter cannot be destroyed, even by burning, but that it can be changed in form into a different substance.

The uses of the elements and compounds and the properties that make them useful appeal to the students of all the schools. The uses were rated as interesting by 75 per cent of the students and as educationally valuable by 87 per cent.

In the light of the above data the teacher should associate the necessary abstract material as closely as possible with actual problems of his students' experience. Learning elements can be made to appeal to students by presenting them through projects, studies of local industries, or other activities of interest to students.

SIRUP FROM JERUSALEM ARTICHOKES

BY

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ABSTRACT

Levulose, the finest and sweetest of all sugars, is available in polymerized form in the tubers of the Jerusalem artichoke (*Helianthus tuberosus*). The commercial development of levulose has been advocated both as a supplementary source of food and for the production of sugar in regions in which sucrose production is not permissible. The peculiar physical properties of levulose, its higher sweetening power and the distinct flavor will enable its use for purposes for which other sugar products are unfitted. The Jerusalem artichoke, being of a hardy nature, is adaptable to a wide variation of soil and climate and sometimes may serve as an important source of this sugar. This investigation had as its object the production of a palatable sirup from these tubers, the difficulties attendant to the crystallization procedure being reserved for future study.

The tubers, upon reaching maturity, are washed, sliced and dried, and the dried material is used for the preparation of the sirup. An extract is prepared by diffusion in the regular manner in a six cell diffusion battery. The principal scientific interest centers in the method of hydrolysis of the solution of the polysaccharide material. A study of various combinations of the reaction time, temperature, degree of acidity and concentration of solids in the extract was necessary before optimum conditions for the reaction could be established.

Following the experimental work in the laboratory, the process selected was adapted to a semi-plant scale. The operations are essentially as follows. The extract of 30–35 per cent total solids as obtained from the diffusion battery is filtered with the aid of Super Cel using a small Shriver filter press. It is then acidified with HCl to a pH of 4.2 and transferred to a copper converter having a capacity of about 40 gallons. Steam is introduced directly into the reaction mixture until a pressure of 25 lbs. is reached. This pressure is maintained for about 20 minutes after which the solution is blown off. The converted extract is transferred to a glass lined evaporating pan and concentrated under diminished pressure to 50–60 per cent solids. After withdrawal of the sirup from the pan, it is neutralized with sodium carbonate to a pH of 5.4 and then filtered through active char (carboraffin) to reduce the color. Finally it is evaporated in the vacuum pan to a solids content of about 82 per cent.

The resulting sirup has a color ranging from a light yellow to a dark reddish brown. The taste varies somewhat depending upon the character of the original dried material, the conditions of evaporation, and the extent of active char treatment. In the present form the product is recommended chiefly for table use and for cooking in which a colored sirup is permissible.

THE ELECTRODIALYTICAL PROCESS AS A METHOD FOR ACIDIFYING AND PURIFYING POLYSACCHARIDE SOLUTIONS

BY

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Research work having as its ultimate goal the preparation of a palatable syrup from the tuber of the Jerusalem artichoke (*Helianthus tuberosus*) has been in progress at the University of Illinois for several years. However, in the preparation of such a syrup two problems are of considerable importance: (1) the conversion of the polysaccharides contained in artichokes (inulin and various levulins) into simple sugars, and (2) the removal of undesirable non-sugar material which also occurs in the tuber.

Since certain difficulties are inherent in all of the conventional methods of solving these two problems, the possibility was investigated of accomplishing by one process both the acidification of the diffusion-battery extract obtained from artichokes, which acidification is necessary to effect conversion of the polysaccharides to simple sugars, and the removal of at least part of the non-sugar material in it. This process is based on the phenomenon of electrodialysis, which may be defined as the migration through diaphragms of ions under the influence of an electrical potential.

The extract containing, in addition to the polysaccharides, such salts as naturally occur in the artichoke tuber, was treated in an electrodialytic apparatus fitted with such diaphragms that an excess of the cations in the salts escaped. As a result an appreciable amount of water was ionized, the OH^- ions also migrating to the anode to equalize the positive charges carried to the cathode, and the H^+ ion concentration of the extract was increased. At the same time a considerable percentage of the colloidal material in the extract was discharged and coagulated. Therefore the procedure accomplished both the acidification of the extract and the removal of much of the inorganic salts and the organic colliodal material in it.

A series of investigations was carried out in which the independent variables, viz. rate of flow of extract through the process, current density, concentration of solid material in the extracts, and the nature of the diaphragms, were varied and their effect on the dependent variables was noted, viz. $[H^+]$ produced in the extract, colloidal material coagulated, and cost of the process.

The results obtained may be summarized in a few generalizations:

(1) The final pH of the extract depends chiefly upon the per cent of cations or of total ash removed from it.

(2) Increasing either the rate of flow of the extract, or its concentration, or both, while other variables are held constant decreases the $[H^+]$ produced.

(3) Increasing the current density while other variables are held constant increases the $[H^+]$ obtained.

(4) The current density is directly proportional to the rate of flow of the solution if other variables are held constant.

(5) If the $[H^+]$ to be produced in the extract remains constant and the rate of flow of the extract is increased its concentration must be decreased or the current density increased, or both.

(6) About 40 per cent of colloidal material is coagulated during the production of an extract with pH of 4.2, that required for conversion of the polysaccharides under the conditions of our work.

(7) At 2 cents per kilowatt hour the cost of current to produce this pH is 0.04 to 0.1 cent per pound of finished syrup.

(8) With less permeable diaphragms in the apparatus the final pH is only slightly higher than with more permeable ones.

HOW IMPORTANT IS THE TIME FACTOR IN EXAMINATIONS?

BY

J. H. SAMMIS

Peoria Central High School, Peoria, Illinois

The importance of the time factor in the successful completion of examinations is bound to vary with the type of test used. We are concerned here with the short completion, multiple choice, or true-and-false test given as part of the daily assignment in any class in science. Lack of time has so frequently been offered as the reason for failure to satisfactorily handle a test that the author for a period of over two months gave fifty tests to his classes, which were given with one minute by stop watch for each question, and then repeated with an additional one minute allowance per question, any changes or additions being made in different colored pencil.

The results were uniformly consistent. Doubling the time for answering succeeded in raising the average grades in every test given by less than 5 per cent. In many cases individuals actually lowered the grade made with the original one-minute allowance. Instances of lowering grades were particularly in evidence among pupils ranking consistently in the lower quartel of their classes.

In view of the fact that the beauty of the short daily test lies in the small amount of time it takes, it hardly seems advisable to give too much time for answering questions on tests of the type discussed, notwithstanding pupil alibis to the contrary.

WHAT SHALL WE DO ABOUT THAT CHAPTER ON PHOTOGRAPHY?

BY

J. H. SAMMIS

Peoria Central High School, Peoria, Illinois

In view of the fact that nearly every text book on general inorganic chemistry contains more material than can be satisfactorily covered in the prescribed time, some of the material must be omitted. In deciding what material to use we feel that those subjects or phases of a subject should be taught which are (1) most commonly used or encountered, (2) most interesting and successfully mastered, and (3) most closely correlated to other subject matter in the curriculum.

If those statements be true, the chapter on photography has been unjustly dealt with in many instances. Examples of photography are daily making up larger and larger portions of our newspapers, magazines, and books, and one must not overlook the fact that motion pictures are photographs.

Photography is surely as interesting and as easily mastered as an understanding of Charle's and Boyle's laws. The relationships between photography and physics (lenses, light, filters, depth of focus, metric system), art (composition, distribution of masses, elimination or emphasis of detail), chemistry (development, compounding of formulae, reduction, intensification, common ion effect), journalism (news stories, year book snapshots) and teaching (lantern slides, copied pictures) is too apparent to need further attention.

The acquisition of entertaining, helpful, or at least harmless hobbies is something we as teachers are urged to encourage. Photography seems to meet the requirements of a fascinating and not too costly a hobby. We feel that the chapter on photography should be taught, and possibly where circumstances and enthusiasms permit, emphasized.

PAPERS IN ECONOMICS

EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN

A symposium of four papers on "Problems of the Illinois Coal Industry," followed by a general discussion, comprised the program of the Economics Section.

The fourth article, "Competitive Position of Fuel Oil and Natural Gas with Coal in the St. Louis District," by C. V. Beck, President, Lumaghi Coal Company, St. Louis, is the only one not here represented.

No chairman was elected for the coming year.

(Signed) WALTER H. VOSKUIL, *Chairman*

COMPETITION OF APPALACHIAN COALS, FUEL OIL, NATURAL GAS AND OTHER FUELS WITH ILLINOIS COAL IN THE ILLINOIS COAL MARKET AREA

BY

W. H. VOSKUIL

State Geological Survey, Urbana, Illinois

ABSTRACT

Illinois supplies coal to seven states in the Upper Mississippi Valley. In this same area vast quantities of coal from West Virginia, Kentucky, and elsewhere, fuel oil from the crude petroleum supplies of the Mid-Continent field, and natural gas from Kansas and the Panhandle of Texas are also marketed. This Upper Mississippi Valley is a battle ground for competing fuels that originate in widely separated districts. Each fuel industry is equipped and prepared to supply a far greater quantity of fuel than the normal market of the area requires. Each fuel has been driven, by the keen competition for the market, into lower and lower price levels until a balance between costs of production and selling prices have been all but disregarded.

The boundaries of this territory, in which 90 per cent of the Illinois output is sold, have been determined by the competition of fuel oil and natural gas in the Southwest; the eastward movement of coal from Colorado, Wyoming and Montana into Kansas, Nebraska and the Dakotas; ex-lake coal in the shore counties of Minnesota and Wisconsin; and Indiana and Appalachian coals in the territory east of Illinois. Consumption of energy in the Illinois market territory in 1929—a year when the total Illinois output was 60,658,000 tons—is shown in the following table.

Summary of Energy Consumption in Illinois Market Area in 1929
(Gasoline Excluded)

	Quantity	Coal or Coal Equivalent, Tons
Bituminous coal, tons	102,858,155	102,858,155
Coke, tons	4,580,764	4,580,764
Briquets, tons	687,377	687,377
Anthracite, tons	2,705,946	2,705,946
Fuel oil, barrels	28,871,165	6,880,000
Natural gas, 1,000,000 cu. ft.	95,410,000	3,816,400
Water, power, 1,000,000 kw.-hr.	2,814,435	2,388,000

Low-cost transportation to lake territory offers a difficult problem for Illinois producers, but in the case of Appalachian coals, the preference engendered by the special qualities of some of these coals and the lower prevailing wages do not offer insuperable difficulties. The situation with respect to fuel oil may be expected to improve when the output of crude is controlled and the price raised sufficiently to make more cracking profitable. Markets in the states producing natural gas are becoming saturated, and future development means that outside outlets must be found, of which the Illinois market territory is the most important. Eventually these competitive interests must enter into closer cooperation to obtain for each a fair share of the market on the basis of scientific distribution.

ECONOMIC IMPORTANCE TO THE ILLINOIS COAL INDUSTRY OF THE MECHANICAL PREPARATION OF COAL

BY

D. R. MITCHELL* AND C. M. SMITH**

University of Illinois, Urbana, Illinois

ABSTRACT

Although the scientific preparation of coal is of fundamental economic importance to the coal industry of this State, it has been largely overlooked as a means of bettering the industry's status. However, an increasing demand on the part of consumers for cleaner and more closely sized coal is resulting in renewed interest in coal preparation.

The proportion of coal marketed in the larger and more profitable sizes has been declining for several years. In 1900, egg and lump coal constituted nearly 60 per cent of the State's output; whereas, in 1931 they made up only 40 per cent of it, the decline in the proportion of lump coal having been particularly severe. Correspondingly, the proportion of screenings rose from about 10 to 30 per cent.

Since screenings must frequently be sold at a loss the tremendous economic importance of their increased production is evident. One factor in the low price of screenings is that they normally carry a higher content of impurities than do the larger sizes of coal.

Although the mechanical cleaning of coal was once a major activity in Illinois, it declined almost to the vanishing point, following the World War. Within the past four years, however, there has been a pronounced increase in the amount of coal being cleaned mechanically. This is true in Indiana also, where more coal is being mechanically cleaned than in Illinois, although the Indiana production is less than one-half the Illinois production.

It is frequently asserted that Illinois has been losing its markets to eastern coals but analysis of coal shipments showed that, between January 1932 and January 1933, 80 per cent of the loss suffered by Illinois operators to competing producers was to Indiana and western Kentucky mines.

Coal from both of these districts is much like Illinois coal in composition, but the practice of mechanical cleaning has been growing rapidly in both states, and although price is probably the ruling factor, it seems clear that greater cleanliness and uniformity of product has aided these operators in invading Illinois' natural markets.

Contrary to the experience of the deep mines in Central and Southern Illinois, the output of some large strip mines in Northern Illinois has been increasing rapidly in recent years. In each case the product is either partly or wholly cleaned mechanically, and uniformity of output is assured by routine chemical analyses.

It is evident that the consumer satisfaction engendered by an acceptably clean coal of uniform ash and sulphur content has been a factor in enabling these mines to grow in the face of the depression. It is by fostering such consumer satisfaction that Illinois operators in general can hope to recapture their former markets. The scientific preparation of coal is a step in this direction.

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THE GROWTH OF COAL SHIPMENTS BY MOTOR TRUCK INTO ST. LOUIS AND ITS EFFECT ON THE TRANSPORTATION AND MINING INDUSTRIES

BY

FRANK T. TIRRE

Better Business Bureau, East St. Louis, Illinois

ABSTRACT

At the beginning of the practice of hauling coal from mines by truck, direct to consumers in St. Louis, the general trucking rate was $2.00 per ton. At this rate the railroads were not bothered or even concerned, as it made no inroads upon their tonnage, so to speak, but the individual trucker soon discovered that this rate would enable him not only a fair profit on the haul, but it also opened up an easy avenue for him to get into the coal business at a nominal cost regardless of the equipment he had; he advertised by telephone number, carried no stock on hand, securing his coal from nearby mines in Illinois and delivering direct to the consumer in quantities of from 1 to 8 tons at a very low figure, much less than the rail rate that dealers with yards and railroad switches must pay. Regular dealers must and do have to take care of public demands under any and all conditions while these individual truckers, sometimes called "Snow Birds", meet none of these obligations or requirements. They became so numerous that at the present time more than 1,200 are engaged in this particular line of transportation of coal into St. Louis.

While there is no means of accurately checking the total movement of coal at both sides of the Mississippi River, it is estimated that ⅓ of the total truck coal goes to points on the east side such as East St. Louis, Madison, Granite City, etc. Due to the fact that East side cities are closer to the mine a relatively larger amount per capita of truck coal goes to these communities. This estimate of ⅓ of the truck tonnage to East side communities and ⅔ to St. Louis, Mo., is arrived at after consultation with a number of large truck mines who agree, after an analysis of their records, that this division is approximately correct. It is therefore apparent that the total truck movement and consequent loss of rail tonnage is approximately as follows, during the period under observation in this analysis.

	Tonnage actually checked as coming across Free Bridge to St. Louis. Estimated as 2/3 of total movement.	1/3 estimated as going to East side communities.	Total estimated movement.
Feb. 9-10 (24 hours)	8,655	4,328	12,983
Feb. 10-11 (24 hours)	10,438	5,219	15,657
Feb. 11- (16 hours)	8,412	4,206	12,618
Feb. 12- (12 hours)	1,263	632	1,885
Feb. 13-14 (24 hours)	8,513	4,256	12,769
Feb. 14-15 (24 hours)	7,837	3,918	11,755
Total	45,118	22,559	67,677

From the above it is apparent that the total truck movement during this five day period was approximately 67,677 tons, which was lost to the railroad, and is the equivalent of 1504 forty-five ton cars.

The above gives a very accurate picture of how trucking is increasing to St. Louis, Missouri. The Free Bridge has been checked more or less periodically for the last eighteen months. Each check reveals a material increase over all preceding checks. The check made in November and December showed a peak movement of slightly over 6,000 tons a day. This check shows an increase over any preceding check of from a minimum of 30 per cent to a maximum of 70 per cent increase. It explodes completely the idea that trucks cannot successfully operate in bad weather. The first day of this check it was 3 below zero, one of the coldest days in recent years, and there was a large quantity of snow and ice on the roads.

The year 1930 is the last year in which accurate figures of the truck coal loadings, St. Clair and Madison County, Illinois, are available. During 1930 slightly over 900,000 tons were loaded into trucks. From the above figures, it will be seen that in a good week truck loadings now are running close to 90,000 tons a week total.

Papers In Geography

Extract from the Report of the Section Chairman

Of the eight papers that comprised the program of the Geography Section, only four are here represented. The others were:

"Reconnaissance Traverse in Ontario Peninsula," by Charles C. Colby, University of Chicago, Chicago, Illinois.

"Father Nile and Egyptian Agriculture," by W. O. Blanchard," University of Illinois, Urbana, Illinois.

"Distribution of Fisheries of the North Atlantic," by Vellora Foster, Northwestern University, Evanston, Illinois.

"The Water Factor in the Geography of East St. Louis," by Lewis F. Thomas, Washington University, St. Louis, Missouri.

Attendance at the meeting was nineteen.

Mr. Alfred W. Kasel, Moline High School, Moline, Illinois, was elected chairman of the Geography Section for 1933–34.

(Signed) Ruby M. Harris, *Chairman*

PROBLEMS OF LAND UTILIZATION IN ANTRIM COUNTY, MICHIGAN

BY

HERBERT N. COWLES

Northwestern University, Evanston, Illinois

ABSTRACT

Antrim County is situated on the east shore of Grand Traverse Bay, which is an arm of Lake Michigan located in the northwestern part of the lower peninsula of Michigan.

The topographic features of Antrim County, glacial in origin, may be classified into four physiographic provinces: (1) The lake benches and valley flats which border the inland lakes and extend into the interior valleys; (2) the rolling uplands, or rolling hills that occupy the high areas of the western townships; (3) the hilly uplands, which are the high recessional moraines of the central townships; and (4) the high plains, which are the barren outwash plains of the southeastern townships.

Antrim County was originally covered with excellent stands of hardwood forest along with a little white pine. The western part of the county has been cleared for about eighty years and is now farmland of relatively good quality.

The central and eastern parts of the county have been cleared of virgin timber and are now covered with a dense second growth of hardwood. These sections are poorly suited for agriculture but the second growth should be of value when mature.

The manufacturing industry has practically ceased to exist with the decline of the lumber industry. One large lumber, iron, and chemical plant is now in operation.

Recreation has become of major importance in Antrim County, where a splendid chain of lakes, numerous streams, large forested areas, a favorable summer climate, and ready access give this area unusual advantages. While resort development is fairly extensive along some of the lakes, no lake has approached its potential development. Hunting is apparently the one use for which the wastelands of the southeastern townships are suitable. The value of these lands for recreation will be increased when they are better stocked with game, and when the fire hazard is reduced.

Much of the area of Antrim County which formerly was utilized for lumbering or other industrial purposes is now utilized for recreation. The loss of population following the exhaustion of the forest resources is made up in part by the annual influx of tourists and resorters during the summer. Farms which once supplied forest and industrial workers with food products, now supply summer visitors with fresh garden, orchard, dairy, and poultry products, thus supplementing the income from crops. Taxes paid by owners of summer homes make up in part for the taxes once paid by industry. The problem of land utilization, arising from the loss of the most important resource of the county, the forests, may be met, in part, by the development of the recreational resources along with specialization of agriculture to meet the particular demands.

THE APPLE INDUSTRY OF CALHOUN COUNTY

BY

ALFRED W. KASEL

Moline High School, Moline, Illinois

Calhoun County, located in western Illinois, has achieved an outstanding position among the counties of the state in the production of apples. The county at present (1933) produces approximately a third of the commercial apple crop of the state. The average annual commercial apple crop in the county for the past eleven years has been approximately 422,000 barrels. In 1930 it exceeded 600,000 barrels.[1]

Significant changes in the marketing of Calhoun County's immense crop of apples have come about within the past decade. Chief among these changes are the improvement of facilities for transporting the apples to market, the rise of Chicago as a major market comparable with St. Louis, the advent of the itinerant trucker, and the improvement of facilities for the wholesaling of apples by commission firms in St. Louis.

Nearly all of the county's apples prior to 1925 were carried to the St. Louis market or to railway loading points by river craft. Since 1931 none have been carried by this method. Improvement of railway facilities and highways, the construction of a vehicle bridge across the Illinois River at Hardin in 1931, and the increased use of the motor truck have been the major adjustments which eliminated river craft as a means for transporting the apples.

The need for better facilities than river craft afforded became acute with the ever increasing volume of apples shipped from the county after 1910 and also by a demand on the part of apple buyers for a better quality of produce. The improvement of rail facilities in 1924 accomplished by the extension of a branch of the Alton Railroad from Titus to East Hardin ushered in a new era for the apple shippers of Calhoun County. The building of this railroad was the principal factor in making Chicago a major market for Calhoun County apples comparable with St. Louis.

The motor truck has become a major means of transporting the apple crop to the market centers within the past several years, mainly because of the improvement of Illinois highways. The use of the motor truck is a distinct advantage to the industry.

In the summer of 1932 the facilities for the wholesaling of apples by St. Louis commission firms were greatly improved through the establishment of the St. Louis Apple Exchange. The exchange was organized for the purpose of combining the receipts of apples in one central location in order to serve the interests of the grower, shipper, and buyer.

Although the previously described changes have meant an improvement in the former inefficient methods of marketing the apples, there are a number of problems remaining to be solved before Calhoun County can be said to have a really efficient system of marketing. The problems are concerned with an expected large increase in production within the next decade, standardization of pack, successful advertising, development of the by-product industry, improvement of roads within the county, and the development of a successful cooperative marketing organization to help solve the problems connected with the before mentioned factors.

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[1] Data from Illinois State Department of Agriculture.

THE LAND UTILIZATION OF TOWANDA TOWNSHIP McLEAN COUNTY, ILLINOIS

BY

MARGARET MEANS

Bloomington, Illinois

Towanda Township is located in the central part of McLean County, Illinois. It is a congressional township, six miles square. The first settlers came between 1840 and 1850. The early occupations were typical of other agricultural communities of the open prairies. The first settlements were made in the groves where fuel, water, shade and shelter were found.

Cattle raising was introduced in the first decade of settlement. After the Civil War a more scientific agriculture was introduced, including a rotation of crops, especially corn, oats and wheat, and livestock production, including hogs, cattle and sheep.

The topography of Towanda Township is that of a gently rolling prairie with very little variation of relief, brought about mainly by the formation of glacial moraines and stream erosion. The main drainage system is that of Money Creek.

Soils are largely loessial in character. The upland prairie soils comprise about 95 per cent of the area. They are rich in organic matter and were covered originally with wild prairie grasses.

The native vegetation consists of forest and grasslands. The forests covered but a small portion of the total area and were found mainly along the stream valleys. Much of the prairie land was wet and marshy with coarse high grass. On the uplands the grass was short and wiry.

The climate is continental in character with cold winters and warm summers. The growing season is approximately 173 days. The precipitation averages 37.41 inches per year, well distributed for the growing of crops.

The early settlers of Towanda Township came from Indiana, Ohio, Virginia and Kentucky. Settlements were first made along the streams and then on the open prairie. The population is almost entirely native born and has been chiefly rural since the first settlement to the present time.

Two railroads cross the township and excellent concrete highways cross various parts of the area.

The city of Bloomington furnishes a good local market for agricultural and dairy products while Chicago is the chief grain and hog market.

At the present time corn occupies 50 to 60 per cent of the cultivated area with oats, hay, barley, soybeans and wheat occupying the remaining acreage.

There were 126 farms in Towanda Township in 1928 with an average size of 184 acres. At the present time there is no woodland whatever in the township; 81.4 per cent is in crops, and 18.6 per cent is in pasture.

Farm facilities such as tractors, telephones, automobiles, furnaces, radios and running water, are common throughout the township. The farm homes are well built and well kept. The rural schools are better than the average.

The animal distribution shows that hogs are becoming important, that cattle feeding is not profitable, that sheep show a notable increase, that the work usually done by horses and mules is being carried on by machinery, and that poultry raising is important.

A large percentage of the land is still held by descendants of the original owners. The farmsteads are attractive and well equipped.

Towanda Township is a typical well developed region of the Corn Belt and it represents a well-to-do community in the open country.

A CHILEAN VINEYARD

BY

Robert S. Platt

University of Chicago, Chicago, Illinois

ABSTRACT

The Viña Conchalí is in the heart of Chile in the Central Valley. The district is semiarid and development depends largely on water for irrigation provided by streams from the high Andes. A share of the water diverted from the Rio Mapocho above Santiago and carried in a canal along the valley side is delivered to the Viña Conchalí at the upper edge of the property and thence distributed in a carefully laid out system of ditches reaching every field.

The size of the property is 275 acres, of which 100 acres are in steep slopes of the mountain foot and 175 acres are in the valley plain.

In this setting the owners have developed a high grade wine vineyard. The valley land of alluvial silt, deep and fertile, well drained and well watered, is divided by ditches and roads into 40 fields, practically all occupied by vines. The slope land is unimportant, being given over mainly to untilled pasture. In addition there are small patches of subsistence crops distributed along the base of the slope and along the main road near laborer's dwellings.

There are 26 small houses in which live the fixed inhabitants of the estate, Chileans of mixed white and Indian blood. The Chilean proprietors of the vineyard do not live on the property. The principal house is occupied by the manager, a Frenchman skilled in wine production.

The wine making establishment is at the main transportation focus of the estate, a location reflecting the need for immediate treatment of the perishable crop and also the incentive to nearby reduction of the bulky fruit to a more compact product. After a period of seasoning in storage vats the product is transported by truck to a warehouse in Santiago whence it is distributed to the Chilean market. The functioning of the whole establishment moves in the annual cycle of grapes and wine.

The Viña Conchalí is typical of one sort of development in central Chile. In addition there are grain farms, livestock farms and fruit orchards. These all are in contrast with rural establishments in other parts of Chile—unirrigated farms of the forest region a little farther south and subtropical oases few and far between in the desert regions to the north.

PAPERS IN GEOLOGY

EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN

All of the papers given before the meeting of the Geology Section are here represented.

Average attendance at the meeting was forty-five, maximum was fifty-five.

Mr. Charles H. Behre, Northwestern University, Evanston, Illinois, was elected chairman for 1933–34.

(Signed) J. E. LAMAR, *Chairman*

SOME PENNSYLVANIAN LIMESTONES OF THE CARLINVILLE QUADRANGLE, ILLINOIS *

BY

JOHN R. BALL

Northwestern University, Evanston, Illinois

ABSTRACT

The Carlinville quadrangle is in the southwest part of Illinois about 40 miles north of East St. Louis. The rocks of Pennsylvania age underlying the surficial deposits are chiefly shales and clays which disintegrate readily. Associated with them, however, are several limestones resistant enough to make ledges across the stream channels, and to make rock terraces in some of the valleys.

The limestones and their associated rocks belong to the McLeansboro series of the Pennsylvanian system. The aggregate thickness of the exposed part of the McLeansboro series is slightly over 100 feet. At least seven limestones of this sequence may be recognized quite readily. A few other instances of limestone outcrop, somewhat isolated, are known, and may prove to be different occurrences from those now recognized. The names of a few of the more important limestones follow, beginning with the oldest rock of the list: Shoal Creek limestone, Centralia limestone, Macoupin and Upper Macoupin limestones, and the LaSalle limestone.

Of this list the Shoal Creek limestone probably possesses the greatest amount of historical interest. On account of its frequent exposures in the vicinity of the city of Carlinville it has been called the "Carlinville" limestone. In all probability it has been confused with other limestones, both in the Carlinville quadrangle, and in other parts of the State. It is quite readily distinguished from other limestones of the quadrangle by its common occurrence in two prominent ledges, the upper one thicker and more massive and separated from the lower ledge by about 8 inches of dark shale. With the exception of the LaSalle limestone it is one of the thickest limestones in the quadrangle, and, with its lower member, attains an aggregate thickness of from 6 to 8 feet. In the vicinity of Carlinville it generally underlies other rocks of the McLeansboro series, but near Palmyra, in the northwest part of the quadrangle, it generally occurs as the uppermost of the Pennsylvanian rocks. This is due to the gradual inclination of all the Pennsylvanian rocks, the dip following a general southeast direction.

The Centralia limestone, lying in a stratigraphic position about 17 feet above the Shoal Creek limestone, and the Macoupin limestone, at about the same interval above the Centralia, are both quite distinct lithologically from the Shoal Creek. These two limestones resemble each other very closely, however. In some of the earlier geologic literature describing the rocks of this part of the State, occur references that imply some confusion in identity between the Centralia and Shoal Creek limestones, also. The Centralia limestone is one of the more fossiliferous rocks of the quadrangle and contains numerous brachiopods of common Pennsylvanian types. In color, texture, and in its habit of weathering, the Macoupin limestone resembles the Centralia quite closely. It may be distinguished, however, by its abundant fauna.

The LaSalle limestone is a prominent limestone. In the southeast part of the quadrangle, due to the structural attitude mentioned above, it becomes the capping rock of the McLeansboro series as far as represented in the outcrops. It is thicker, locally, than the Shoal Creek limestone, and is responsible for faintly developed rock terraces east of Carlinville.

* Published with the permission of the Chief, Illinois State Geological Survey.

THE MICROGRAPHY OF THE LEAD AND ZINC ORES OF THE UPPER MISSISSIPPI VALLEY

BY

A. F. BANFIELD

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ABSTRACT

Study of the Upper Mississippi Valley lead and zinc ores by means of the reflecting polarizing microscope leads to the following conclusions regarding their paragenesis.

The ore minerals—barite, calcite, galena, marcasite, pyrite and sphalerite—indicate deposition under low pressures and at temperatures less than the boiling point of water. No diagnostic minerals occur which prove or disprove any of the known theories of origin, but the association of marcasite and pyrite indicates that the ore solutions varied from acid to alkaline or neutral, for pyrite is generally deposited from alkaline or neutral solutions at all temperatures while marcasite is deposited from acid solutions and at low temperatures. Paragenesis of the ore minerals is as follows: (1) Pyrite was deposited first, in considerable abundance and over a long period of time. While marcastie has been considered the common iron sulphide in the past, pyrite being thought quite rare, the author's studies show that pyrite is almost as abundant as marcasite, solution and dolomitization of the Galena dolomite, which preceded ore deposition, made the country rock porous and enabled ore solutions to percolate through it and deposit pyrite, mainly by replacement, as small isolated crystals. The amount of pyrite so disseminated decreases gradually away from the fractures along which ore solutions traveled. At the point of pyrite deposition the ore solutions must have been alkaline or neutral although they may originally have been acid, the acidity being reduced by their reaction with the calcareous country rock. (2) Marcasite was deposited next as a thin band lining fractures. Its contact with pyrite forms a sharp line of demarkation while its upper surface consists almost entirely of crystal faces. The change from pyrite deposition to marcasite deposition was caused either by increased acidity of the ore solutions, or by their reaction with the wall rock being prevented by the coating of pyrite. (3) Sphalerite was deposited on the well defined crystal terminations of marcasite. Near the end of its deposition sphalerite was accompanied by galena, calcite, and soft, greenish botryoidal masses of pyrite and marcasite. (4) Galena was deposited with and after sphalerite, erratically in the flats and pitches and abundantly in the crevices. (5) Calcite commonly occupies the center of flats and pitches and hence is younger than the above minerals. It occurs in two forms—an older rhombohedral and a younger scalenohedral. (6) Barite is rare but where seen is apparently the last mineral deposited.

Summary. The ore minerals of the Upper Mississippi Valley lead and zinc deposits were laid down in the following order: (1) pyrite disseminated in country rock; (2) pyrite along fractures; (3) marcasite along fractures and to a much lesser extent disseminated in the country rock; (4) sphalerite alone; (5) sphalerite with soft greenish botryoidal iron sulphides, galena and calcite; (6) galena; (7) calcite in rare early rhombohedral forms and abundant later scalenohedral forms; (8) barite. The relation between stages 5, 6, and 7 is gradational.

THE ORIGIN AND ECONOMIC IMPORTANCE OF BEDDING PLANE MOVEMENTS

BY

CHARLES H. BEHRE, JR.

Northwestern University, Evanston, Illinois

The term "fault" is restricted in practice to such movements only as take place in planes at sufficient angle to the bedding to produce noteworthy offsets. On account of their difficulty of recognition, movements parallel to the bedding or nearly so are largely neglected, yet they are mechanically necessary under many structural conditions.

In the case of parallel folds, gliding on bedding planes necessarily results if the folding is at all measurable. The famous Bendigo saddle reefs are clearly related to such movements. In folding produced by lateral compression bedding plane movements pass upward along the limbs of the folds until they come near the anticlinal crest, where load and support from below are lessened; here on the crests they tend to pass into recognizable reverse faults—the obvious results of thrusting. Such larger movements are frequently accompanied by smaller fractures which allow internal adjustments within the hanging- and foot-walls. Such fractures are reported from numerous mining districts.

Most larger thrust faults are either nearly horizontal, in which case they are commonly almost parallel to the bedding planes, as in the Wisconsin-Illinois lead-zinc district (where the movements are small), or the fault plane curves so that the angle of dip varies as the surface is approached. It is shown diagrammatically that such a curvature tends to result in openings of considerable width along the major fault plane. These openings afford means for the ingress of solutions; hence in part the common occurrence of mineralization in lens-like masses along the dip of the plane, forming at least some of the familiar "ore shoots" of such districts as Grass Valley, California, and Leadville, Colorado. Moreover small faults whose planes intersect the major thrust at sharp angles represent a mode of adjustment by the underlying and overlying rock masses, permitting the partial "chinking-in" of lenticular openings like those mentioned. Minor faults of this origin also afford means of ingress for mineralizing solutions.

Finally, where the major fault plane is curved, as mentioned above, and intersects the bedding at a steep angle, the strata cut by the fault are put under varying horizontal stress by the shift in the bulge on the opposite rock wall. Under such conditions those beds which project farther into the fault plane than others tend to be pressed back, away from the fault. Thus again movement along bedding planes is set up.

Several faults which have been carefully studied in ground plan or vertical section or both are cited as illustrations, the examples selected being partly from the published literature, partly from the writer's experience. Their bearing on mineralization and mining problems is discussed and the conclusion is drawn that many ore deposits are definitely related to faults of the types mentioned in which the movement is essentially along bedding planes.

CLEATING IN COAL

BY

E. C. Dapples

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Cleating in bituminous coal has been observed for many years in districts where it has a marked influence upon the mining of coal although in other states such as Illinois it has been passed by unnoticed. Although most pronounced in bituminous coals, it does not seem to be a criterion of rank since it may be observed in all coals ranging from lignite through bituminous; anthracite however exhibits columnar structure. Reger and Behre in West Virginia and Pennsylvania came to the conclusion that the average strike direction of the principal cleating paralleled the local structure which in turn paralleled the principal ranges of the Appalachians.

In order to determine the persistence of the strike direction of cleating in Illinois coals, numerous readings were taken at various points. In Perry county, three miles south of Pinckneyville, the cleating in the No. 6 coal fell into two systems, N. 7°–37° W. and N. 52°–55° E. The limestone overlying the coal showed jointing in two series as follows, N. 16°–39° W. and N. 55°–65° E. At Pyatts the same coal possessed three cleat systems, (1) N. 45°–59° E., (2) N. 5°–35° W., and (3) N. 84°–85° E. Ten miles southeast at Hallidayboro, the coal showed three systems of cleats, one direction being less prominent than the others. These are listed as follows:

N. 35°–70° W.; N. 10°–19° W.; and N. 30°–40° E. (least prominent). Here as at Pinckneyville the overlying limestone was jointed in two directions, N. 53°–73° E. and N. 7°–23° W. Two miles north of Marion the same coal showed well developed cleat in a direction of N. 30°–40° W. and a poorly marked one N. 15°–38° E. Along the LaSalle anticline, at Lowell, strike directions of cleats were N. 46°–48° E. and N. 33°–55° W., while jointing in the non-carbonaceous material was exceedingly prominent in the following two systems, N. 35°–47° W. and N. 46°–55° E.

At all points of observation jointing in the non-carbonaceous strata paralleled cleating, and the prominent direction of jointing was always the strike of the pronounced cleat. It was further apparent that cleating was more pronounced along the axes of anticlines and became less marked away from the folds. Such observations are in direct accord with the conclusions of Behre and Reger for the Appalachian district. It is believed therefore, that jointing in sedimentary strata and cleating in coal are closely related, being formed contemporaneously by the same tectonic stresses rather than the result of processes of drying or coalification.

SUBSURFACE GEOLOGY IN THE EAST ST. LOUIS REGION *

BY

George E. Ekblaw and L. E. Workman

Illinois State Geological Survey, Urbana, Illinois

A study of available sets of sample cuttings from many of the deep wells in the vicinity of East St. Louis reveals some interesting problems.

The strata dip generally northerly and easterly, successively higher formations are encountered at the surface, and each outcropping formation increases in thickness away from the Ozark anticline. Pennsylvanian strata thicken rapidly in Illinois but occur only locally in Missouri. There is a marked unconformity at the base of the Pennsylvanian system. Chester strata, absent in Missouri but almost everywhere present in Illinois, thicken rapidly from west to east and from northwest to southeast, overlying the Ste. Genevieve formation unconformably. The St. Louis formation has a fairly uniform thickness, ranging from 250 to 300 feet. In Missouri it is thinner owing to surficial erosion but in Illinois it has its full thickness and is overlain conformably by the Ste. Genevieve formation whose thickness varies according to its location relative to the regional structure. It appears that to the west the St. Louis formation overlaps the older Salem and Warsaw formations, but the data are too scanty to assure the relations.

The Salem and Warsaw formations are fairly uniform but are slightly thinner to the north and east. The Keokuk-Burlington formations are also fairly uniform although they are appreciably thicker north and west than east of Mississippi River and south of East St. Louis. The Fern Glen formation is of uniform thickness in the East St. Louis region. It thins out and disappears to the west and is also lacking a short distance north and west of Alton, due probably to non-deposition. The Kinderhook series is thin everywhere and is sometimes absent in the East St. Louis region but it thickens appreciably to the north.

The combined Devonian and Silurian systems are absent in the west and their thickening to 500 feet in the east is a noteworthy feature. Most of this thickening is in the Silurian system which consists of a lower gray limestone, a middle "red rock", and an upper gray shaly limestone. These formations successively appear from west to east, showing that there is an important angular unconformity between the Devonian and Silurian systems. The Devonian system thickens from a few feet in the west to as much as fifty feet in the east. The Maquoketa formation is fairly uniform in thickness although it has some regular variations. It thins to the west, probably as a result of the same erosion that terminated the Silurian formations. The Kimmswick, Decorah, Plattin, and Joachim formations may be considered as a single unit that thickens slightly to the east. The St. Peter formation is fairly uniform in thickness although irregularities would not be unexpected. The Prairie du Chien series, consisting of the Powell, Cotter, and Jefferson City formations, and the Roubidoux formation are encountered in several wells but show no marked variations. Formations below the Roubidoux have been encountered in but few wells.

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STUDY OF THE INTERVAL BETWEEN COAL NO. 6 AND THE SHOAL CREEK LIMESTONE *

BY

M. W. FULLER

Illinois State Geological Survey, Urbana, Illinois

Stratigraphic studies of Pennsylvanian cyclothems in Illinois have shown that thicknesses of the individual cythothems vary considerably in different parts of the basin. This variation has resulted from two factors, (1) proximity to source area of sediments, and (2) differential warping during Pennsylvanian time, generally along preëxisting axes.

In general, cyclothems increase in thickness toward the southeast. This is particularly true of the sandstone and sandy shale members. Coals increase in number because of the wedging in of many new cyclothems toward the source area. Underclays and marine beds, however, generally increase in thickness toward the north and west.

In studying the general thickening of Pennsylvanian sediments to the southeast, two persistent, easily recognizable beds, coal No. 6 and the Shoal Creek limestone, were chosen and the interval between them was determined at as many points as possible. From these data an isopachous contour map was prepared. This shows a decrease in interval over known anticlinal structures and an increase in interval over known synclinal structures.

This interval has a minimum thickness of 83 feet in northwest Macoupin County on the flank of a nose of the old Ozark dome which during Pennsylvanian time was much more stable than the progressively subsiding basin. Here six cycles are represented between coal No. 6 and the Shoal Creek limestone. Several lack their sandstone, coal, and shale members. The interval is greatest in east central White County in the deepest part of the basin where 708 feet of strata are present between the datum planes and about 14 cyclothems are represented.

The most important structure in Illinois that affected Pennsylvanian sedimentation was the DuQuoin anticline. This structure was initiated at the close of Mississippian time and differential warping continued throughout the Pennsylvanian period. The interval between coal No. 6 and the Shoal Creek limestone increases markedly east of the anticline as the result of the wedging in of many new cyclothems and the thickening of clastic members of the persistent ones. The effect of the LaSalle anticline on Pennsylvanian sedimentation is less well known but was probably similar, as several sandstones wedge out on the flanks of the structure, making traps for oil and gas.

In northeast Madison County and adjacent parts of Montgomery and Bond counties there is a decrease in interval which marks the crests of the New Douglass dome and Panama anticline. In the southwest part of Marion County and adjacent parts of Clinton and Washington counties there is a decrease in interval which seems to be closely related to the structures from which oil and gas are obtained.

Because this isopachous map shows a decreased interval over known anticlinal areas, it is possible that this method of mapping will reveal previously unknown structures which might yield oil or gas.

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OUR PRESENT KNOWLEDGE OF AMERICAN COAL BALL PLANTS

BY

A. C. Noé

University of Chicago and Illinois State Geological Survey

The investigation during the past year centered about the coal balls collected in the old strip mine at Calhoun, Richland County, which has yielded much excellent material.

During previous years it was primarily the material from Harrisburg and Danville which was examined and of which preparations and microphotographs were made. As a rule, coal balls from only one locality are examined at a time in the paleobotanical laboratory of the University of Chicago where the coal ball studies for the Illinois State Geological Survey are carried out.

About 240 Calhoun coal balls were cut of which a number were sectioned and studied in detail. A research student, Mr. Roy Graham, used some of this material for the preparation of a dissertation on which he is to receive his doctor's degree at the 1933 June Convocation of the University of Chicago.

Of particular interest is the fact that the Calhoun coal is one of the youngest in the State, being of McLeansboro age. Worthen classified it as No. 13 or 14, the Harrisburg coal as No. 5, and the Danville coal as No. 7. The impending reclassification of Illinois coals according to cyclothems will undoubtedly give other numbers but their relative positions will not be materially changed.

The fossil plants found in Calhoun coal include a number of species of Calamites, Sphenophyllum, Lepidophloios, Lepidodendron, various ferns, such as Anachoropteris, Botryopteris, Corynepteris, Scolecopteris, Ptychocarpus, Cyathotrachus, Psaronius, a new fern genus, Sphaerotheca, a number of Cydofilicales such as Heterangium, Telangium, Conostoma, as well as a Gymnosperm, Cordaites.

The time-saving cellulose peel method has been used almost exclusively in preference to cutting individual coal ball sections and grinding them down to microscopic thinness. After the coal ball is cut in two or more portions and has been found to contain valuable information, its cut surface is smoothed. Afterward this surface is etched with diluted hydrochloric acid which removes a thin layer of the limestone matrix but leaves all organic enclosures intact. A solution of cellulose acetate in acetone or of parlodion in equal parts of absolute alcohol and ether is poured on and left to dry until a solid film forms. This film, which is easily removed, contains the organic particles in exactly the same position which they held while imbedded in limestone. In other words, we have a very thin section where calcium has been replaced by cellulose. This method has been improved by Mr. Graham, who used nitro-cellulose dissolved in butyl acetate (see "Stain Technology," April, 1933 for more complete report). In microphotographs prepared from such cellulose peels, the minute spores show extremely well, even at a magnification of 1,000 diameters.

The floras of all Illinois coal balls so far investigated can be correlated with the fossil plants of the Stephanian group of the Upper Carboniferous period in England and the continent.

THE CHERT OF THE NIAGARA SERIES OF THE CHICAGO AREA

BY

JOHN R. SCHULTZ

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The chert of the Niagara series in the Chicago area shows the following field relationships, which are believed to be diagnostic:

(1) Many of the chert bands branch laterally into two.

(2) Many nodules show finger-like projections which penetrate the wall rock at right angles to the bedding.

(3) Several steeply inclined layers or "feeders" of chert, which connect above and below with nearly horizontal bands, were observed in the Joliet quarry.

Other important features, but of less diagnostic value, are (a) silicified fossils in the chert and wall rock, (b) irregular inclusions of wall rock in the centers of many nodules, (c) silicification along joints and bedding planes, (d) distribution of the chert along bedding planes and along the tops of shale intercalations, and (e) arching of shale stratification around chert nodules.

It is thought that the chert has originated through segregation of siliceous material from out of the Devonian shales which formerly covered the area, and in part from the finely divided siliceous matter originally present in the Niagaran series itself. The agent effecting the segregation was, in all probability, circulating ground water. Colloform structures in the chert indicate that the silica was carried in solution as a colloid, and was precipitated by reaction with the carbonate wall rock.

Microscopic evidence indicates that the silica was originally precipitated as a gel, which later crystallized into various forms of hydrated, crystalline silica, later recrystallization of which converted a part of the mass into quartz.

The chert replaced, and to a smaller extent displaced, the surrounding wall rock. Cavity filling seems to have been relatively unimportant.

PENNSYLVANIAN ROCKS OF MADISON AND ST. CLAIR COUNTIES, ILLINOIS

BY

H. R. WANLESS

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Madison and St. Clair counties lie on the western edge of the Eastern Interior coal field. The contact of the Pennsylvanian and Mississippian systems crosses western St. Clair County and western Madison County, touching the Mississippi bluffs near Alton. It lies concealed beneath recent alluvial sediments in the American bottoms. A large outlier of the Eastern Interior coal field occurs in the eastern part of St. Louis County, Missouri. The succession of Pennsylvanian strata exposed in these counties ranges through the Pottsville, Carbondale, and lower McLeansboro formations or from the Babylon to Macoupin cyclothems of the classification introduced by the writer and J. M. Weller. The succession of strata in this district are abnormally thin, due to the influence of a weakly positive area along the eastern flank of the Ozarks which, during most of the Pennsylvanian period, stood above the profile of equilibrium and did not receive as thick accumulations of sediment as the trough to the east. The St. Louis area lay rather on the southwest edge of this Ozark flank, and its effect on sedimentation is even more pronounced northward, in Jersey, Greene, Pike, Calhoun, Brown and Adams counties. Southward from the St. Louis region, and even in the eastern parts of Madison and St. Clair counties, the section of strata thickens notably, and in southeastern Illinois the zone represented in these counties by less than 500 feet of sediments is represented by over 2000 feet. Shales, sandstones and coals are the strata which have thinned most notably in this area, and limestones and more or less refractory clays make a much larger portion of the section than elsewhere.

THE WARSAW FORMATION[1]

BY

J. MARVIN WELLER

Illinois State Geological Survey, Urbana, Illinois

Since Hall proposed the name Warsaw in 1857[2] for strata between the Keokuk and St. Louis limestones, the limits of this formation have been revised several times.[3] In 1908, Stuart Weller[4] correlated the upper eight feet of this formation at its type locality with the Salem limestone of Indiana and since that time it has been customary to recognize both the Warsaw and Salem formations in the Mississippi Valley. Because the Warsaw formation as thus restricted was considered equivalent to the Harrodsburg limestone of Indiana, the latter name has been abandoned.[5]

Practically all of the common Warsaw and Harrodsburg fossils are present in the Salem limestone of Indiana but in the Salem there also occurs a variety of small molluscs associated with innumerable shells of *Endothyra baileyi*. This is known as the Salem or Spergen Hill fauna and on its basis the Salem limestone was recognized in the Mississippi Valley. It is now known that this fauna is of no value for precise correlation but records a peculiar environment that existed at different times in different areas. It first appears in the Short Creek oölite at the base of the Warsaw formation in southwestern Missouri, and recurs in the Salem limestone of Indiana, in the so-called Salem of Ste. Genevieve County, Missouri (probably in part of lower St. Louis age), and in the Ste. Genevieve limestone at various places. Very similar forms occur in Chester and Pennsylvanian strata.

From Alton, Illinois, northward, beds referred to the Salem do not resemble the typical Salem limestone lithologically or faunally. Except for a small area in and adjoining southeastern Iowa where the so-called Salem is separated by an unconformity from the underlying Warsaw (restricted), there is no more basis for their differentiation than there would be for the recognition of the upper and lower divisions of the Warsaw (restricted) as distinct formations. It is doubtful that the so-called Salem-Warsaw (restricted) boundary in the Mississippi Valley is drawn at exactly the same horizon as the Salem-Harrodsburg boundary in Indiana or that the lithologic change at which the former is drawn occurs at even an approximately uniform horizon between Hancock and Monroe counties, Illinois. Because of these and other uncertainties it seems unfortunate that the Warsaw formation should have been restricted, thus causing the abandonment of such a well established name as Harrodsburg, particularly as it is impracticable to attempt any subdivision of these beds in some areas where a single name for this entire interval would be convenient.

It is proposed, therefore, to restore the Warsaw formation to its early status, assigning to it all beds between the Keokuk and St. Louis limestones as these are now limited. Where desirable the Warsaw formation may be subdivided into more or less local members.

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[1] Published with the permission of the Chief, Illinois State Geological Survey.

[2] Hall, James, Observations upon the Carboniferous limestone of the Mississippi Valley: Amer. Jour. Sci., ser. 2, Vol. 23, p. 193, 1857.

[3] Hall, James, Report on the Geological Survey of Iowa, Vol. 1, p. 97, 1858.
Weller, Stuart, The Salem limestone; Ill. Geol. Survey Bull. 8, p. 163, 1908.
Butts, Charles, Geology and mineral resources of Jefferson County, Kentucky: Kentucky Geol. Survey, ser. 4, Vol. 3, pt. 2, p. 157, 1915.
Van Tuyl, F. M., The stratigraphy of the Mississippian formations of Iowa: Iowa Geol. Survey Vol. 30, p. 185, 1925.

[4] Weller, Stuart, *Op. cit.*

[5] Butts, Charles, *Op. cit.;* Cummings, E. R., The nomenclature and description of the geological formations of Indiana: Indiana Dept. Cons., Pub. 21, p. 493, 1922.

THE STRATIGRAPHIC POSITION OF THE HOING SAND *

BY

L. E. WORKMAN

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The "Hoing sand" is a stratum of sandstone and sandy dolomite, that bears oil and gas in the Colmar-Plymouth Field of southwestern McDonough County in western Illinois. It was encountered at a depth of 417 feet in an oil test well on the J. Hoing farm and from this farm it received its name.

The "sand" varies from a porous, white to brown, quartz sand to a more or less porous, brown, sandy dolomite. The sand grains are of fine to medium size, apparently having been well rounded and frosted at the time of their deposition but now more or less coated with secondary crystalline quartz. The dolomitic sandstone and sandy dolomite have a matrix of brown dolomite crystals the size of silt. Scattered fragments of brown resinous *Sporangites huronense* are found in both the sandstone and sandy dolomite. The Hoing sand lies on a dark brown, highly bituminous shale of the Maquoketa formation and is overlain by brownish gray, coarsely granular to lithographic limestone in which sand grains of the Hoing sand type are common.

The Hoing sand was originally interpreted by Savage and Blatchley[1] as being of Devonian "Hamilton (?)" age, and the statement was made that the oil occurs "in a sandy limestone that is doubtfully identified with the lower part of the Devonian or the upper part of the Silurian systems." In later studies, after considerable drilling had been done in the field, Morse and Kay[2] definitely assigned the Hoing sand to the base of the Niagaran series. It was interpreted as "sand that was washed into the valleys and low areas when the Maquoketa shale was land surface and exposed to erosion," and that it was "reworked by the Niagaran sea."

Studies of numerous sets of sample well cuttings from Western Illinois bring out the following points regarding the stratigraphic relationships of the Hoing sand: (1) The unconformity at the base of the Silurian does not extend through the Maquoketa shale in this region and the Maquoketa does not have any sand grains of the Hoing sand type which might be left as a residual product of erosion to be concentrated by Silurian seas as the Hoing sand; (2) sand grains of this type are not found in the undoubted Silurian beds anywhere in this region; (3) there are no typical Silurian beds above the Hoing sand in the Colmar-Plymouth field; (4) sand grains of the Hoing sand type are characteristic of basal Devonian strata in this region and elsewhere in Illinois; (5) the Hoing sand in the Colmar-Plymouth field grades upward from porous sandstone into dolomitic sandstone and finally into sandy, dolomitic limestone of undoubted Devonian age; (6) the Hoing sand and the limestone beds above it contain *Sporangites huronense* common in Devonian strata; (7) the Hoing sand horizon is encountered in wells westward from the Colmar-Plymouth field where the Devonian unconformity successively overlaps Maquoketa and Kimmswick formations of Ordovician age.

It is therefore concluded that the Hoing sand is Devonian in age.

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[1] Blatchley, R. S., "Plymouth Oil Field," Illinois State Geol. Survey Bull. 23, pp. 51-53, 1917 (Extract published 1914).

[2] Morse, W. C., and Kay, F. H., "The Area South of the Colmar Oil Field" and "The Colmar Oil Field—A Restudy," Ill. State Geol. Survey, Bull. 31, pp. 8-55, 1915.

PAPERS IN PHYSICS

EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN

The Physics Section held a joint session with the Chemistry Section for the first five papers (see Papers in Chemistry) after which the two groups separated. Six papers were given before the Physics Section, only four of which are here represented. Those not included are:

"Photoelectric Effect of Caesium Vapour," by Jacob Kunz, University of Illinois, Urbana, Illinois.

"An Electron-coupled Harmonic Amplifier," by David B. Chapman, University of Illinois, Urbana, Illinois.

Attendance at the meeting ranged from thirty to fifty.

Dr. Jacob Kunz, University of Illinois, was elected chairman for 1933-34.

(Signed) O. B. YOUNG, *Chairman*

INVESTIGATION OF CABLE INSULATION BY IONIZATION CHARACTERISTICS

METHODS OF DETECTION AND MEASUREMENT OF IONIZATION IN DIELECTRICS *

BY

J. TYKOCINSKI TYKOCINER

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SUMMARY

The results of the investigation on methods of detection and measurement of ionization in dielectrics may be summarized as follows:

(1) The assumption of the existence of surges and oscillations due to ionization in dielectrics has been experimentally verified.

(2) These oscillations were studied and utilized in the development of apparatus for detecting and measuring the relative intensity of ionization.

(3) Characteristic curves were obtained which correlate the applied voltage and the effective values of oscillations due to ionization. These curves make possible the study of the effect of applied voltage on certain properties of dielectrics and especially of cables.

(4) The existence of a time effect in connection with the intensity of oscillations due to ionization and the applied voltage has been ascertained.

(5) It was found that the time effect is characteristic of the quality of a cable in regard to impregnation and to a property which tends to shift the voltage at which copious ionization sets in.

(6) Ionization in a cable can be detected by radio-engineering methods, utilizing the electric impulses which ionization produces.

(7) A large range of frequencies was used in designing the apparatus. Frequency ranges as high as 30,000 kc. and as low as 100 kc. were tried and all gave similar results. Also audio-frequencies of about 2 to 5 kc. have been utilized in a great number of investigations on cables.

(8) The radio-frequency oscillations produced by ionization were utilized in three different ways. The first method was to amplify the magnitude of modulated radio-frequency currents and measure their effective values with thermoelectric and thermionic instruments. The second method was to apply intermediate detector action, and to measure amplified group frequency. The third method was to suppress the radio frequencies by rectification, and to select definite group frequencies for measurement.

(9) The utilization of lower group frequencies necessitated the use of special bridge arrangements for balancing the charging current. On the other hand the application of higher frequencies required special provision for guarding against interference from outside electromagnetic fields.

(10) The curves obtained with both types of apparatus are similar in character. They give the relation between the voltage applied to the cable and the intensity of the sum of the oscillations produced in a cable when ionization takes place.

(11) Both types of surge-measuring apparatus indicate the existence of bubbles and airpockets in a cable, if provision is made to prevent discharges taking place in transformers, condensers, and other parts of the circuits connected with the cable. They may thus be used as impregnation-testing apparatus.

* Published in full in University of Illinois Engineering Experiment Station Bull. 259, 1933.

(12) An application was made of the radio-frequency method to the testing of samples of paper moving between rotating nickel electrodes in air. Characteristic curves were obtained showing that the voltage at which corona discharge sets in, and the relative effective values of oscillations produced, are indicative of the character of the surface and texture of the paper.

(13) Methods have been devised for locating sources of ionization in cables. The underlying principles were verified by a number of experiments. Their applicability for testing of cables, however, was found to be limited to special cases.

Conclusions.—The following conclusions may be drawn from these results:

(1) In the oscillations associated with ionization in the form of discharges in dielectrics, especially in cables subjected to high alternating potentials, a clue has been discovered which makes possible the detection of early stages of deterioration.

(2) The various methods developed for measuring these oscillations have laid the foundation for the study of composite dielectrics from a new point of view, namely, that of correlating the processes which take place in dielectrics with the frequencies, amplitudes, and wave form of these oscillations.

(3) With the embodiment of these methods into apparatus new tools have been added to the equipment of research and testing laboratories. These apparatus may serve to control the processes of manufacturing condensers and cables, to safeguard their operation, and to assist in systematic work towards improvements.

A BALANCED BRIDGE FOR TESTING INSULATION*

BY

HUGH A. BROWN

University of Illinois, Urbana, Illinois

In the course of an investigation of the methods of testing high voltage cables apparatus for directly detecting the presence of ionization, discharges in the gaseous voids in the cable insulation under potential stress were evolved. The apparatus and method is readily adaptable to the testing of various types of dielectrics. To make the minute discharge detectable the 60-cycle cable charging current was balanced out with a special capacitance bridge. This bridge is composed of the cable under test, a discharge free zero loss air condenser and two resistance and inductance ratio arms. Variable resistance and inductance is placed in each ratio arm. The junction between the ratio arms was grounded, and the opposite junction (between cable and condenser) was connected to one high voltage testing transformer secondary winding terminal. The other terminal of this winding was grounded. This bridge is adjusted for an amplitude balance of the 60-cycle charging current of the insulation sample and air condenser. Phase balance need not be obtained. When the bridge is thus balanced the presence of the ionization discharges in the cable or other insulation sample can be detected by the characteristic sound in a telephone receiver connected to the output diagonals of the bridge through the medium of a bridge output transformer and a suitable vacuum tube amplifier. A preliminary amplifier followed by an effective inductively coupled filter is provided between the bridge output transformer and the final amplifier, to suppress the unbalanced 60-cycle residue and its harmonics. This makes the ionization discharge more readily

* Published in full in University of Illinois Engineering Experiment Station, Bulls. 259 and 260, 1933.

detectable, and with an output meter connected to the second or final high gain amplifier the comparative intensity of the discharges may be determined.

A known 5,000-cycle voltage is used to calibrate the entire apparatus. The coupled filter is designed to pass a band of frequencies of from 4,000 to 10,000 cycles. The conglomerate discharge frequencies lie within this band. When using a properly designed coupled circuit filter system between stages of the amplifier, the discharge free air condenser may often be dispensed with, so that the amplifier magnifies the ionization discharges. Disturbances caused by the ionization discharges are produced in the variable inductance in circuit with the cable, and these pass through the filter to be amplified. When the apparatus is used in this manner it is found that there is an optimum adjustment of the variable inductance in circuit with the cable for the greatest deflection of the output meter. Thus a complete or partial resonance effect of the circuit to the conglomerate discharge group frequencies of 4,000 to 10,000 cycles is indicated. The apparatus described may be used to test the variation of ionization discharge intensity in a cable with variations of cable voltage, time, cable temperature, etc. Peculiar behavior of the ionization discharges has been noted when such tests are made. Oil filled cable was found to be free from discharges, and the apparatus showed discharges to exist when a small amount of air was pumped into the oil filled cable through a hole in its sheath. If the output meter is replaced by a telephone receiver the presence of the discharge is recognized by a cracking or frying noise. In case of very minute discharges a fine sizzle or hissing sound is obtained. The sound characteristics of various kinds of discharges make an interesting study. The apparatus may be used to detect and measure the ionization discharges in other types of insulation, and it may be used to detect the presence of corona discharges at voltages considerably below those required to produce visible corona.

COMPARATIVE STUDY OF THE EFFECT OF DISCHARGES IN CABLES *

BY

ELLERY B. PAINE

University of Illinois, Urbana, Illinois

SUMMARY

Many peculiar and interesting characteristics of the detectable and measureable ionization discharge currents in paper-insulated cables were discovered. Among the more important is the fact that the insulation is a complex dielectric including solid, liquid, and gaseous materials, in which crystal and amorphous structures may change from time to time with changes in potential gradients, temperatures, chemical products of corona discharge, etc. Ionization discharge starts at a certain voltage impressed upon the cable and increases with the voltage, at first rapidly, then at a decreasing rate. In practically all cables the ionization discharge intensity, as directly measured with a bridge, will occur at voltages below those at which any change in power factor is noticeable. In many cases power factor remained constant, or decreased slightly with increasing voltage, but the ionization discharge intensity, although of low value, increased in proportion to the applied voltage raised to a power greater than unity.

* Published in full in University of Illinois Engineering Experiment Station Bull. 260, 1933.

Comparative studies and results indicate that the falling off characteristic of the ionization discharge with time is due to ionization discharges which are fixed locally in certain gaseous voids in the cable insulation. The cumulative rise of discharge current for the first minute is a phenomenon that has had no parallel which would suggest an explanation. When the ionization discharges do not fall off during the first 30 minutes it is believed that the discharges in the gaseous voids or spaces migrate or shift in their locality. Oil is drawn into electric fields, but special experiments showed that ionization discharges disrupt and scatter oil films in the vicinity of the discharges. Distribution of cable oil or compound is thus effected. This conclusion was arrived at by studies of thin transparent films of mixtures of saturant and air in which electric fields and ionization discharges were active. The increase in power factor did not follow the increase and decrease in ionization discharge immediately. The change in power factor may be due to an end result of previous time-ionization phenomena.

Practically all solid cables showed a certain amount of ionization discharge upon cooling from an elevated temperature down to some critical temperature above the normal ambient value. When a cable is in the process of deterioration, or when a local hot spot is present, the ionization discharge intensity at this particular interval of the cooling may reach intense values.

The impregnation of the paper and interlayer spaces often improves with use, due to redistribution of the saturant, infiltration of oil from joints, terminal potheads, etc.

Oil-filled cables were found to contain no ionization discharges either at operating temperatures or ambient temperatures.

New cables which have recently been manufactured, and have not been in use, nor out of the lead presses in the factory for more than one or two weeks often give ionization discharges which are greater in intensity than those occurring with these same cables, or like cables, when they have been allowed to stand or have been put into actual use. They show formation of voids upon cooling. These characteristic ionization discharges in new cables may in some cases result in slight damage to certain parts of the surface of the insulated paper before they shift or disappear, due to better distribution of the saturant. Although the power factor remained constant for varying voltage, the ionization discharge intensity increased with voltage.

Insulated wires may show considerable ionization discharge within the porous structure of the insulating material, particularly in the case of weather-proof wires, and also in the case of rubber-covered wire, to a certain extent, when the rubber has aged considerably. The existence of the ionization discharges in these pores evidently increases the potential gradient in the solid dielectric portions of the insulation in rubber insulation which has aged to a considerable extent.

Ionization discharges of considerable proportions will exist between the surface of wire insulation and a flat metal contact plate at potential gradients considerably below the value necessary for visible corona discharge, and investigation indicates that this invisible corona has a small but definite deteriorating effect upon the rubber insulation at the line of contact. The physical effect may be that of corona cutting on a small scale.

PHYSICS BOOKS OF HISTORICAL INTEREST IN THE COLLEGES OF ILLINOIS

BY

CLARENCE R. SMITH

Aurora College, Aurora, Illinois

The writer of this paper has been prompted to his theme by two experiences which came to his attention and by an experience of his own, all having to do with the resources of small college libraries in the line of old books. The personal experience was to find in the dead storage of the library of the college of his own employ, an old leather bound volume bearing on its back the simple title, "Newton's Chronolog." This book was stacked among other old theological books, and had been overlooked by many persons of theological interests who apparently did not stop to think that the writer of this volume might have been of far greater fame in other fields. Persons of scientific bent who had passed by this simple title probably did not consider that a writer of a book on theological matters could actually be the great "Sir Isaac" himself. The book was published in Dublin in 1728. How it came into our possession is a mystery except that it doubtless was in some one or other of the numerous private collections which have been presented to the college throughout the years of its history. The book is now in careful keeping and not classified among our resources in theology but a prized possession of our department of physics.

The ordinary college seems to be in a position almost unique for the collection of old books. The heirlooms from many a book lover fall into the hands of descendants who have other tastes. What more kindly disposition could be made of the books than to give them to the college which has already advertised the limitations of its library and its needs for help?

It seemed to be a worth while experiment to choose a field—in this case physics—and tabulate the resources of the various colleges of Illinois as to books of historical interest. The three larger universities of the State were not included since their resources would naturally be large and it was expected that they might obscure the main purpose of the project; namely, to organize resources not commonly recognized. To all the other institutions giving college degrees, a letter was written explaining the project and requesting them to send lists of their books in physics published previous to 1883 and written in English.

The list finally compiled includes 121 titles and represents the replies of sixteen colleges. Among the colleges which failed to respond, the larger institutions were most numerous, probably due to the larger amount of labor required to examine their more extensive collections. It is hoped that this report may serve to stimulate interest that will later lead to more extensive organization of this kind not only in physics but in other fields.

NOTE.—Mimeographed copies of the book list may be obtained gratis from the author.

Papers In Psychology and Education

Extract From the Report of the Section Chairman

The program of the Section in Psychology and Education consisted of four papers, all of which are here represented.

The acting chairman was reelected for the year 1933-34.

(Signed) Ralph W. Pringle, *Chairman*

THE QUALITY OF EXTENSION WORK

BY

CLEM O. THOMPSON

University of Chicago, Chicago, Illinois

ABSTRACT

Many criticisms have been made of the extension programs carried on by institutions of higher learning on the grounds that the quality of the work done by students in extension is beneath the level of academic respectability. Work done off campus in some instances may be of a questionable character, but there is no valid argument to support the conclusion that the extension method of instruction is fundamentally unsound when applied to certain subjects. Existing evidence indicates that this method of instruction, applied to non-laboratory courses, is equal if not superior to the classroom method. Supplementing the existing literature on this problem is a recent study made by the writer.

The data show clearly that students receive higher grades when studying by correspondence than when working on the campus. When the factors, instructors and courses, were constant, the difference in favor of students studying by correspondence is over one-half letter grade, and when the factors, students and departments, were constant the difference was over two-fifths of a letter grade in favor of work done by correspondence.

The quality of work done in extension classes is about the same as of that done on the campus. Here, when the factors, instructors and courses, are held constant the difference is two-tenths of a grade point in favor of studying in extension classes; when the factors, students and departments, are held constant, the difference, only one one-hundredth of a grade point, is in favor of work done on the campus.

The significance of these findings is pertinent to the training of teachers-in-service. All of us are aware that there are many teachers now at work who hold life certificates who, because of economic conditions, cannot attend formal classes. But by the extension method of study these teachers can be led to keep up to date. The extension method should also appeal to those who cannot afford to continue their studies toward the completion of a curriculum. May we arrive at the point where we measure an education for what it is worth, not by the geographical location of the student while at work.

THE UNMEASURED VALUES IN EDUCATION

BY

George D. Wham

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ABSTRACT

Notwithstanding the acknowledged benefits of the use of standardized objective tests, a teacher may be permitted to doubt their present adequacy to measure the ultimate outcomes of education, and to raise the question of whether as commonly used they may not be producing an unwarranted over-emphasis of such outcomes as can be objectively measured, and conversely a wholly unwarranted under-emphasis, if not neglect, of certain tremendously significant values that cannot as yet be objectively and quantitatively measured. If teachers are judged wholly by objective results, naturally they will teach to secure outcomes that can be objectively tested; and just as naturally will they tend to lose sight of the imponderable and at present unmeasurable outcomes, however significant they may be.

Three great educational values are in constant need of emphasis: the *intellectual*, involving not only organized conceptual knowledge but also the cultivation of thought power in its use; the *ethical*, involving goodness and the cultivation of a sensitive concern for the welfare of all; and the *aesthetic*, involving beauty with its soul-stirring sublimation and glorification of the experiences that make up life. These three values I conceive to constitute the very essence of a civilized personality, the very outcomes essential to the operation of a successful democracy.

As previously affirmed, no one of these values has gone a great way toward adequate realization. Much less is there any objective or quantitative test now in existence that can enable a teacher to do more than conjecture how much capacity a given pupil may have in the future in any one of them. As to *thought power*, there is no way of telling how much ability a given pupil may have in future years to assemble his resources of knowledge and through sustained thinking arrive at a solution of some great and intriguing life problem. As to *ethical behavior*, there is no way of telling how much capacity a given pupil may have in the complex cross-currents of his future life to inhibit the selfish and shortsighted desire when promised the kingdoms of the world. As to *aesthetic appreciation*, there is no way of telling how much responsiveness a given pupil may prove to have to the massed glory of light and shade and color of a great picture, or which of two pupils will slump in his seat and which ascend to the seventh heaven in response to the tremendous tone pattern of stimulation of a symphony orchestra.

I may in closing be allowed to express again my misgivings that the success with which the outcomes of some of the techniques and the verbal formulations may be objectively measured may be contributing a sad by-product of neglect of these finer and far greater values that cannot be so measured. As some evidence that I am not wholly eccentric and unsupported in the position I have taken, I close by quoting a typical opinion of a thoughtful educator, Dr. Ambrose L. Suhrie, of New York University:

"The very gratifying progress we have made during the past decade or two in measuring native capacity and the more or less tangible aspects of achievement has unfortunately been accompanied by a deplorable neglect of many of those intangible aspects of spiritual growth which are as yet unmeasurable. We are sometimes almost forced to the conclusion that to do a little good we have quite unintentionally done a great deal of harm."

RELATIVE EFFECTIVENESS OF DIFFERENT REVIEW INTERVALS

BY

H. A. PETERSON, MARY C. ELLIS, NORINE TOOHILL, AND PEARL KLOESS

Illinois State Normal University, Normal, Illinois

Very little of an experimental nature has been published on the question of when one should review. Lyon's work included no experiments on this question.[1] Our own are but a beginning.

(1) *Comparison of a two-day with a seven-day interval.* Here we compared the effects of a review placed two or three days after learning with one seven days after learning, the tests having been given on the 10th and 21st days after learning. The subjects were freshmen in elementary psychology at the Illinois State Normal University. The equivalent group method was used, there being three groups of 14 each in the first trial, and 21 in each of three groups in the second trial. Two trials were made to increase reliability. One of these groups reviewed two or three days after learning, the second, seven days after learning, and the third had no review. The materials were 6-page passages of historical and psychological reading matter of suitable difficulty. The directions were to study them in the manner customary in social science classes. The study time was 50 per cent more than the reading time of the selection. At the close of the study time a question-and-essay-answer test was given. The reviews were duplicates of the original learning conditions, except that there was no test. Ten and 21 days after learning all of the groups were tested, using the same test as on the previous occasion.

Results. In general there was a slight advantage for the shorter interval, but the difference was not great enough to be significant. We think that what happened was that the advantage of an early review before much fading out had occurred was about compensated for by the advantage of a review near testing time.

(2) *Comparison of a one-day and a nine-day interval.* Here each advantage was increased in intensity. The result was the same as before; the reviews after these intervals were approximately equally effective. In this experiment the subjects were sophomores, and the materials were of the ordinary sociological reading matter variety. One of them was 11 pages long and rather difficult.

Conclusion. While of course memory fades in the manner depicted by the usual curves of forgetting, the situation is complicated by the relation of the reviews to both learning and the times of reproduction. A review that occurs soon after learning rescues more from oblivion than one that comes later, but it is also longer in advance of the time when the information will be used than is the later review. In the cases tested above these advantages appear to be about equal in strength.

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[1] Lyon, D. O., The Optimal Distribution of Time: Jour. of Ed. Psych., 1914.

A PSYCHOLOGICAL VIEW OF THE DEPRESSION

BY

J. A. MELROSE

James Millikin University, Decatur, Illinois

The depression is called an economic depression because its acute symptoms are economic. The name is inadequate. We have economic plenty but bad distribution and the basis of the latter is inadequate social and moral thinking.

Human culture started with original nature and its needs. That nature and those needs are basicly unchanging. The latest baby born presents to our complex culture essentially the same nature that babies presented to incipient culture before the dawn of history. Culture is never "passed on"; it is created anew in each generation upon the original nature and needs of babies and growing youth. Original human nature started all culture and continues to be the basis of all sound cultural norms.

Man has a dual nature of '*feeling*' and '*sensation*' which function over definite and distinct mechanisms in his body. These basic factors of his nature and intelligence are the foundations respectively of his '*spiritual*' and '*physical*' experience and become generalized socially under the respective terms of *culture* and *civilization*. Feeling is the deeper element; it lodges close to the life of the self and responds to the sensory or physical world with accepting or rejecting reactions. It is the center of values and choice, viewed in common sense terms.

A well ordered culture must keep '*feeling*' and '*sensory*' factors in the same general relation to each other that they have by nature in the functioning of the human individual. Progress does not consist in a mere increase of material resources. It is a dual process depending upon the intrinsic duality of human nature and need. Social progress involves both a material advance and a progressive readjustment of this advance to human and social needs. When this latter adjustment lags a "moral deviation" occurs which threatens the stability of the whole culture.

The principle of coordination between the '*physical*' and the '*spiritual*' factors of human nature and human culture has the widest generality of all social principles. Religion (when not exploited) has addressed itself in all ages to the task of maintaining this basic cultural equilibrium. This is why all primitive religions consider their religion their "prosperity policy."

The Middle Ages overstressed *feeling* and built culture too much around it. They neglected *sensory* knowledge. Modern times reacted from this extreme and in time swung to the other extreme. There has been overweening interest in material progress to the neglect of values. This movement has in turn run its course and as there has been no adequate guidance back to cultural balance there has been going on a blind retreat back to feelings to be noted in individualism in thought, religion, and morals, and a lapse from the *head* to the *viscera* in expressionism in art, the cult of unintelligibility in literature, Emperor Jones in opera, and jazz in music. Material upperstructure cannot continue to rise while cultural foundations weaken and give way.

PAPERS IN ZOOLOGY

EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN

The Zoology Section, after the first five papers on the program, divided into two groups to hear separate programs of eight papers in Zoology and seven in Entomology.

Articles not here represented are as follows:

"Morphological and Life History Studies on *Stylet cercariae*," by D. B. McMullen, Monmouth College, Monmouth, Illinois.

"Temperature Effects on the Heart Rate of Double Embryos of Fundulus," by Marie A. Hinrichs, Chicago (read by title).

"Some Studies on Guppyi, (*Lebistes reticulatus*)," by Vernice Rathwell Wodrich, Bradford, Pennsylvania (read by title).

"The Pretarsus (Articularis) in Coleoptera," by W. P. Hayes and C. W. Kearns, University of Illinois.

Average attendance at the meeting was thirty, maximum was forty-two.

It was voted to leave the selection of the chairman for 1933-34 to the Council.

(Signed) WILLIAM P. HAYES, *Chairman*

A CONCEPT OF SPECIES AMONG FISHES

BY

DAVID H. THOMPSON

Illinois Natural History Survey, Urbana, Illinois

AN ABSTRACT OF ORIGINAL OBSERVATIONS

Counts of the numbers of spines and rays in the fins of darters show that the degree of difference between the mean spine or ray counts of two populations increases as the water distance between these populations increases. It has not been possible to relate these differences in mean spine or ray numbers to differences in the environment.

During the past two years counts have been made of the spines and rays in the fins of many other kinds of Illinois fishes. By using the mean number of spines or rays in each of the seven fins of each of the spiny-rayed fishes of the state (a group comprising 47 species), we have been able to calculate coefficients of difference (the average of seven percentage differences) between any two species. These coefficients of difference for all combinations have been summarized in a table. From this table it is possible to construct a family tree showing the degrees of relationship of these 47 species, as well as their relative rates of evolution. This biometrical family tree of spiny-rayed fishes corresponds very closely to those family trees constructed by systematic ichthyologists from a much wider range of characteristics and is less open to criticism since it involves the experience and judgment of the investigator to a smaller degree.

Sterile hybrids are found in nature which involve six kinds of Illinois sunfishes. The occurrence of hybrids between certain described species and genera of sunfishes and not between others offers the possibility of an empirical test of the validity of coefficients of difference as indices of degree of relationship. The parents of 14 known hybrid combinations all show coefficients of difference below 4.7 per cent. Furthermore, combinations of these six species which are known to enter into sterile hybrids are the only ones which show coefficients of difference smaller than 4.7 per cent. Other nearly related species among which we are fairly certain hybrids do not occur show coefficients exceeding 5.7 per cent. For example, the two species of crappies, which from external appearances and general morphological characteristics resemble each other more closely than do many of the species which are known to hybridize, show a coefficient of difference of 5.7 per cent. Similarly, the large mouth black bass and the small mouth black bass resemble each other closely but show a coefficient of difference of 6.1 per cent.

The genetic meaning of this relation between hybridization and differences in the spine and ray counts of the fins is not clear. The most promising viewpoint seems to be that the *number* of spines or rays in a fin has little adaptive significance and that changes in the general genetic constitution produce random plus and minus variations in this number. Averaging the percentage differences of seven fins expresses the total amount of genetic difference between two species more accurately than does the difference in one fin.

BIOLOGY IN HUMAN BEHAVIOR

BY

C. E. MONTGOMERY

DeKalb, Illinois

Although biology in one aspect or another has been a part of public education for nearly a half century, its real application to human life does not mean much to the average person of today. Except to those who have done special work in some field of biology, the year of required work in many of the higher schools means little more than another subject to fill up the curriculum. The lack of ability of the ordinary individual to see the importance of biology in its many applications to daily life should be the greatest concern of the teacher of this subject. This work should not be offered as a panacea for all human ills but to create a deeper understanding in the lay mind of the fundamental life processes. The fact that man is a member of the great living organization should place the subject of biology in the schools on the same plane as the conventional three R's.

Upon examination of the biological courses offered by the colleges and universities one need not be surprised to find the situation as it is. The old standard courses of botany and zoology are excellent for the specialist in these lines but they offer little useful material to the person who never does further serious work in biology. A large percentage of college graduates have had the regular year of work in some biology course, yet when faced with common community problems that involve biological knowledge they are no more able to aid the situation than those who have not been in college.

The forces of heredity and environment have so fashioned the human being that no clear understanding of the life of man is possible without a knowledge of both of these in their various relationships. One should know not only something of how heredity works but the nature of the living materials which are inherited and what environment does to develop it. Truly the biologist does not know all the facts about life, yet if the known facts should be impressed on the mind of the average layman, many problems of life would be much more easily solved. Crime, pauperism, health, recreation, sanitation, etc., are not merely social in character but are fundamentally biological.

The social worker, minister, teacher, judge of our courts and all others who are trying to alleviate human difficulties must of necessity know the nature of the chemical machine with which they are dealing. The failure of the human family to improve itself along with the development of its civilization is due largely to the lack of real information concerning its own animal nature.

The suggestions of this paper are offered to biology teachers with the hope that they may stimulate further consideration of the problem of bringing more practical phases of biology to the general student.

FAMILY ORIGINS IN A SOUTHERN ILLINOIS COMMUNITY

BY

CLARENCE BONNELL

Harrisburg Township High School, Harrisburg, Illinois

This is a study of family histories of 140 biology students in the Harrisburg Township High School in connection with similar studies over a period of years, made originally in relation to problems in heredity.

Harrisburg township is a typical Ohio River Valley community of 15,000 people situated twenty miles from the river. It has two main industries, farming and coal mining, upon which other industries depend. Many miners own their homes. Their children constitute a large part of the school and are among the best students.

Thirty years ago the population was stabilized. Almost any family name in the township could be found in some other similar Ohio River Valley community. Their ancestors had come largely by way of the Cumberland Gap or down the Ohio in the days of flat boats. Fully half of the students in 1933 had ancestry traceable to Kentucky, Tennessee, Virginia, Georgia, and the Carolinas. A later migration of Germans and Irish was also fused with the earlier comers. Strangely, not less than ten per cent of this stabilized population had some American Indian blood traceable to such tribes as the Pawnees, Cherokees, and Crows.

Development of the immense coal fields following 1900 brought many families from the Ozark Hills region in adjoining counties and from southern Indiana and Kentucky. These differed little in origins from those who had come in the century before. Soon a new element came, mostly Lithuanians and Hungarians. To this was added a few English and Scotch miners and a scattering of other Europeans. (The negro population is omitted in this discussion.) Thus, the population increased five-fold in thirty years.

The older English-Scotch-Irish-German-French-Dutch-Welch stock, which came during the nineteenth century and became amalgamated in the Ohio Valley, refer to the newer Europeans as "foreigners". This older group and their descendants have traditions retained from the days of trappers, Indian fighters, and Black Hawk, Mexican and Civil War veterans. The ancestral elements of this group are now so blended that they are discovered only by tracing the line of descent. The surnames no longer indicate national origins. All these groups, the older ones which came during the century after the Revolutionary War and the Europeans who came during the first twenty-five years of the present century, are now so well assimilated that their children in the high school of 1000 students are not distinguishable by speech, scholarship, manners, dress, physical appearance, or traditions. Outward appearances are gone although a foreign language is spoken in some of the homes and some of the children can speak one or more of them. Two more generations will see the family trees branching to include representatives of all these groups in nearly every family. With immigration limited and transportation and communication increased, and through the influence of schools, there will be nothing remaining in this community to distinguish national origins except as they may be traced in family histories.

ALBERTUS MAGNUS, THIRTEENTH CENTURY ZOOLOGIST

BY

Sister Mary Ellen O'Hanlon

Rosary College, River Forest, Illinois

Albert Graf von Boldstädt, son of the nobleman, Count von Boldstädt, was born in Lauingen, Suabia in 1193. In his early youth he left his native home to attend school in Padua. There he entered the Dominican Order in 1223. After the completion of his studies he was given the work of teaching and of organizing schools. He taught at Hildesheim, Freiburg, Strasburg, Ratisbon, Paris and Cologne. At Paris he received the bachelor's degree and the licentiate. At Paris, too, he received the doctor's cap about the year 1245. His almost continuous program of study, teaching and writing was at least partially interrupted several times by the imposition of difficult offices of trust and dignity including the office of provincial of the Dominican Order in Germany, 1254-57, and the bishopric of Ratisbon between the years 1260 and 1262.

Of Albert's voluminous writing, *Opera Omnia*, including theology, philosophy and the natural sciences, two complete editions have been published, one at Lyons in 1651 in twenty-two folio volumes, and the other in Paris in thirty-eight quarto volumes in 1890-1899. The part of his works which treat of plants and animals is contained in the treatise on nature (Opus naturarum) and includes *De Plantis* and *De Animalibus*.

De animalibus is divided into twenty-six books; the first nineteen of these are based upon Aristotle's works on animals; the next two books deal with Albert's own observation on the form and structure of animal bodies, the perfections and imperfections of these forms and their causes. Books twenty-two to twenty-six inclusive contain the descriptions of a large number of animals many of which were described by Albert for the first time. The animals described include 113 quadrupeds, 114 birds, 130 aquatic animals, 61 reptiles and reptile-like animals, 41 worms and worm-like animals.

At the suggestion of Richard von Hertwig, Dr. Herman Stadler delivered a lecture entitled "Albert the Great as an independent student" before the Verein fur Naturkunde in Munich on March 20, 1905. Stadler published in 1916 and 1920 a complete edition of Albert's *De Animalibus* from the original Cologne manuscript. This splendid and elaborately indexed edition, dedicated to Richard von Hertwig and Erich Wasmann, S. J., appears as volumes 15 and 16 of the *Beiträge sur Geschichte des Philosophie des Mittelalters* and covers over 1700 pages.

Prof. Heinrich Balss, Haupt Conservator of the zoological collection of the University of Munich, published a monograph through the Munich press (1928) entitled *Albertus Magnus als Zoologe*. In this exposition of 115 pages there are nearly one hundred titles included in the bibliography and literature citations.

When one stops to consider that zoology was but one of practically all of the natural sciences among which Albertus Magnus divided his energies; and that perhaps an even greater amount was devoted to philosophy, theology, teaching and the many other responsibilities and occupations that crowded into and filled his life, there seems to be no other conclusion than that of George Sarton's that Albert's activity was nothing short of miraculous. (Introduction to the history of science, vol. 2, p. 933.)

Albertus, who because of his remarkable versatility won the two significant titles of "The Great" and "Doctor Universalis", was canonized nearly seven centuries since, Sanctus et Doctor Ecclesiae by the present reigning pontiff, Pope Pius XI, on December 16, 1931.

THE MOLLUSCAN FAUNA OF THE GREAT RIVER VALLEYS OF ILLINOIS

BY

FRANK C. BAKER

University of Illinois, Urbana, Illinois

The paper lists the Molluscan land species found in ten localities on the Ohio and Mississippi river banks from Hardin County on the Ohio northward to Jo Daviess County on the Mississippi. It shows that the number of species increases southward, certain species being found only in southern Illinois while others are restricted to the northern part of the State. The river bluffs are peculiarly adapted to the needs of land snails; they afford protection and food as well as moisture, and the numerous outcrops of limestone afford lime in abundance. Several races are confined to the large valleys. Two species, known only from the Mississippi River bluffs in the southern part of the State, are believed to be migrants from Missouri.

The paper is based on field work carried on for the State Natural History Survey during 1931–1932 for the purpose of obtaining data needed for the preparation of a handbook of the land mollusks of Illinois.

A SYNONYMIC CATALOG OF THE REPTILES AND AMPHIBIANS OF ILLINOIS

BY

WALTER L. NECKER

Chicago Academy of Sciences, Chicago, Illinois

ABSTRACT

The object of the paper was to present a complete bibliography of Illinois herpetology, with a concordance of the scientific names used, in the hope that a greater interest in our herpetofauna might be awakened and encouraged. Since there is at present insufficient Illinois material in museums to warrant a really comprehensive work on the reptiles and amphibians of this State, and since the only inclusive account was published over forty years ago, such a listing serves to bring the subject up-to-date for further research.

Sixty papers dealing with Illinois herpetology enumerate seventeen species of salamanders, nineteen of frogs, five of lizards, forty-one of snakes, and fourteen of turtles actually found. *Natrix sipedon confluens* Blanchard, not previously reported from the State, is added on the basis of specimens from Olive Branch, Alexander County, in Field Museum of Natural History.

The author urgently requests all persons interested in this part of our fauna to communicate with him and to cooperate in his work toward a "Herpetology of Illinois."

A STUDY OF THE PHARYNGEAL TEETH IN THE BLUNT NOSED MINNOW

BY

RAY CHAMBERS

University of Illinois, Urbana, Illinois

The taxonomic value of the teeth of fishes is readily expressed in the following quotation from D. S. Jordan, 1910. "No progress can be made in the study of these fishes (Cyprinidae) without careful attention to the teeth, as the genera are largely based upon dental characters." Cox, 1897 says, "It is often necessary to know the nature of the lower pharyngeal bones and teeth in identification, especially in suckers, minnows, and sunfish." Inasmuch as these characters have been stressed as taxonomic guides it is necessary to establish them as unvarying in order to give them their full value.

This account, a summary of the results obtained from a study of 56 specimens of the blunt-nosed minnow, shows that there are deviations in numbers and arrangement of the teeth in individual specimens as well as for different specimens of the group.

The pharyngeal teeth are situated on the pharyngeal bones of the fifth brachial arch. They are used as masticatory organs and possibly aid in affording the fish a chance to taste his food. The teeth are composed of the three tooth tissues. The prismatic structure of the enamel is not well marked and is probably absent in some cases. The cement is more appropriately named "bone attachment."

Fifty-six specimens were examined and it was found that 41 had the normal dentition formula of 4-4 as given by various authorities. The remaining 15 showed various deviations from the normal involving asymmetry between the two sides in the same fish as well as the presence of both supernumerary and subnormal numbers of teeth.

The size of the individual seemingly does not have any direct relationship to the number and arrangement of the teeth. This is shown by the fact that of a group of five specimens 48 mm. in length three had the normal dentition formula of 4-4, one of 4-4,1 and another of 2,4-4,2.

In some of the bony fishes teeth are "shed" but the old tooth functions until the new one is fully developed and ready for use. In one specimen there were four teeth on one side and three on the opposite side but there was not the slightest indication of regeneration of the "missing" tooth.

The main row of pharyngeal teeth is fastened directly and firmly to the pharyngeal bones. The median teeth are usually very broad and rather heavy with a sharp hook. Adjacent teeth laterad of the meseal series become longer, more slender, and more sharply hooked.

The secondary teeth are in a longitudinal row immediately posterior to the main row. They are arranged so as to fit between two teeth in the primary row and are fastened to the jaw by means of strong ligaments. The median secondary tooth is almost as heavy as the median primary one. It is broader and shorter with about the same angle of hook. It is less than one-third the length of the adjacent primary ones.

CONCLUSIONS

(1) The pharyngeal teeth furnish important data for identification of fishes but in the blunt nosed minnow neither the number nor the arrangement is absolute.

(2) The pharyngeal teeth are variable in form within the species or even in the same individual.

(3) In the blunt nosed minnow the size of the specimen has little or nothing to do with the number of pharyngeal teeth.

(4) The secondary row of pharyngeal teeth is not firmly attached to the pharyngeal bone.

SHELL INJURIES OF LAND MOLLUSKS

BY

T. Dale Foster

University of Illinois, Urbana, Illinois

ABSTRACT

F. C. Baker and others have called attention to the importance of the study of abnormal specimens of Mollusca in papers discussing monstrosities found in the Unios, with reference to variation and possible specific change. One type of abnormality which has no relation to the problem of evolution and yet has considerable biological importance is that sort of abnormality associated with or resulting from damage to the shell or to the animal. Under conditions of nature molluscs are constantly subjected to injury of the shell either by attack of predators or by accidental breakage. Studies of repair and abnormality due to injury to the mantle seem to be lacking in the recent literature.

For two years, monthly collections of land snails have been made in the vicinity of White Heath, Illinois, on the floodplain of Sangamon River. This habitat appears to be optimum for the development of *Polygyra thyroides* and *Polygyra pennsylvanica* because of their abundance. In making the October collection, a living specimen of *P. thyroides* was observed to be seriously injured, bearing a large irregular hole in its shell. This hole was so large that the foot extruded through it instead of through the normal aperture when the snail crawled. The specimen was brought to the laboratory and kept under observation. In 26 days the repair was completed and the individual was apparently normal except no cuticle was formed over the regenerated portion of the shell. The study of this individual suggested a statistical study of the adult shells in the combined monthly collections for evidence of mishap.

Of the 401 specimens of *P. thyroides* examined, 133 had recorded on their shells some form of injury. About 33 per cent of the adults were injured in some manner. Most of the injuries were of a minor character although about 5 per cent of the total number had injuries that involved serious damage to the shell. Sixty-six specimens of *P. pennsylvanica*, taken from the same habitat, exhibited about 15 per cent of the total injured of which again 5 per cent bore major injuries.

Injuries of like nature were observed to occur in other species found associated with these two species. No attempt is made to explain the cause of these injuries. The habitat is an undisturbed woodland on a river floodplain, free from domestic animals, so the snail injuries cannot be the result of their tramping. No doubt the amount of injury is closely correlated with the specific habits. Active species exhibit more injuries than the more seclusive forms.

These observations have particular value in demonstrating the extent to which repair is possible for the injured shells of land snails. The region of the aperture and especially the reflected lip seem to be particularly susceptible to accidental breakage but here the free edge of the mantle which secretes the shell facilitates reconstruction. Regeneration of broken areas far removed from the aperture gives evidence that the mantle surface is capable of reforming new shell material. In many cases traumistic injuries inflicted damage to the mantle and other soft parts of the body as demonstrated by abnormal form of the shell of the injured snail. In numerous specimens injuries to the mantle became perpetuated as spiral incised lines or ridges continuing in successive whorls as the shell grew in size beyond the damaged area.

A COMPARATIVE STUDY OF RIVER POOL AND POND COMMUNITIES, WITH SPECIAL REFERENCE TO THE SPHAERIIDS

BY

T. DALE FOSTER AND WILLIAM C. VAN DEVENTER

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In connection with life history studies on the finger nail shell, *Sphaerium solidulum*, carried on at the University of Illinois under the direction of Dr. H. J. Van Cleave, observations were made concerning the habitat relations of this species.

Collections were taken from an oxbow pond near Muncie, Illinois. This pond formed part of the stream bed of Stony Creek until the stream was straightened during the building of a railroad grade in 1872. Part of the pond was deepened by removal of soil for the railroad grade. Since then the portion of the old stream-bed connecting the pond with the stream has been filled by sedimentation and the encroachment of vegetation. This area now supports cat-tail, willow, and button-bush. Elodea and algae grow in the pond near the shore.

The sphaeriids are numerically predominant in the pond community. A bottom sample from 1/16 sq. m. of bottom yielded 120 *Sphaerium*, 3 *Physa*, and 1 leech. Other animals taken at different times were: snails, *Helisoma* sp.; other sphaeriids, *Musculium* sp., and *Pisidium* sp.; mussels, *Uniomerus tetralasmus;* backswimmers; water beetles, *Petlodytes 12-punctatus;* burrowing dragonfly larvae, *Gomphus* sp.; mosquito larvae; red chironomid larvae; leeches; crayfish, *Cambarus propinquus;* amphipods, *Hyallela knickerbockeri;* isopods, *Asellus communis;* frogs, *Rana pipiens* and *Acris gryllis;* turtles, *Chrysemys* sp.; sunfish, *Lepomis* sp.; minnows, *Notropis* sp.; suckers, *Catastomus* sp.; mud cat, *Amieurus* sp.

Collections from pools connected with the stream in Stony Creek and in Salt Fork into which it flows yielded: crayfish, *Cambarus propinquus;* minnows, *Notropis whipplei*, *N. gilberti*, and *Hyborhynchus notatus;* suckers, *Catastomus nigricans;* black bass, *Micropterus salmoides;* isopods, *Asellus communis;* burrowing dragonfly larvae, *Gomphus* sp.; red chironomid larvae; mussels, *Lasmigona complanata*, *Cyclonaias tuberculata*, and *Lampsilis* sp.; water beetles, *Petlodytes 12-punctatus;* snails, *Goniobasis livescens;* sphaeriids, *Sphaerium solidulum* and other species of *Sphaerium;* Bryozoa, *Plumatella* sp.; caddis worms *Hydropsyche* sp.; mayfly larvae, *Hexagenia* sp., and *Heptagenia* sp. Of these the crayfish were numerically predominant. The sphaeriids were not numerous.

Trematode larvae of the family Allocreadiidae develop in the sphaeriids of this locality. The metacercaria encyst in *Hexagenia* nymphs, and the adults are found in fishes (*Lepomis* and *Amieurus*). Thus the entire life history of these trematodes is accomplished within the pool community.

The stream-bed pools represent the earliest stage in a hydrosere leading to dry land. The pond fits into this sere, and the marshy area adjoining the pond represents a stage still more advanced. The pond has a number of species in common with the stream pools. These include *Cambarus propinquus*, *Sphaerium solidulum*, *Asellus communis*, the chironomid larvae, and some of the fish. Other species (as *Goniobasis*, *Hydropsyche*, and *Heptagenia*) taken in the stream pools are typically rapids forms which are only visitors to the pool community. Other stream pool species (as the *Hexagenia* and the mussels) disappear altogether in the pond. The sphaeriids, however, which occupy only a minor place in the stream pool community, become overwhelmingly predominant in the pond.

VARIATIONS AMONG ATYPICAL SPERMATOZOA IN VALVATA TRICARINATA

BY

C. L. FURROW

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ABSTRACT

Among the gastropod molluscs the Prosobranchs present a variety of conditions of sexuality. The Prosobranchs, in fact, are, in a majority of instances gonochoristic, but, other members of the group are generally hermaphroditic. In certain other cases some members pass through phases in which the animals are first gonochoristic, then hermaphroditic, only to become, later on during the life cycle, gonochoristic or unisexual.

It appears significant, especially, in the light of recent investigations in sex differentiation that a series of variations should occur in the process of spermatogenesis in this hermaphrodite snail. In *Valvata tricarinata* the early gonial stages pass through separate strata during the period of sexual segregation, and later, spermatogenesis and ovogenesis occur at the same relative time. Always the male cells mature a short time before the ovocytes. It seems probable that the presence of a tendency toward increasing abnormality in the apyrene group may be the result of the interaction of the male and female systems which are so close together in the hermaphrodite gland.

Altogether three species of Valvata, one American and two European species have been studied to-date and each species has presented a widely differing set of conditions of spermatogenesis. *Valvata piscinalis*, which was first studied by von Kemnitz (1914), occupies a position in many respects similar to the unisexual gastropods. Von Kemnitz has established that only a single typical spermatogenesis occurs in *Valvata piscinalis*. Later, Artom and Cavallini (1931) in a careful study reported on both *Valvata piscinalis* and *Valvata cristata*. Their conclusions tend to confirm the work of von Kemnitz in showing again the total absence of an aberrant spermatogenesis in *Valvata piscinalis* and a definite tendency toward a typical spermatogenesis in *Valvata cristata*.

It is certain from a study of the conditions of sexuality in the three species of *Valvata* mentioned above that a series of increasing tendency toward aberrant spermatogenesis occurs in this genus with *V. piscinalis*, *V. cristata*, and *V. tricarinata* forming a series of increasing tendency toward a typical sperm formation.

INSTINCT BUT A RESPONSE TO THE LAW OF HABIT

BY

HENRY JAMES REYNOLDS

Chicago, Illinois

ABSTRACT

"Inherited habit" as applied to instinct is of course not new. I am however just now attempting to not only show that there is such a thing, but also to tell what it is and how it acts. The organism being but the sum total of its cell units is therefore a thing dominated by the cell. But the cell in its turn is also a thing dominated by what has gone before. It is but that which has been moulded and fixed by many repetitions in past generations—a thing dominated by what I would call the "law of habit." In the full article I have especially endeavored to bring out the following points:

(1) By no process of reasoning could instinctive knowledge in the newly born be accepted as a thing which had been imparted by the mother to the offspring through either teaching or example.

(2) When we fully realize that the cell never dies but merely divides or fertilizes itself, passes over to the next generation and there continues to live, then should we also know that acts in the newly born which were a part of the life conduct of the ancestors for many previous generations must be but the automatic repetitions in the new organism of such life conduct of the past.

(3) In setting forth the modus operandi by which this is done, I have sought to show, through a study of the *law of habit* that such repetitions cannot be other than simply that which is compelled by the operation of the uncanny principles of this law. The cell itself, in previous generations, having originally taken on the habit of breeding true through thousands of repetitions and then never dying simply keeps right on repeating in the new organism through the compelling influence of habit the same old practice. Habit having become master the act can not now be done in any other way than by the routine one which is directed by the habit.

(4) As an analogy, attention has been directed to the fact that such things as Leibnitz's law of continuity, Von Baer's law of embryonic development, Galton's law of regression, Mendel's law of heredity, and the fixity of "kind" which is everywhere apparent in nature, may also be all included in the same category. As the planets respond to Keppler's laws of planetary motion so the thing we call instinct, similarly compelled by the *law of habit*, becomes but another one of the great cycles and rhythms of nature. A fool-proof automatic thing in which neither brain nor intelligence is involved and which occurs alike in vegetable as well as in animal life.

(5) Finally, to better explain the thing we call the "homing" instinct, it would seem to be necessary to add to the "special senses" of touch, taste, smell, sight and hearing one or two other similar but yet unknown senses which, if they exist at all in man are today only rudimentary.

AMBYSTOMA TALPOIDEUM (GRAY) IN ILLINOIS

BY

HILDA A. STEIN

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ABSTRACT

During some explorations in November, 1931 in Southern Illinois, several specimens of the Mole salamander, *Ambystoma talpoideum* were found. The only previous record of this particular salamander's being found in Illinois has been the one made by Kennicott.

This time the collections of *Ambystoma talpoideum* were made on the island at Horseshoe Lake, a State Game Preserve about one mile south of Olive Branch and about fifteen miles north of Cairo. Originally Horseshoe Lake was an old oxbow of the Mississippi River and it is one of the few remaining original Cypress swamps in Illinois.

The particular area where the specimens of *Ambystoma talpoideum* were found was at the base of a sloping hillside which constitutes the shoreline of the island. Usually during seasons of high water this portion is flooded.

When found, *Ambystoma talpoideum* was under rotten logs buried in the ground about an inch or so. It had the characteristic lichen-like markings on its body making it harder to find.

Ambystoma talpoideum seems to be one of the rare species in this locality. Usually it is considered one of the southern salamanders. Finding it not only adds another record for its being in Illinois but also establishes a new northern limit for this southern species.

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NATURAL VS. ACCIDENTAL DEATH IN DIFFERENT HABITATS OF THE SNAIL *VIVIPARUS CONTECTOIDES*

BY

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ABSTRACT

Different habitats for *Viviparus contectoides* have been studied in a detailed investigation of the life cycle (VanCleave and Lederer, 1932). Normally the females of this species have a life span of about three years, while males live but a little more than one year. In the Erie Canal (Durhamville, N. Y.) studies gave evidence that natural death is the chief factor reducing populations except for the young snails consumed as food by other animals. In the Illinois River (above Peoria, Illinois) entire populations of this snail are killed off by toxic effects of sewage. Evidences and interpretations are discussed.

BEYOND THE WALLS OF THE MUD-DAUBERS' NESTS

BY

BOYD B. PALMER

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ABSTRACT

A study of over 1,000 nests of the yellow mud-dauber, *Sceliphron cementarium* shows that three factors determine the location of nests—protection from rain, light, and enemies. Of these, protection from rain is perhaps the most important. In the matter of construction there appears to be no particular uniformity in the arrangement of their structures. Cells within the same nest may vary in size and shape. Of the number examined, only 41 per cent contained closed cells, 567 contained, besides the host, the prepupae of the blue wasp, *Chalybion caeruliun*. Differences in the prepupae of both are described. A total of 233 closed cells were found to be entirely empty, and 523 cells were provisioned with spiders, with an average of four spiders per cell. The spiders used for provisioning the nests are listed, and also the parasitic and predaceous enemies. Among these a chalcid wasp, *Mellitobia chalybii*, is the most important parasite.—*Abstracted by Wm. P. Hayes.*

SOME INFLUENCES OF MAN ON BIOTIC COMMUNITIES

BY

WILLIAM C. VAN DEVENTER

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ABSTRACT

The introduction of civilization into a primitive area involves: (1) extinction of the large and slow-multiplying animals; (2) destruction of climax vegetation and much of the animal life which depends upon it; (3) spread of certain plant forms which are man-tolerant, and essentially sub-climax in nature; and (4) modifications of number-relations among the smaller animal species which are man-tolerant. Some of these smaller animals merely adjust their habits so as to survive under the new conditions, usually with reduced numbers (skunks, opossums). Some, however, are actually benefited through an increase of food or of suitable breeding places, or through the destruction of their enemies (some rodents, birds, and insects). These are enabled to increase their numbers and extend their range. At the same time civilization brings with it a very definite biota of parasites and weed forms, both plant and animal, which are able to survive and propogate most successfully under man-influenced conditions.

Thus in areas where civilized man is well-established there are developed biotic communities of civilization which contain the following elements: (1) man, (2) domestic animals and plants, (3) man-tolerant native animals and plants, (4) imported weed forms, plant and animal, (5) parasites, native and imported. These different elements assume different degrees of relative importance according to whether we are studying (1) communities of man's dwelling and its environs; (2) communities of meadows, pastures, and cultivated fields; or (3) communities of relict woodlands and other semi-wild areas.

Conditions over a region may remain essentially primitive even though settled agriculture is practiced over certain portions of it. Such conditions persisted in Western Europe until about 1300 A. D. Up to this time great areas of forest remained uncut, and most of the larger animals were still found in them. During the period from 1300-1700 these forests were largely cut or burned, and the wild life destroyed. This period of biotic disturbance in Europe corresponds to the period from 1650-1880 in America, and from about 1820-1900 in certain parts of Australia. In all three cases the period was marked by destruction of natural conditions and wild life, and also by great increases in human population and extraordinary prevalence of epidemic disease.

Such a period gives way to one in which the destruction of natural conditions is largely completed. At the same time diseases tend to be endemic rather than epidemic. This change in the nature of their occurrence seems to be independent of any medical advance. Somewhat later, but belonging in the same train of events, the human population comes to increase much more slowly or actually reaches a level, and violent changes in the number-relations and range of animal species cease to take place. Thus the biotic community, with those elements eliminated which were not man-tolerant, and with the addition of the new elements which were brought in by civilization, strikes something like a balance.

NOTES ON THE FLIGHT AND ABUNDANCE OF THE SEED CORN BEETLE, *AGONODERUS PALLIPES* FAB.

BY

J. H. BIGGER

Illinois Natural History Survey, Urbana, Illinois

The purpose of this paper is to assemble various scattered notes that have accumulated during several years relative to the flight habits of the beetle, which indicate that there are two definite flight periods each year, fall and spring.

Fall flight periods have been noted in the following cases: (1) Morgan county, October 1, 1925; (2) Calhoun county, October 2, 1925; (3) Calhoun county, September 9, 1927; (4) a flight late in September, 1932, which is well recalled, though the date was not definitely noted at the time.

Spring flights were noted as follows: (1) Macon county, April 12, 1923; (2) Pike county, March 25, 1925; (3) Morgan county, March 19, 1926; (4) Morgan county, March 23, 1926; (5) Greene county, March 22, 1928; (6) Sangamon and Christian counties, March 24, 1929; (7) Warren county, April 7, 1931; (8) Morgan county, April 9, 1933.

Specimens have also been noted as follows: (1) Adults under clods in a corn field, Adams county, May 5, 1925; (2) Adults under trash in field of clover, Morgan county, June 25, 1925; (3) Pupae and emerging adults dug from around roots of corn at Carlinville, Macoupin county and Lebanon, St. Clair county, June 26-27, 1930; (4) Pupae dug from roots of corn at Carthage, Hancock county, June 27, 1932 and adults emerged from this material July 5, 1932.

TABLE I

Infestation by the Seed Corn Beetle, Agonoderus pallipes Fab., in Four experiment fields, 1929-1932.

Treatment.	Per cent of infestation.				
	1929	1930	1931	1932	Average
Carthage					
Animal residue series	6.0	0.0	0.0	37.0	10.8
Crop residue series	.5	0.0	1.0	9.0	2.6
Clayton (Early plowed)					
Animal residue series	4.5	6.0	(a)	33.5	14.7
Crop residue series	0.0	2.0	(a)	21.0	7.7
(Late plowed)					
Animal residue series	6.0	5.0	(a)	25.0	12.0
Crop residue series	1.0	1.0	(a)	14.0	5.3
Carlinville					
Animal residue series	0.0	12.0	0.0	2.5	3.6
Crop residue series	0.0	1.5	0.0	2.5	1.0
Lebanon					
Animal residue series	.5	9.0	-------	-------	4.8
Crop residue series	1.0	2.5	-------	-------	1.8

(a) No records.

Hibernation as adults is indicated. Data suggest that the period of immature stages is from early May to late June or early July, 6-8 weeks. There is no evidence of a second brood, but it is shown that sufficient time elapses for it to be possible.

For the first time definite data are published showing the relative abundance of this insect under two rotation practices. Studies were carried on at experiment fields of Illinois Agricultural Experiment Station.[1] Table I gives records for two rotations, (1) Animal residue for fertilizer, four year rotation where manure precedes corn planting; (2) crop residue, four year rotation where sweet clover is plowed under as green manure crop preceding corn.

It appears that the adults choose an area where there is an abundance of decaying manure in which to feed and deposit their eggs. Feeding habits are not definitely determined. Time of plowing is not indicated as important.

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[1] Cooperation of Dr. F. C. Bauer, in charge, Soils experiment fields, Illinois Agricultural Experiment Station.

CODLING MOTH HIBERNATION IN BANDED TREES *

BY

S. C. CHANDLER

Illinois State Natural History Survey, Urbana, Illinois

ABSTRACT

This paper is an attempt to answer the questions propounded by apple growers regarding the percentage of larvae of the Codling Moth *Carpocapsa pomonella* Linne, hibernating under treated paperbands placed around the trunks of the trees and the proportion wintering in other situations. Studies were made in orchards in southern Illinois during two winters on two ages of trees. The following table summarizes the data collected in these studies.

CODLING MOTH HIBERNATION IN BANDED APPLE TREES.

TABLE 1

A Comparison of Larvae in Band, on Tree, and on Ground.

		Per cent of Larvae Found in		
		Band	Tree	Ground
5 Trees 15-18 years.	Winter 1932-33	90%	3%	7%
9 Trees 25-28 years.	Winter 1932-33	77.8%	10%	12.2%
14 Trees Both ages.	Winter 1932-33	81.4%	8%	10.4%
3 Trees 25-26 years.	Winter 1931-32	78.8%	17.2%	3.5%
12 Trees 25-28 years.	Both winters	78.6%	14.8%	6.5%

TABLE 2

Distribution of Larvae over Tree

(Not including those in Band or Ground)

	1931-32	1932-33	Both Years
Base Line	9%	5%	8%
Base to Main Crotches	11%	9%	10%
Main Crotches	3%	9%	5%
Branches	76%	75%	76%

TABLE 3

Height above ground of the larvae in the branches

	1931-32	1932-33	Both Years
4-10 ft. above ground	65.3%	73.7%	71.5%
10 ft. and up	34.7%	26.2%	28.3%

* Contribution from Project 9.1 of the Ill. State Nat. His. Survey.

TABLE 4

Location of Larvae according to Types of Cover

(Not including those in Band)

(1) On Tree

	1932-33
Rough bark	38%
Punky wood (knot holes, etc.)	29%
Split branches	25%
Crotches	4%
Pruned branch ends	2%

(1) On Ground

	1931-33
Decayed twigs, old prunings	11%
Aphis injured roots	30%
Apples or apple mummies	24%
Sprouts	15%
Old pieces of bark	3%
Dead weeds	9%
Trash, artificial cover	11%

TABLE 5

Location of Larvae in present season's prunings

Three trees, 25 years old, averaged 10 larvae per tree in the prunings just cut off, which was 37% of all on tree except band.

CONCLUSIONS

(1) Treated bands are well worth while, catching over ¾ of the larvae wintering on the tree and the ground under it.

(2) Of those larvae not in the band a larger part are usually found on the tree than on the ground.

(3) Of those on the tree ¾ are found in the branches, and in trees of this size, 20-25 feet high, ⅔ of them will be wintering within 10 feet of the ground.

(4) Of those on the tree more than a third are under pieces of rough bark, but many of the rest of them are in places rather inaccessible to birds and to any spray material which may be developed.

(5) It is evidently advisable to burn prunings since they contain an appreciable percentage of the larvae on the tree.

TRANSACTIONS

OF THE

ILLINOIS STATE ACADEMY OF SCIENCE

VOLUME 26 JUNE, 1934 NUMBER 4

Minutes of Council Meetings
Minutes of Twenty-seventh Annual Meeting
Reports of Officers and Committees
Constitution and By-Laws

EDITED BY DOROTHY E. ROSE

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and the retiring secretary.

TRANSACTIONS OF THE ILLINOIS STATE ACADEMY OF SCIENCE

Volume 26 June, 1934 Number 4

CONTENTS

Minutes of Meetings of the 1933-1934 Council

First Meeting

The first meeting of the Council was called to order at 8:00 a. m., May 6, 1933, at the Broadview Hotel, East St. Louis, Illinois, with Vice-President Behre in the chair. Members present were H. A. Ferguson and H. R. Wanless. Mr. A. E. Cockrum, chairman of the Junior Section, was also present.

The Council voted to hold the Twenty-seventh Annual Meeting of the Academy in Decatur early in May, 1934, with Mr. J. H. Ransom of James Millikin University as local chairman, subject to the approval of President-elect Hopkins.

The Council voted to allow honoraria of $150.00 each to the secretary and editor for the year 1933-34.

The following were appointed as a Committee on Ecological Survey:

A. G. Vestal, University of Illinois, *Chairman.*
W. G. Waterman, Northwestern University, Evanston.
V. O. Graham, 4028 Grace Street, Chicago.
V. E. Shelford, University of Illinois, Urbana.
W. C. Allee, University of Chicago, Chicago.
L. E. Sawyer, State Natural History Survey, Urbana.
C. E. Montgomery, State Teachers College, DeKalb.
John Voss, Manual Training High School, Peoria.
Mary M. Steagall, State Teachers College, Carbondale.

The following were named as members of the Committee on Conservation:

Henry C. Cowles, University of Chicago, Chicago, *Chairman.*
M. M. Leighton, State Geological Survey, Urbana.
W. H. Haas, Northwestern University, Evanston.
Jens Jensen, Landscape Architect, Ravinia.
Paul Houdek, 410 Gross St., Robinson.
R. B. Miller, State Department of Conservation, Springfield.
R. S. Smith, Department of Agronomy, Urbana.
H. F. Ferguson, Department of Public Health, Springfield.

The following were appointed a committee on Legislation and Finance:

A. C. Walton, Galesburg, *Chairman.*
John R. Neal, Springfield, Illinois.
A. S. Coggeshall, Springfield, Illinois.
A. C. Noé, Chicago.
W. C. Lodge, Monticello.

The following Committee on High School Science Clubs and Groups was chosen without approval of the chairman:

A. C. Cockrum, West Chicago, *Chairman.*
Miss Mabel Spencer, Granite City, Illinois.

News Letter and Exhibits:

L. A. Astell, Kankakee, Illinois.

Expansion Program:

W. T. Maas, Dupo, Geology.

D. L. Barr, Cicero, Physics.

Rose Cassidy, DesPlaines, Chemistry.

H. L. Wright, Bloomington, Biology.

Rosalie Parr, University of Illinois, Urbana, University representative.

L. J. Thomas, Urbana, University representative.

One additional member is to be added to this committee to take charge of local arrangements for the Junior Section.

The following were selected a committee on the State Hall of Fame:

M. M. Leighton, Urbana, *Chairman.*

W. A. Noyes, Urbana.

H. J. Van Cleave, Urbana.

H. C. Cowles, Chicago.

A. S. Coggeshall, Springfield.

H. B. Ward, Urbana.

F. R. Jelliff, Galesburg.

No action was taken on the selection of a delegate to the Conservation Council of Chicago. Miss Dorothy E. Rose was appointed editor of the *Transactions* for the ensuing year.

The Secretary was authorized to arrange for the preparation of brief memorial articles to the three members of the Academy lost by death during the past year, U. S. Grant, J. P. Goode, and Abel J. McAllister.

The Council voted to ask the chairman of the Junior section and some representative delegated by him to attend the Council meetings during the forthcoming year. It was voted to allow the secretary to expend not more than $100.00 and the editor not more than $25.00 in connection with the duties of their offices.

The Secretary was authorized to send announcement of election to the newly elected members.

The meeting adjourned at 9:15 p. m.

Second Meeting

The second meeting of the Council was called to order at 1:00 p. m., November 18, 1933, at the Quadrangle Club, University of Chicago, with President Hopkins in the chair. The members present were C. H. Behre, G. D. Fuller, J. H. Ransom, and H. R. Wanless.

The minutes of the first meeting were read and approved. It was reported by the Secretary that A. S. Coggeshall had not accepted membership on the Committees on State Hall of Fame, and Legislation and Finance.

The Secretary reported that it had been impossible for the Committee on Publications to have the papers presented at the Section Meetings in Chicago, May, 1932, published in full with funds appropriated for the biennium 1931-33, and that approximately $2,000.00 appropriated for this purpose had lapsed June 30, 1933. The Committee on Publications has, since that date, secured abstracts from most of the authors of these papers of 1,000 words or less length, and these are now ready to be published. The Secretary also reported that $2,000.00 had been appropriated by the State for the publication of the Transactions during the biennium 1933-35. The Council approved the publication of the abstracts of papers presented at the Chicago meeting as Volume 25, No. 3, at an estimated cost not to exceed $500.00 and of the reports of officers and committees made at the East St. Louis meeting at a cost not to exceed $100.00, according to estimates submitted by the Editor. The Committee on Publications was also authorized to assemble the material for Volume 26, Nos. 1 and 2, as quickly as possible. The Treasurer reported correspondence with the Postmaster at Springfield to the effect that the Academy's Second Class Mailing Permit would be valid if no numbers were omitted.

Plans for the Twenty-seventh Annual Meeting were discussed with Vice-President Ransom, but no action was taken. Mr. W. C. Spooner was appointed Chairman of the Zoology Section. The Secretary and Mr. H. F. Ferguson were appointed to choose a chairman of the Medicine and Public Health Section. It was suggested that the Agriculture and Economics Sections join in the preparation of a program in the field of agricultural economics.

The Treasurer reported that permanent funds of the Academy to the amount of $600.00 are invested in two real estate bonds, and that one bond with a value of $200.00 is being called in by a bondholder's committee consisting of officers of the University State Bank, Chicago. The Council voted to authorize the Treasurer to deposit this bond and to enter into the Council minutes of the following record:

> "1. That C. W. Hoff, Frank M. Kelley, and James W. Parker be and are hereby designated as one of the depositaries of the bonds of this Association, and that the officers or employees of said Association are hereby authorized to endorse, in the name of this Association for the purpose of deposit and collection in and with said bank, checks, drafts, notes and other like obligations, issued or drawn to and owned by said corporation, and it is further resolved that endorsements for deposit and collection may be by the written or stamped endorsement of the Association without designation of the party making the endorsement. Including the deposit of bonds with the above bondholders committee."

Mr. Ransom reported the selection of Miss Mary Brock to serve as Chairman of the Committee on Local Arrangements for the Junior Section, and Mr. F. C. Hottes to serve as Decatur member of the Committee on Membership.

Dr. T. H. Frison was appointed Chairman of the Committee on Conservation. Mr. V. O. Graham was appointed delegate to the Conservation Council of Chicago. The Secretary called attention to the fact that The National Forest Purchase Units in Southern Illinois, for which the Academy has been working for several years, are now being actually purchased by the Federal government.

The Secretary reported that Mr. A. E. Cockrum wishes to be relieved of his duties as Chairman of the Junior Section and the Committee on High School Science Clubs. The Council authorized Mr. L. J. Thomas and the Secretary to select a chairman for this committee. The Council appropriated to the Junior Section an amount not to exceed $30.00 in addition to the dues of affiliated High School Science Clubs.

The Council appropriated to the Committee on Membership an amount not to exceed $75.00 for the annual membership campaign.

The Council appointed the Secretary and Librarian as a committee to pass on requests of libraries for exchanges of publications with the Illinois Academy. The Librarian was requested to report to the Council the number of publications received by the Academy in exchanges, and their availability for use, and the degree to which they are used.

The meeting was adjourned at 4:00 p. m.

Third Meeting

The third meeting of the Council was called to order at 1:00 p. m., March 10, 1934, at the University Club, University of Illinois, with President Hopkins in the chair. The members present were H. F. Ferguson, G. D. Fuller, J. H. Ransom, and H. R. Wanless.

The minutes of the second meeting were read and approved.

The Secretary reported that Mr. Coggeshall, Librarian, has informed him that all exchanges which are received are marked as belonging to the Academy. These publications are at all times available for general use, but are not extensively used, because the Illinois State Library is housed in the same building and has duplicates of many of these publications. The Librarian was authorized by the Council to consider the feasibility of arranging for the shelving of these publications in the State Library, so that they might be more convenient for use, and to report to the Academy at its next annual meeting.

The selection of a delegate to the A. A. A. S. for the two meetings in 1934 was deferred until after the annual meeting.

In the absence of Mr. L. A. Astell, chairman of the Junior Section, the Secretary reported that a series of three broadcasts on the activities of the Junior Academy had been arranged over the University of Illinois Station W I L L, on March 17, 24, and 31. The Secretary also reported that the University of Illinois Station had suggested the possibility of a series of weekly talks on science for high school students to be presented during the school year 1934-35. This proposal was discussed, but no action was taken, pending further investigation of its practicability. At the request of Mr. Astell, a grant of $18.00 was approved, to be used to defray the cost of printing an April number of the Science Club Service leaflet. The first issue of this number was distributed in February to affiliated clubs and others interested in affiliation. The Secretary read a statement of the financial condition of the Junior Section prepared by Mr. Astell. Plans for the annual meeting of the Junior Section were discussed.

The Treasurer reported that about 400 members have paid their current years' dues, 240 are 1 year in arrears, 188 are 2 years in arrears, and 135 are 3 years in arrears.

The Secretary reported for the Committee on Publications that the publication of Volume 25, No. 3 has been delayed for several months, but that it is now being printed. The attention of the Secretary has also been directed to a statute relative to the State Division of Printing, stating that there must be omitted from material published by the State Bureau of Printing, "all journals and minutes of proceedings". This makes necessary the publication at Academy expense of minutes of council meetings, reports of officers and committees, lists of officers, the Constitution, and the program for the meeting. The Council approved the publication of the Preliminary program as one number, and of another number of each volume, including such administrative reports as are not eligible for publication at state expense. The reports of the East St. Louis meetings are now assembled and ready to be published within the next few weeks. The Secretary reported that the copy of the general addresses at East St. Louis, to be published as Volume 26, No. 2 and abbreviated summaries of the papers presented at the sectional meetings, to be published as Volume 26, No. 3, have been assembled, and will be edited and ready for submission to the Division of

Printing within a few weeks. Authors of papers to be presented at the Decatur meeting are being requested not to submit complete manuscripts of their papers, but rather short abstracts. The Secretary reported that several members had offered suggestions for accommodating the publication program to the present reduction in funds available for printing. The Committee on Publications was authorized to report at the annual meeting the policy which is to be adopted for the selection of material to be published in the *Transactions.*

The Secretary reported that satisfactory progress is being made on the section programs in Anthropology, Botany, Chemistry, Geography, Geology, Psychology and Education, and Zoology. Difficulties concerned with programs in Physics, and Medicine and Public Health, were discussed. The Agriculture and Economics sections and the Committee on Conservation are cooperating on a symposium on the Conservation of Illinois Resources. It was recommended that this program be presented at the General Session of the Academy. Mr. Ransom reported that the local committee is making satisfactory progress with the arrangements for the meeting. He suggested that two field trips be held, one geologic trip under the direction of Dr. M. M. Leighton, and one industrial trip, under the direction of Messrs. R. E. Greenfield and W. D. Hatfield of Decatur. The Council voted to allot not to exceed $50.00 to be paid to the speaker for the evening session. The President, the Secretary and Mr. D. L. Carroll were appointed as a committee on publicity for the meeting.

The Secretary reported that the addressograph plates and frames used in mailing the Academy's *Transactions* has been destroyed in the fire in the Springfield Arsenal. A committee consisting of H. F. Ferguson, A. S. Coggeshall and the Secretary was appointed to arrange for the making of new plates.

The Secretary reported on correspondence relative to relations between the Junior Academies of Science affiliated with the A. A. A. S., and the Student Science Clubs of America, which distributes the "Science Leaflet". No decision as to the policy of the Academy relative to this matter was made, pending further investigation of the problem.

It was reported that the University of Illinois Section of the American Chemical Society, and the Decatur Chemistry Club would meet jointly with the Chemistry Section of the Academy. It was suggested that these organizations, and the newly organized McLean County Academy of Science be invited to affiliate with the Academy.

The Secretary reported for the Committee on Conservation that a letter circulated by this committee had aided in the continuance of important researches on wild life carried on by the U. S. Bureau of Biological Survey, whose elimination has been proposed as an economy measure.

Word has been received that the Second Class Mailing permit of the Academy, used in distributing its publications, will be revoked if the next number is not in the mails by March 31, 1934. It is expected that Volume 25, No. 3, will be ready for mailing by that date.

The President appointed the following as a committee to audit the Treasurer's accounts before the annual meeting: A. C. Noé, Chairman; J. M. Beal; S. V. Eaton.

The meeting adjourned at 5:15 p. m.

Fourth Meeting

The fourth meeting of the Council was called to order at 7:15 p. m., May 3rd, at James Millikin University, Decatur, with President Hopkins in the chair. The members present were: C. H. Behre, G. D. Fuller, J. H. Ransom, and H. R. Wanless.

The minutes of the third meeting were read and approved.

The Secretary reported that since the last meeting of the Council Volume 25, Nos. 3 and 4, and Volume 26, Nos. 1 and 2 had been printed and mailed, and that he had been informed that the contract for publication of No. 3 of Volume 26 had been let. The publication of this number will bring the *Transactions* up to date.

The Secretary reported a request from Mr. J. C. Chiddix, Editor of the Illinois Chemistry Teacher, to publish in full chemical articles, of which the Academy *Transactions* would include brief summaries. It was voted that this request be approved.

The Council expressed appreciation of the active program which has been carried on during the current year by Mr. L. A. Astell, Chairman of the Junior Section and of the large number of clubs which have become newly affiliated through his efforts. It was recognized that Mr. Astell has not had adequate assistance in the handling of his large volume of correspondence. Accordingly, it was voted that he be asked to submit a preliminary budget at the beginning of the year for such expenses, for consideration by the Council.

Mr. Ransom reported for the local committee that everything is in readiness for the meeting.

The meeting adjourned at 8:00 p. m.

Fifth Meeting

The fifth meeting of the Council was called to order at 8:15 a. m., May 4th at James Millikin University, Decatur, with President Hopkins in the chair. The members present were: C. H. Behre, Jr., G. D. Fuller, J. H. Ransom, and H. R. Wanless. Delegates were also present from the Springfield Nature Society, Peoria Academy of Science, McLean County Academy of Science, and Knox County Academy of Science, all of which are affiliated with the State Academy of Science.

Delegates of the affiliated societies explained briefly the types of programs which are being carried on by their organizations. It was suggested that the Academy might be of real assistance to these affiliated societies in providing them with lists of scientists who might be secured to deliver addresses before their organizations at moderate costs.

It was suggested that a By-Law be prepared, for the location of the city where the annual meeting is to be held, two years in advance of the meeting, in order that each city might have the chance to profit by the experience of the committee which managed the meeting the preceding year. This was referred to the Committee on Resolutions.

The meeting was adjourned at 8:50 a. m.

(Signed) Harold R. Wanless, *Secretary.*

Reports of Officers and Committees For 1933-1934

REPORT OF THE SECRETARY

MINUTES OF THE TWENTY-SEVENTH ANNUAL MEETING, DECATUR

First Business Session

The first business session of the Twenty-seventh Annual Meeting of the Academy was called to order by President Hopkins at 8:50 a. m., May 4, 1934, in the Chapel of James Millikin University with thirty members present.

The President announced the appointment of the following special committees to prepare reports for the final business session of this meeting:

Auditing Committee: A. C. Noé, of Chicago, *Chairman;* J. M. Beal of Chicago, and S. V. Eaton of Chicago.

Nominating Committee: H. J. Van Cleave of Urbana, *Chairman;* Clarence Bonnell of Harrisburg, and H. F. Ferguson of Springfield.

Resolutions Committee: Fred R. Jelliff of Galesburg, *Chairman;* T. H. Frison of Urbana, and C. H. Behre, Jr., of Evanston.

Announcements were made by the chairman of the local committee. The business session was then adjourned until 11:45 a. m.

General Session

The general session of the Twenty-seventh Annual Meeting was opened about 9:10 a. m. in the same room before an audience of about one hundred and fifty.

President Hopkins delivered his address as retiring president of the Academy on "Recent Developments in the Chemistry of the Rare Earth Group."

There followed a symposium on the Conservation of Illinois Agricultural and Human Resources, which was attended by students of James Millikin University as well as members of the Academy. The addresses composing this symposium were on (1) "The Significance of the Conservation of Land Resources," by H. W. Mumford (delivered by Dr. C. L. Steward), Dean of the College of Agriculture, University of Illinois; (2) "The Relationship Between the Standard of Living and Natural Resources," by Simon Litman, Department of Economics, University of Illinois; (3) "Classification of Illinois Lands," by Raymond S. Smith, Professor of Soil Physics, University of Illinois; (4) "Soil Erosion Control Projects," by F. A. Fisher, Soil Erosion Service, and (5) "Utilization of Illinois Lands for Forestry, Wildlife, and Recreation," by T. H. Frison, Chief, State Natural History Survey.

Second Business Session

The second session of the business meeting of the Academy was called to order by President Hopkins at 11:45 a. m., in the same hall, with sixty members present.

Minutes of the first business session were read and approved.

The following reports were read and approved: Reports of the Editor, Treasurer, Librarian, Committee on Membership, Committee on High School Science and Clubs, Committee on Legislation and Finance, Committee on Conservation, Delegate to the A. A. A. S., Delegate to the Conservation Council of Chicago.

The Committee on Affiliation reported that applications for affiliation had been received from the McLean County Academy of Science and the University of Illinois Chapter of the American Chemical Society. It was voted that these applications for affiliation be approved.

No report was presented by the Committee on Ecological Survey.

The report of the Committee on State Hall of Fame recommended the discontinuance of this committee until there might be an improvement in general economic conditions.

There was some discussion of the publication policies of the Academy, and it was recommended that this subject be discussed further at the final business session at 5:00 p. m.

As no new business was presented, the meeting was adjourned at 12:15 p. m.

Third Business Session

The final session of the annual business meeting of the Academy was called to order at 5:10 p. m., in the same room by President Hopkins, with forty members present.

The minutes of the second session were read and approved.

The report of the Committee on Resolutions was presented by Chairman Jelliff. The report was accepted by vote of the members present.

The Committee on Nominations brought the following recommendations:

For President, Charles H. Behre, Jr., Northwestern University, Evanston; for *First Vice-President*, Charles D. Sneller, Peoria; for *Secretary*, the committee, realizing the importance of this office felt indisposed to attempt to name a successor to Dr. Wanless, and therefore recommended that the Academy delegate to the Council the selection of a secretary.

For the elective member of the Committee on Publications, Lyell J. Thomas, Urbana.

For the Committee on Membership: W. V. Balduf of Urbana, *Chairman;* Vida Latham of Chicago, A. C. Noé of Chicago, B. K. Richardson of Springfield, and one additional member to be selected by the Council after the place of meeting for 1935 has been determined.

For the Committee on Affiliation: J. C. Hessler of Galesburg, *Chairman;* H. H. Radcliff of Decatur, Rosalie M. Parr of Urbana, Mary M. Steagall of Carbondale, and E. M. R. Lamkey of Normal.

It was moved and seconded that the nominations be closed, and the Secretary be instructed to cast a ballot for the nominees. The motion was carried with no dissenting votes and the nominees were declared elected.

The report of the Auditing Committee was presented by A. C. Noé, and was accepted by vote of those present.

It was voted that the Committee on Publications be authorized to determine the publication policy of the Academy for the ensuing year. This committee was also authorized to consider the best place for the publications received in exchange by the Academy, and to report to the Academy.

The Secretary reported that the McLean County Academy of Science and several other individuals and organizations had invited the Academy to hold its 1935 meeting at Bloomington. An invitation for the 1936 annual meeting was presented by Dr. F. M. Fryxell of Rock Island. Other invitations were extended in behalf of Evanston, Carbondale, Harrisburg, and Rockford. It was voted that if and when the Academy should meet at Rock Island, the Council should attempt to arrange to hold a joint session with the Iowa Academy of Science, and that the same arrangement should be attempted with the Wisconsin Academy of Science in the event of a Rockford meeting.

As no further business was presented, the meeting was adojurned at about 5:40 p. m.

(Signed) Harold R. Wanless, *Secretary*

Junior Section Meeting

The annual meeting of the Section of High School Clubs was attended by more than 300 delegates and representatives of the fifty-seven affiliated clubs.

The summary of awards as outlined below indicates how the competition has come to challenge genuine effort on the part of all contestants in that no one club is able to carry away all the honors in few sections and in no division. The record of the Physics awards, it should be noted, in which the description of the entry, the name of the school and winner represents a model for emulation.

The full benefits of the news letter plan was not realized during the year. Accordingly, plans are being made to adjust this matter in the future.

The annual business meeting was held in the auditorium of the James Milliken University immediately preceding the program.

The four features of the program included: (1) an interest-creating, illustrated lecture on "Geological Adventures," by Dr. T. T. Quirke of the University of Illinois, (2) sound films on "The Molecular Theory of Matter" and "Oxidation and Reduction," courtesy of the University of Chicago Press, (3) Talks and demonstrations by student delegates as follows:

Geology: The Cahokia Mounds—Kenneth Laurent, Dupo Geology Club, Dupo High School.

Biology: The technique of making photomicrographs (lantern slides)—George Hatzenbuhler, Amateur Burroughs Club, Bloomington High School.

Chemistry: Silvering glass (demonstration)—Merritt Kreuzinger, Maine Chemistry Club, DesPlaines. The Romance of Rubber (lantern and demonstrations)—Elbert Drazy, Edisonian Science Club, Kankakee.

Physics: The Development of the Photo-electric Cell (demonstration)—Edward Koranda, Morton Physics Club, Cicero.

General: Variety in the Science Club Program—Charles Meyer, Vocational Science Club, Granite City;

and (4) presentation of awards by Dr. B. S. Hopkins, President of the Illinois State Academy of Science.

Following the program a tea dance was presented by the students of James Milliken in honor of the visitors.

Music for the banquet was furnished by Miss Vera June Appel, violinist and the Millikin Male Quartet.

After the banquet, Junior Section delegates joined with the members of the Senior Academy to hear Dr. George Finley Simmons of the University of Chicago, on the subject of "A Three-Year Windjammer Cruise to the Islands of the South Atlantic."

Of the field trips Saturday morning, the trip to the coal mine and the one to the starch works seemed to give rise to very great interest.

The committee is pleased to announce that after making a most intensive campaign, there is a small credit surplus and a stock of the last issue of "Science Club Service," with which to take up the work next year.

In some measure these items were made possible through personal donations. These included a cash donation applying to the May issue of Science Club Service, the seventeen-volume science encyclopedia for the club securing the greatest number of new clubs, and stenographic materials and services indicated elsewhere. It is hoped that this generous spirit may continue to aid the work until a financial plan may be evolved whereby the organization may grow into full stature.

Respectfully submitted,

(Signed) Louis A. Astell, *Chairman*

WINNERS OF AWARDS

First Grand Prize: Vocational Science Club, Granite City Community High School, Granite City.

Second Grand Prize: Edisonian Science Club, West Chicago High School.

Club securing greatest number of new members: Morton Physics Club, Morton High School, Cicero.

Biology

All-round Club: Amateur Burroughs Club, Bloomington High School, Bloomington, Illinois

Individual Poster

1. Granite City Community High School
2. Visitation High School, Chicago
3. Bloomington High School

Group Poster

1. Visitation High School, Chicago
2. Visitation High School, Chicago
3. Joliet High School

Individual Project

1. Bloomington High School
2. West Chicago High School
3. Bloomington High School

Group Project

1. Bloomington High School
2. Bloomington High School
3. Joliet High School

Commercial Projects, Individual

1. Joliet High School
2. Bloomington High School
3. Joliet High School

Commercial Products, Group

1. Bloomington High School
2. Kankakee High School
3. Joliet High School

Collections

1. Eastern Illinois Teachers College High School
2. West Chicago High School
3. Bloomington High School

Models

1. Joliet High School
2. Bloomington High School
3. (No entry)

Scrap Book

1. Joliet High School
2. Granite City Community High School
3. Joliet High School

CHEMISTRY

All-round Club: Maine Chemistry Club, Maine Township High School, DesPlaines, Illinois

Individual Poster

1. Wintress Selett, Normal High School
2. J. B. Sterne, Pittsfield High School
3. Eileen Culhane, Siena High School, Chicago
4. Marie Lawler, Siena High School, Chicago

Group Poster

1. Maine Township High School, DesPlaines
2. Dupo High School
3. Dupo High School
4. Morton High School, Cicero

Individual Projects

1. Leon Aikens, Dupo High School
2. Charles Burval, Maine Township High School, DesPlaines
3. Merritt Kreuzinger, Maine Township High School, DesPlaines
4. Robert Hooten, Bloomington High School

Group Projects

1. Maine Township High School, DesPlaines
2. Maine Township High School, DesPlaines
3. Maine Township High School, DesPlaines
4. Dupo High School

Commercial Products, Individual

1. Roland Kennedy, Granite City Community High School
2. Emma Jane Watkins, Normal High School
3. Marjorie Sanderson, Pittsfield High School
4. Normal High School

Commercial Products, Group

1. Pittsfield High School
2. Pittsfield High School
3. Visitation High School, Chicago
4. Normal High School

Collections

1. William Rapp, Granite City Community High School
2. George Franklin, Dupo High School
3. Harold Voss, Granite City Community High School

Models

1. Bill Eichelman, Jr., Maine High School, DesPlaines
2. Warren Mench, Maine High School, DesPlaines
3. Leon Aikens, Dupo High School
4. Leon Aikens, Dupo High School

Scrapbook

1. John Mason, Morton High School, Cicero
2. Marjorie Hanson, Normal High School
3. Florence Kukarski, Visitation High School, Chicago
4. Roberta Canady, Dupo High School

Geology

All-round Club: Bloomington Geology Club, Bloomington High School, Bloomington, Illinois

Individual Poster

1. John Gray, Bloomington High School
2. Robert Miller, Granite City Community High School

Group Poster

2. Bloomington High School

Individual Project

1. Robert Brown, Bloomington High School

Group Project

1. West Chicago High School

Collections

1. Edwin Olson, Bloomington High School
2. Leon Aikens, Dupo High School
3. Kent Adamson, West Chicago High School

Models

1. Normal McDonald, Dupo High School
2. Jack Mortimer, Bloomington High School

Scrapbook

1. Perry Burnett, Bloomington High School
2. Alvin Mercer, Granite City Community High School

Physics

All-round Club: Morton Physics Club, Morton High School, Cicero

Individual Poster

1. Streamlining. Edward Sigul, Morton High School, Cicero
2. Dry Cell. Emerson Horn, Mt. Pulaski High School

Group Poster

1. Machine Chart. Morton High School, Cicero
2. Short Wave Phenomena. Kankakee High School

Individual Project

1. Talking Light Beam. Robert Hale, Morton High School, Cicero
2. Demonstration of Induction. C. Meyer, Granite City Community High School

Group Project

1. Diving Helmet. Brant and Dell, Pittsfield High School
2. Air Compressor. Lacey and Heyday, Pittsfield High School
3. Conroy and Gray, Pittsfield High School

Commercial Products, Individual

1. Sound System, Louis Palnke, Kankakee High School
2. Commercial Photo Tube, Ed Koranda, Morton High School, Cicero

Commercial Products, Group

1. Telescope. Pittsfield High School

Models

1. Model Boat. Greeman, Kankakee High School
2. Two-cycle Engine. Pittsfield High School

Scrapbook

1. Albin Yasska, Morton High School, Cicero
2. Virgil Mercer, Granite City Community High School

Radio

1. Power Amplifier. Hruly, Morton High School, Cicero.
2. Power Wave Radio. Logan, West Chicago High School.

Junior High School

All-round Club: Vocational Science Club, Granite City Community High School, Granite City, Illinois

Individual Poster

1. Edward Durbin, Granite City Community High School
2. Richard Holshouser, Granite City Community High School
3. Bob Suter, David Prince High School, Jacksonville

Individual Project

1. Robert Marker, West Chicago High School

Group Project

1. Vocational Science Club, Granite City Community High School

Collections

1. Edward Jenkins, Granite City Community High School
2. James Fuhrman, Granite City Community High School

Models

1. Kenneth Richardt, West Chicago High School
2. John Dieter
3. Leonard Libby, Granite City Community High School

Scrapbook

1. Richard Holshouser, Granite City Community High School
2. Mary Madison, West Chicago High School
3. Virgil Blevins, Granite City Community High School

News Letters

Mimeographed

1. Kankakee High School
2. Granite City Community High School

Dittoed

1. Visitation High School, Chicago

Handcraft

1. Maine Township High School, DesPlaines
2. Morton High School, Cicero

Other Events

The afternoon was devoted to the meetings of eight sections of the Academy, which were held in various rooms at James Millikin University.

The annual banquet of the Academy was served to about 100 members and guests at the First Presbyterian Church. Following the banquet, addresses of welcome were given by O. W. Smith, Mayor of Decatur, and Jesse H. White, President of James Millikin University, and an illustrated lecture was given by Professor George Finlay Simmons of the University of Chicago on "A Three-Year Windjammer Cruise to the Islands of the South Atlantic."

On Saturday morning, four excursions were provided for members and guests of the Academy. Dr. William D. Hatfield conducted a trip to the Decatur Sewage Disposal Works and the Water Purification Plant. Dr. R. E. Greenfield conducted a trip through the plant of the Staley Corn Products Company. Dr. M. M. Leighton and Dr. George E. Ekblaw conducted a geological trip to study features in the glacial history of the Decatur region. Mr. D. W. Beggs and Dr. Gilbert H. Cady conducted a trip through the coal mine in the city of Decatur.

REPORT OF THE TREASURER

For Year Ending April 30, 1934

Receipts

Balance on hand May 2, 1933	$814.61	
Initiation fees and dues	704.00	
Allowance from A. A. A. S.	162.00	
Sale of *Transactions*	9.00	
Old debt paid for reprints	10.83	
Interest on bonds and savings	11.28	
Junior Academy	76.00	
		$1787.72

Expenditures

Expenses of annual meeting, 1933:			
Programs	$53.61		
Registration	25.00		
Officers' expenses	31.78		
Speakers' expenses	24.85		
Junior Academy	58.34		
		$193.58	
Chairmen of sections, postage, etc.		42.05	
Junior Section, 1934		114.57	
Editor's salary, 1933		50.00	
Editor's salary, 1934		150.00	
Secretary's salary		150.00	
Printing Transactions		268.89	
Addressing Transactions, postage		52.74	
Expenses of Treasurer's office		90.64	
Expenses of Secretary's office		122.22	
Membership campaign		60.00	
Council meetings		20.08	
Refund on dues overpaid		4.00	
			$1318.77
Balance in University State Bank			468.95
			$1787.72

In presenting the above report, the Treasurer would call attention to the fact that collections have equalled those of the preceding year, while expenditures have somewhat increased. Much of this increase is due to bills from the year 1932-33. Considering the rather large expenditure for printing, the balance on hand is gratifying.

The present membership consists of 84 life members, 505 members fully paid up, 174 members in arrears for one year, 184 who are in arrears for two years, and 137 who are in arrears for three years. These last will be dropped from the rolls at the date of this meeting. We have received 40 new members during the year; 26 have resigned, and 6 have been lost by death. The net membership on April 30, exclusive of those who are being dropped at the present meeting, but including the paid up new members, is 985 personal members, and 70 societies and clubs.

The entire report is respectively submitted.

(Signed) Geo. D. Fuller, *Treasurer*

REPORT OF THE AUDITORS

Statement of resources as of April 30, 1934

Balance in University State Bank	$468.95
Mortgage bonds	600.00
Accrued interest	20.00
Office supplies	10.00
Total resources	$1098.95

We, the committee appointed to audit the report of the Treasurer of the Illinois State Academy of Science, have examined the accounts, which appear to have been correctly kept, and have verified the entries of expenditures against approved vouchers made by the President and the Secretary.

We find the balance in the bank of $468.95, and the mortgage bonds of $600.00 as reported April 30, 1934, to be correct.

(Signed) A. C. Noé
J. M. Beal
Scott V. Eaton

REPORT OF THE LIBRARIAN

The approximate number of Transactions on hand that were published since Volume 22 is as follows:

Volume 23,	No. 1	100
23,	2	Exhausted
23,	3	Exhausted
23,	4	Exhausted
24,	1	50
24,	2	100
24,	3	Exhausted
Volume 24,	No. 4	50
25,	1	25
25,	2	250
25,	3	350
25,	4	375
26,	1	100

Sometime ago I made a suggestion to Dr. Wanless that as the Museum Library is not used to any extent by the public, the exchanges which are sent to the Academy be deposited in the State Library. Since making this suggestion I have taken up the matter with Miss Harriet Skogh, Librarian of the State Library, who assures me that they would be very glad to receive these publications as a *gift* to the State but they would be unable to keep them as a separate unit. They would have to be scattered on the shelves with the subject they represent. Miss Skogh feels that if they are made as a loan there would be great difficulty, if, at some future time the Academy wished to recall the loan. I would suggest that if some suitable arrangement can be made, the volumes be placed in the State Library as they, undoubtedly, would find a far wider field of usefulness than in the Museum Library. I wish to add that some years ago the greater portion of the State Museum Library was transferred to the State Library and only that portion remains in the Museum which is more or less in constant use by the Museum staff.

The approximate number of publications received by the Academy for the past year is seventy-five.

Respectfully submitted,
(Signed) Arthur Sterry Coggeshall, *Librarian*

REPORT OF THE COMMITTEE ON PUBLICATIONS

The report made by this committee at the 1933 meeting called attention to the continued delay in the publication of the *Transactions* of the Chicago meeting (1932). The general addresses presented at this meeting were published by the Academy in May, 1933. The committee was unable to secure the release of any additional funds from the appropriation for the biennium 1931-33 to publish the papers given at the section meetings at Chicago, and approximately $2,000.00 of the appropriation lapsed June 30, 1933. The budget of the State Department of Registration and Education for the biennium 1933-35 included an item of $2,000.00 for the publication of the Academy *Transactions*. In order that this budget might be spread over the two years, giving maximum benefit to the Academy, the committee, with the advice of the Council, decided to limit publication of papers presented at the section meetings in 1932, 1933 and 1934, to brief summaries. The manuscript of the number including the papers presented at the 1932 meeting was accordingly returned to the authors, and, during the fall of 1933, it was reassembled in abbreviated form. This was submitted for publication out of the new appropriation in December, 1933, but was delayed nearly three months before its final approval and publication as Volume 25, No. 4. In order to hold the second class mailing permit, the number including the reports of officers and committees at the Twenty-sixth Annual Meeting, 1933, was published by the Academy as Volume 25, No. 3. The preliminary program of the Twenty-seventh Annual Meeting was published during April, 1934, as Volume 26, No. 1, and mailed at the same time as the preceding number. The general addresses presented at the East St. Louis meeting have just been printed as Volume 26, No. 2, and are in the mails today. The summaries of papers presented at the section meetings at East St. Louis have been submitted for publication as Volume 26, No. 3 and the contract has been let. It will be ready for distribution later this spring.

The following is a summary of the publication of the year:

Volume 25, No. 2—1,500 copies, $170.00. Academy funds.
Volume 25, No. 3—1,500 copies, $96.84. Academy funds.
Volume 25, No. 4—1,500 copies, $952.89.* State appropriation.
Volume 26, No. 1—1,700 copies, $43.78. Academy funds.
Final program for 27th meeting—1,000 copies, $24.48. Academy funds.
Volume 26, No. 2 (in mails)—1,500 copies, $121.51.* State appropriation.
Vol. 26, No. 3 (in press)—1,500 copies, $289.54.* State appropriation.

The committee also reports the loss of all addressograph plates and bars in the State Multigraph Bureau, through the Springfield Arsenal fire. New plates are in the process of being prepared.

The committee wishes to express its regret to the members of the Academy and especially to the authors of manuscripts for the long delay in recent publication, for the necessary reduction in size of the *Transactions*, and for the diversion of a larger amount of Academy funds for publication purposes. The advice of the Council and past officers and other members was sought and generously received, and thanks are extended to those who aided the committee in explaining to officials of the State government the function of the Academy and the value to the State of the publication of its *Transactions*.

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* Preliminary estimate.

The committee has been informed of a statute governing the office of the Superintendent of Printing, which states that:" * * * there must be omitted all journals and minutes of proceedings. * * *" This requires the future publication of the minutes of business sessions and council meetings, reports of officers and committees, the constitution, the program, and any lists of present or former officers or committees to be published at Academy expense.

The committee has received from some members alternative plans for the solution of its publication problem. These suggestions have been gratefully received and considered. The following suggestions are excerpted from such letters:

(1) Reduction of the maximum allotment of space per author from 20 printed pages to 2,000 words.

(2) Selection from all the papers presented at each annual meeting of a few outstanding papers which would be published in full.

(3) The printing of an abstract of each paper presented at the meeting, with the statement that a copy of the full paper might be secured for exactly the cost of having a copy typewritten. Each manuscript in full would then be filed with the librarian of the Academy, who would take care of such requests for the full papers as may be received.

A study of the publication policies of other State Academies of Science which issue transactions reveals a range in space devoted to single papers from a short paragraph to 200 pages.

The committee would welcome further suggestions by the membership of the Academy toward the establishment of a permanent publication policy, either at the present business meeting, or in writing, to the committee for 1934-35.

(Signed) B. Smith Hopkins
H. R. Wanless
Lyell J. Thomas

REPORT OF THE EDITOR

The December issue (No. 2) of Volume 25 of the Academy's Transactions, containing papers presented in general sessions at the Chicago (1932) meeting was published in June, 1933. Funds were not released for further publication until March, 1934.

In order to meet post office requirements and prevent the quarterly mailing permit from lapsing, it became necessary to designate the issue containing the minutes of the Twenty-fifth Annual Meeting as No. 3 of Volume 25, which was distributed late in March of this year. Papers presented at the Chicago meeting constitute No. 4 of Volume 25, and was distributed together with No. 1 of Volume 26, Announcement of the Twenty-seventh Annual Meeting, in April, 1934.

Papers presented in general sessions at the East St. Louis meeting comprise No. 2 of Volume 26, which has just been distributed. No. 3, consisting of papers presented in section meetings at East St. Louis is now in press. Its distribution will bring the Academy's printing program up to date.

Respectfully submitted,
(Signed) Dorothy E. Rose, *Editor*

REPORT OF COMMITTEE ON AFFILIATION

The two applications for affiliated membership that have come to the attention of the committee are those of the McLean County Academy of Science and of the University of Illinois Section of the American Chemical Society. These, as the committee understands, have already qualified for membership. The committee therefor recommends their admission to affiliated membership.

(Signed) JOHN C. HESSLER, *Chairman*

REPORT OF MEMBERSHIP COMMITTEE

In the campaign for new members this year, nominees were addressed as usual, and the personal solicitation method was stressed more than usual. In addition, special attention was given to the field of education, in an effort to build up a stronger section of psychology and education. An effort was also made to secure greater representation in the Academy from the members of the Illinois Biology Teachers Association, which is an affiliated organization. Many nominees declined their nominations by letter on the basis of financial inability to take advantage of the opportunity of joining, although they expressed the wish of doing so in the near future. On the whole, however, the number of new members secured (40) indicates a fairly successful campaign considering the prevailing economic situation.

The Council of the Academy appropriated the sum of $75.00 for membership campaign expenses. Expenditures totaled $67.40, leaving a balance of $7.60.

Respectfully submitted,

DON L. CARROLL, *Chairman*

REPORT OF THE COMMITTEE ON HIGH SCHOOL SCIENCE AND CLUBS

Following the resignation of the Chairman, Mr. A. E. Cockrum, the committee held its first meeting during the High School Conference at the University of Illinois. Perspective for the problems at hand represented the chief outcome of this meeting.

With a budget allowance from the Senior Academy Council on which to work, the initial step in the campaign for new clubs and retention of old ones, was the preparation and mailing of approximately a thousand copies of the first issue of the Science Club Service leaflet with accompanying form letters. The results were sufficiently gratifying to warrant the belief that with greater effort still greater results might be had. The chairman accordingly proposed that radio facilities be obtained with the understanding that script for the speakers to draw upon would be supplied by him. Five such radio programs were scheduled with speakers in the following order: Dr. L. J. Thomas, Dr. H. R. Wanless, and Dr. B. S. Hopkins, all over Station W. I. L. L., and Dr. Charles H. Behre, Jr., followed by Dr O. D. Frank over W. G. N. An additional talk over K. Y. W. was given by the chairman on the subject of "Science Club Work for the Changing Social Order," under the auspices of the Men Teachers Union of Chicago. This series of talks created more interest than any single form of attack thus far inaugurated. One reason for this was found in the fact that post-card announcements of the series were sent out in advance.

In order to reduce the mass of correspondence that would naturally arise from such a series of talks, a second issue of the Science Club Service was prepared and mailed to all contacts as well as affiliated clubs. This issue of the leaflet contains such inspirational and staple information as to be useful in the early fall campaign for new club affiliations, and there is a sufficient supply to meet these needs if the mailing list is carefully selected, a detail which the chairman will be glad to work out.

The work of the Junior Section could not have been carried to its successful conclusion without the generous support of the Senior Academy and the various individuals and organizations. It is a matter of personal pride to note that the Junior Section has not used all of the budget allowance made possible by the Senior Academy this year. The Junior Section through its active committee desires to thank the Senior organization for all the support it has received, both financially and cooperatively. It further desires to express its appreciation to the following: To Dr. H. R. Wanless for obtaining station time over W. I. L. L.; to Dr. C. H. Behre, Jr. for such time over W. G. N.; and to all the speakers who participated in the work; also to the W. M. Welch Manufacturing Company, the Illinois Biological Teachers Association, and the Illinois Association of Chemistry Teachers for loving cups; to the administrative and commercial departments of the Granite City Community High School, the Maine Township High School; and the Kankakee High School for stenographic and clerical assistance; and finally to those generous individuals who have made voluntary cash contributions to the end that the various aspects of the work might move without interruption.

It should be remembered that the economic conditions through which the public schools of the State as a whole have been passing, has not shown the improvement reflected in the business world. Nevertheless, it is interesting to note that the Junior Section moved forward in unmistakable ways. It has broken all previous records in the total number of affiliations maintained; all previous records in the total number of members in such affiliated clubs; all previous records in re-establishing clubs with dues two or more years in arrears; and, we believe that it will reflect this solidity of growth through the most satisfactory meeting it has had when viewed from every angle. An analysis of the affiliation records may be summarized as follows: 1930—27 clubs; 1931—40 clubs; 1932—41 clubs; 1933—24 clubs; 1934—57 clubs.

Recommendations for the furtherance of the work include:

(1) Changes in the Constitution and By-Laws of the Junior Section, to include provisions for chairmen as follows: (a) Radio Service, (b) Expansion and Editorial Service, (c) Zone Activities on the basis of six zones embracing from four to 23 counties each. The promulgation of this work has been delegated to Dr. Lyell J. Thomas of the Advisory Committee.

(2) The continuance of the Science Club Service leaflet on the basis of two to three issues per year, depending upon the growth of the organization, and with the last issue of the year designed to serve the purposes of the affiliated and contact group for the moment, also to serve as the campaign issue for the following season.

(3) The development of the Advisory Committee. The details of this recommendation are left in the hands of the present Advisory Committee.

(4) The consideration of the nominations for the expanded Junior Committee as presented by Dr. Rosalie M. Parr, Chairman of the Nomination Committee.

(5) That any action on the part of the Senior Council to include the Chairman of the Junior Section as a member of its group, might well carry with it the provision that such chairman would be ineligible to attend these meetings unless he or she personally was a member of the Illinois State Academy of Science.

A cumulative financial record has been maintained in the correspondence directed to Dr. George D. Fuller, Treasurer, as dues made payable to him were transmitted by the chairman to him.

It is believed that no organization ever worked under a more harmonious influence, and that everything possible has been done to make the work efficient, effective, and economical.

REPORT OF THE COMMITTEE ON LEGISLATION AND FINANCE

The work of the committee during the past year has been centered around the question of finances for the publication of our *Transactions*. In spite of the work of the various members of the committee, both by correspondence and by personal visits, and the very efficient assistance of our Secretary, it was impossible to obtain the release of the balance of two thousand dollars ($2,000) in the appropriation given the Academy by the preceding administration. It was possible, however, to obtain a reduced appropriation in the new budget. This has been finally released and the members already have received their copy of the first of the *Transactions*, which had been held up because of the question of finances.

(Signed) A. C. Walton, *Chairman*

REPORT OF THE COMMITTEE ON STATE HALL OF FAME

The committee has nothing to report except that the financial conditions during the past year have not been such as to warrant any consideration of a State Hall of Fame.

This matter will need to await more favorable conditions in the State, in spite of the fact that it would be appropriate for the State to recognize its outstanding men in the scientific world.

I therefore suggest that this committee be dissolved with the expectation that the matter will be brought before the Academy again in due time.

Respectfully submitted,

(Signed) M. M. Leighton, *Chairman*

REPORT OF THE DELEGATE TO THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

The representative of the Illinois State Academy of Science attended the meeting of the Academy Conference section of the American Association for the Advancement of Science at Boston during the Christmas holidays, and completed the committee work in that Conference which he had been carrying on as past-Chairman of the Conference group.

The meeting at Boston was primarily centered around two questions. The first dealt with the question as to the credit value which should be attached to a clock hour spent in laboratory or field work. While this question aroused considerable comment from laboratory men that they felt not enough teaching credit was being awarded for such work, nevertheless the general opinion was that the problem was primarily one for administration rather than for faculty settlement.

The second question of discussion was as to the attitude that the various State Academies, which have adopted the Junior Academy movement, should have toward the new national organization of High School Science Clubs which was being sponsored primarily by the Chemistry people. The matter was referred to the various State Academies for consideration and suggestions. The result is to be reported at the next meeting to be held in Pittsburg in 1934. Meanwhile it was urged that all states engaged in, or contemplating, Junior Academy organization should not let down their efforts in this direction because of the present apparent competition aroused by the new organization. Your delegate has reported the matter to the Council of the Academy and the matter now rests in their hands awaiting their decision.

Respectfully submitted,
(Signed) A. C. Walton, *Delegate*

REPORT OF DELEGATE TO ILLINOIS CONSERVATION COUNCIL

The Council represents about sixty different organizations. The meetings are held the third Thursday of each month from October until May at the Morrison Hotel in Chicago.

The aims of the organization are first to inform the delegates concerning various conservation movements taking place throughout the country, and second to serve as a clearing house for conservation ideas in order that action may be directed along lines in which all organizations may be in agreement.

The year has seen great forward steps in conservation due chiefly to the leadership in Washington. The Everglades as a national park has again drawn the attention of Congress and many places have been proposed that have no claim for any place in our consideration for national parks. National forestry has been in the center of attention. Illinois has been granted six hundred thousand acres in the southern part of the State, the beginning of what will be a national forest in the future. Several million acres must eventually return to forestry in this State if our resources and scenery are to be returned to a reasonable condition. The State has been handicapped by the depression in its movement to add to the State parks.

In spite of the depression much more has been gained than is usual in any one year.

Respectfully submitted,
(Signed) V. O. Graham

REPORT OF THE COMMITTEE ON CONSERVATION

The present organization of your Committee on Conservation was not established until about six months ago. Shortly thereafter it was felt that a vigorous protest should be lodged with all the United States Senators and Representatives from Illinois, members of the special Wild Life Committee of the Senate, and the Sub-Committee of the House dealing with agricultural appropriations against the elimination of three fundamental and important divisions of work of the U. S. Bureau of Biological Survey. It was felt that the elimination of this fundamental scientific work at a time when conservation activities were being pushed at an accelerated speed and when trained leadership was needed more than ever was inconsistent, unsound, and false economy. This committee's letter of protest was read at the appropriation hearings in Washington and the prompt response and action of our Illinois Senators and Representatives was extremely gratifying. I am glad to report that this protest, together with those of other organizations throughout the country, led to the reinstatement of the desired appropriations in the budget and the final passage of the appropriation bill.

Since the last meeting of this Academy, the establishment in Illinois of the Shawnee and Illini National Forests has been approved by the Federal Commission. At the present time the U. S. Forest Service has options on about 100,000 acres of the 600,000 within the area of the two Illinois National Forest Units as now defined and the actual purchase of this land will soon be an accomplished fact. An office of the Forest Service for the immediate supervision of these newly established units has been established at Harrisburg, Illinois. It will be recalled that this Academy has helped support the move for the establishment of National Forests in Illinois ever since this movement was started by the State Natural History Survey and the Illinois Agricultural Experiment Station.

It is hoped that this committee can play in the future an increasingly important part in conservation policies and activities of this State and the nation.

Respectfully submitted,
(Signed) T. H. Frison, *Chairman*

REPORT OF THE COMMITTEE ON RESOLUTIONS

I. Whereas, In view of the national migratory waterfowl situation and the great importance of the Illinois River valley as a migration route for many species of waterfowl now greatly reduced in numbers, be it therefore

Resolved, That this Academy urges and endorses the acquisition by the Federal Government for a wild-life refuge or sanctuary of a large tract of water area and submarginal land in the Illinois River valley between Pekin and Beardstown as mapped, described, and presented to President Roosevelt's Wild-Life Restoration Committee by the Illinois State Natural History Survey, the Illinois Agricultural Experiment Station, and a special committee of the Ecological Society of America.

II. Whereas In Illinois there is a serious need for a varied and broad land utilization program and since such programs to be most effective must rest upon impartial and scientific data, be it therefore

Resolved, That this Academy goes on record as endorsing the past and present programs of the State Scientific Surveys and the Illinois Agricultural Experiment Station and further that these fact-finding research organizations supply the leadership in the evaluation and scientific guidance of land utilization problems in this State.

III. Whereas In Illinois there are 4,800 square miles of land subject to destructive erosion, 4,600 square miles subject to serious erosion, and 19,700 square miles subject to harmful erosion, be it therefore

Resolved, That this body endorses the splendid accomplishments of the Civilian Conservation Camps in this State and urges the continued maintenance and operation of these camps in furthering the development of State and National forests and erosion control projects.

IV. *Resolved*, That we express our feeling of regret and sorrow for the death of the following members:

Dr. C. C. Farrington, Field Museum, Chicago, Illinois.
A. S. Galajikian, Knox College, Galesburg, Illinois.
Arthur J. Mason, Homewood, Illinois.
Sylvester Miller, 1344 Garfield Avenue, Aurora, Illinois.
Marie A. Prucha, 2530 South Clifton Park Avenue, Chicago, Illinois.
Jesse L. Smith, Highland Park, Illinois.

We feel that in their deaths the State Academy has suffered a distinct loss and shall gratefully remember them for their virtues and accomplishments.

V. *Resolved*, That the State Academy of Science views with great pleasure the fine work being done by the local academies of the State, now affiliated with the State Academy, and we recommend that the Council be authorized to prepare a list of speakers, who can be made available to these local academies at minimum expense.

VI. Whereas, The present policy of the Illinois State Academy of Science is to assign the place of the Annual Meeting of the Academy only one year in advance and

Whereas, It is desirable for numerous reasons to systematize places for future meetings in the interests of equable geographic distribution of meeting places, be it therefore

Resolved, That an additional by-law be enacted as follows: "The Council elected for the year 1934-35 is empowered to select the place of the Annual Meetings for May, 1935, and for May, 1936. Thereafter each successive Council shall select the place of the Annual Meeting for the spring of the first year following the retirement of said Council, except when unforeseen circumstances make it necessary for said Council to act with respect to the more immediate meeting as well."

VII. Whereas Mr. Louis A. Astell has shown exceptional devotion, energy, and skill in furthering the work of the Junior Section of the Academy of Science and of the affiliated high school science clubs, be it

Resolved, That the Illinois State Academy of Science express its hearty appreciation in the strongest terms of the excellent work of Mr. Astell and do whatever may be in its power to assist him in its furtherance.

VIII. *Resolved*, That the resolutions adopted at this meeting be placed on record and that copies of pertinent resolutions be duly transmitted to interested persons.

IX. *Resolved*, That we thank the officers and Council of the Academy for their efficient services during the past year.

X. *Resolved*, That the State Academy extend its grateful appreciation to the local committee, whose efficient service has made this meeting possible; Dr. J. H. Ransom, for his individual efforts; to The James Millikin University, for the use of its buildings; to the Decatur press for its generous publicity; and all other organizations and individuals who have contributed to the success of the sessions.

(Signed) Fred R. Jelliff
T. H. Frison
Chas. H. Behre, Jr.

CONSTITUTION AND BY-LAWS
OF THE
ILLINOIS STATE ACADEMY OF SCIENCE

CONSTITUTION

Article I. Name

This Society shall be known as The Illinois State Academy of Science.

Article II. Objects

The objects of the Academy shall be the promotion of scientific research, the diffusion of scientific knowledge and scientific spirit, and the unification of the science interests of the State.

Article III. Members

The membership of the Academy shall consist of two classes as follows: *National Members and Local Members.*

National Members shall be those who are members also of the American Association for the Advancement of Science.

Local Members shall be those who are members of the local Academy only. Each member, except life members of the Academy, shall pay an admission fee of one dollar and an annual assessment of one dollar.

Both national members and local members may be either *Life Members, Active Members, or Non-resident Members.*

Life Members shall be national or local members who have paid fees to the Academy to the amount of twenty dollars at one time or complete payments before the annual meeting of 1928. The dues from such a source are to be placed as a permanent fund and only the income is to be used.

Active Members shall be national or local members who reside in the State of Illinois.

Non-resident Members shall be active members or life members who have removed from the State of Illinois. Their duties and privileges shall be the same as active members except that they may not hold office.

Charter Members are those who attended the organization meeting in 1908, signed the constitution, and paid dues for that year.

For election to any class of membership, the candidate's name must be proposed by two members, be approved by a majority of the committee on membership, and be acted upon favorably by a majority vote of the Council.

Article IV. Officers

The officers of the Academy shall consist of a President, a First Vice-President, a Second Vice-President, a Secretary, a Treasurer, a Librarian, and an Editor. These officers, with the exception of the Second Vice-President, the Librarian, and the Editor, shall be chosen by ballot at the annual meeting and shall hold office for one year or until their successors qualify.

The Second Vice-President, who may be a resident of the town in which the next annual meeting is to be held, may be appointed by the Council each year when the next meeting place shall have been decided upon, in order that he may serve as ex-officio chairman of the Committee on Local Arrangements.

The Chief of the State Museum Division of the Department of Registration and Education of the State of Illinois shall be the Librarian of the Academy.

The Editor shall be selected by the Council upon the recommendation of the Committee on Publication.

The above officers shall perform the duties usually pertaining to their respective offices.

It shall be one of the duties of the President to prepare an address which shall be delivered before the Academy at the annual meeting at which his term of office expires.

The Librarian shall have charge of all the books, collections, and material property belonging to the Academy.

The Editor, under the direction of the Committee on Publication, shall have entire charge of the editing and printing of the annual volume of the Transactions and also of such other papers as the Committee on Publication shall deem advisable.

Article V. Council

The Council shall consist of the President, First Vice-President, Second Vice-President, Secretary, Treasurer, Librarian, the retiring president and his immediate predecessor, and the Secretary of the preceding year. To the Council shall be entrusted the management of the affairs of the Academy during the intervals between regular meetings.

At the Annual Meetings the presiding officer of each of the affiliated scientific societies of the State shall meet with the Academy Council for the discussion of policies.

Article VI. Standing Committees

The Standing Committees of the Academy shall be a Committee on Publication, a Committee on Membership, and a Committee on Affiliation and such other committees as the Academy shall from time to time deem desirable.

The Committee on Publication shall consist of the President, the Secretary and a third member chosen annually by the Academy. It shall pass upon the papers published by the Academy, subject to review by the Council.

The committees on Membership and Affiliation shall each consist of five members chosen annually by the Academy.

Article VII. Meetings

The regular meetings of the Academy shall be held at such time and place as the Council may designate. Special meetings may be called by the Council, and shall be called upon written request of twenty members.

Article VIII. Publications

The regular publications of the Academy shall include the Transactions of the Academy and such papers as are deemed suitable by the Committee on Publication.

All paid up members shall receive gratis the current publication of the Academy except in case of emergency.

Article IX. Affiliation

The Academy may enter into such relations of affiliation with other organizations of appropriate character as may be recommended by the Council, and may be ordered by a three-fourths vote of the members present at any regular meeting.

Article X. Amendments

This constitution may be amended by a three-fourths vote of the membership present at an annual meeting, provided that notice of the desired change has been sent by the Secretary to all members at least twenty days before such meeting.

BY-LAWS

I. The following shall be the regular order of business:

1. Call to order.
2. Reports of officers.
3. Reports of standing committees.
4. Election of members.
5. Reports of special committees.
6. Appointment of special committees.
7. Unfinished business.
8. New business.
9. Election of officers.
10. Program.
11. Adjournment.

II. No meeting of the Academy shall be held without thirty days previous notice by the Secretary to all members.

III. Fifteen members shall constitute a quorum of the Academy. A majority of the Council shall constitute a quorum of the Council.

IV. No bill may be incurred against the Academy by officers or committees in excess of five dollars, except as provided for in By-law IX, unless approved by the Council. No bill against the Academy shall be paid without an order signed by the President and the Secretary.

V. Members who shall allow their dues to remain unpaid for three years, having been annually notified of their arrearage by the Treasurer, shall have their names stricken from the roll.

VI. The Librarian shall have charge of the distribution, sale, and exchange of the published Transactions of the Academy, under such restrictions as may be imposed by the Council.

VII. The presiding officer shall at each annual meeting appoint a committee of three who shall examine and report in writing upon the account of the Treasurer.

VIII. No paper shall be entitled to a place on the program unless the manuscript or an abstract of the same shall have been previously delivered to the Secretary. No paper shall be presented at any meeting, by any person other than the author, except on vote of the members present at such meeting. Manuscript of papers must be handed to the Secretary at the time of the Annual meeting. All papers are limited to twenty pages, additional pages are to be paid for by the author. Except by invitation of the Council, no paper may be accepted for the program unless the author is a member of the Academy or an applicant for membership. No paper shall be accepted for publication which has already been published elsewhere.

IX. The Secretary and the Treasurer shall have their expenses paid from the Treasury of the Academy while attending council meetings and annual meetings. Other members of the Council may have their expenses paid while attending meetings of the Council, other than those in connection with annual meetings.

X. These by-laws may be suspended by a three-fourths vote of the membership present at any regular meeting.

XI. The Treasurer shall maintain a permanent fund for the Academy, only the interest on which may be used. This permanent fund shall consist of (1) life membership dues, (2) donations, and (3) funds as the Council may see fit from time to time to add from accumulations in the treasury.

CONSTITUTION AND BY-LAWS

OF THE

JUNIOR SECTION

ILLINOIS STATE ACADEMY OF SCIENCE

CONSTITUTION

Article I. Name

This organization shall be known as the Junior Section of the Illinois State Academy of Science.

Article II. Objects

The object of this organization shall be to create and foster the best interest of science together with the spirit of American democracy through scientific, moral, and social activities in the various high schools and communities of the state.

Article III. Membership

The membership shall consist of the active members of the various scientific clubs affiliated with the Illinois State Academy of Science, under the rules and regulations prescribed by the latter Society.

Article IV. Delegates

The number of delegates from each club shall be the same regardless of the size of the club.

This number of delegates will be determined annually by the Governing Committee as prescribed in Article VI below.

Only the official delegates of the various clubs shall vote on the matters representing the official business of the organization.

These provisions shall not be construed as barring additional guests from the several clubs as far as accommodations can be provided.

Article V. Officers

The officers of the Junior Section of the Illinois State Academy of Science shall consist of a President, a Vice-President, a Secretary, and a Treasurer.

These officers shall be elected by the delegates from the several clubs represented at the regular annual meetings of the organization.

The above officers shall perform the duties usually pertaining to their respective offices.

Article VI. Governing Committee

The Governing Committee shall consist of the chairman of the Section of the Illinois State Academy of Science designated as "High School Science Clubs," together with such other members as may be elected by the Junior Section.

This committee shall in turn be governed through the Council of the Illinois State Academy of Science, through constitution and by-laws of the latter society in-so-far as they may involve the activities of the Junior Section of the Illinois State Academy of Science.

Article VII. Limitation of Expenses

No bills in excess of $5.00 shall be incurred by the Junior Section without the authorization of the Council of the State Academy.

Article VIII. Bills

No bill against the Junior Section of the Illinois State Academy of Science shall be paid without an order endorsed by the President, Secretary, and Treasurer of the Illinois State Academy of Science and the chairman of the Governing Committee of the Junior Section.

Article IX. Meetings

The regular meeting of the Junior Section of the Illinois State Academy of Science shall be held at such time and at such place as the Council of the Illinois State Academy of Science may designate. Special meetings may be called by the chairman of the Governing Committee, by written notice to the several members of the said committee.

Article X. Affiliation

Affiliation of the various clubs with the Illinois State Academy of Science shall obtain in the manner prescribed by that Society.

Article XI. Dues and Special Assessments

Dues and special assessments in addition to the fees for affiliation above, may be made by the Governing Committee, providing such levies are in keeping with the provisions of Articles VII and VIII above.

Article XII. Amendments

This constitution may be amended by a three-fourths vote of the official delegates present at an annual meeting, and subject to ratification of the Council, provided that notice of the desired change has been sent to the chairman of the Governing Committee and to the Secretaries of the State Academy and the Junior Section of the Illinois State Academy of Science at least twenty days before such meeting.

BY-LAWS

I. The following shall be the regular order of business:

1. Call to order.
2. Reports of officers.
3. Reports of standing committees.
4. Election of members; i. e., recognition of new clubs affiliated with the Academy, etc.
5. Reports of special committees.
6. Appointment of special committees.
7. Unfinished business.
8. New business; roll call of clubs for reports of outstanding activity.
9. Election of officers.
10. Program.
11. Adjournment.

II. The Chairman of the High School Section shall at each annual meeting appoint a committee of three who shall examine and report in writing upon the account of the Treasurer.

III. These by-laws may be suspended by a three-fourths vote of the official delegates present.

AFFILIATED HIGH SCHOOL SCIENCE CLUBS

Arlington Heights, Ill.: Arlington Heights Science Club. (1930.)
Atwood, Ill.: Atwood Phy-Chy Club, High School. (1934.)
Aurora, Ill.: Aurora General Science Club, Junior High School. (1934.)
Bloomington, Ill.: Amateur Burroughs Club. (1931.)
Bloomington Geology Club. (1933.)
Modern Alchemists Club. (1929.)
Charleston, Ill.: Teachers College Science Club. (1934.)

Chicago, Ill.: Botchemzo Club, Parker High School. (1930.)
Bowen Bird Boosters, Bowen High School, 2710 East 89th Street. (1934.)
Crane Tech Zoa-Phyta Club, Crane Tech High School, Oakley and Jackson. (1934.)
Harrison Biology Club, Technical High School. (1930.)
Mendel Science Club, Visitation High School. (1932.)
Morgan Park Science Club, Morgan Park High School, 11043 Hermosa Ave. (1930.)
Senn Science Society, Senn High School. (1934.)
Siena Biology Club, 5600 Washington Blvd.
Siena Chemistry Club, 5600 Washington Blvd. (1931.)
University Science Club, University of Chicago High School. (1934.)
Visitation Chemistry Club, Visitation High School. (1932.)
Volta Science Club, Visitation High School. (1931.)
Waller Science Club, Waller High School. (1934.)
Chicago Heights, Ill.: Bloom Audubon Club. (1932.)
Cicero, Ill.: Morton Biology Club, Morton High School. (1934.)
Morton Chemistry Club, Morton High School. (1934.)
Morton Physics Club, Morton High School. (1933.)
Morton Radio Club, Morton High School. (1934.)
Danville, Ill.: Danville Science Club. (1920.)
DesPlaines, Ill.: Maine Chemistry Club. (1930.)
Dupo, Ill.: Dupo Chemistry Club. (1934.)
Dupo Geology Club. (1933.)
East St. Louis, Ill.: East St. Louis Junior Scientific Society, High School, (1934.)
Lansdown Science Club, Junior High School. (1934.)
Elgin, Ill.: Senior Science Club, High School. (1934.)
Fairfield, Ill.: Fairfield Science Club. (1932.)
Gillespie, Ill.: Gillespie Science Club. (1931.)
Glen Ellyn, Ill.: Science Club, Glenbard High School. (1930.)
Granite City, Ill.: Vocational Science Club, High School. (1930.)
Grant Park, Ill.: General Science Club, High School. (1934.)
Gurnee, Ill.: Warren Biology Club. (1930.)
Jacksonville, Ill.: Science Club of David Prince Junior High School. (1934.)
Joliet, Ill.: Joliet Biology Club, High School. (1934.)
Joliet Junior Chapter, National Rocks and Minerals Association, High School. (1934.)
Kankakee, Ill.: Edisonian Science Club. (1933.)
McLeansboro, Ill.: McLeansboro Science Club. (1933.)
Milford, Ill.: General Science Club. (1934.)
Mt. Pulaski, Ill.: Mt. Pulaski Science Club. (1930.)
Normal, Ill.: Chem-Mystery Science Club, High School. (1933.)
Paris, Ill.: Illinium Science Club, High School. (1930.)
Pittsfield, Ill.: Pittsfield Chemistry Club. (1933.)
Rockford, Ill.: Rockford Biology Club. (1930.)
Lincoln Chemistry Club, Lincoln Junior High School. (1931.)
Rockton, Ill.: Mote Scientifique, Hononegah Community High School. (1931.)
Timewell, Ill.: Timewell Science Club, High School. (1934.)
Urbana, Ill.: Urbana Science Club, High School. (1934.)
Villa Grove, Ill.: Villa Grove Science Club, High School. (1930.)
West Chicago, Ill.: Edisonian Science Club. (1928.)
Winnetka, Ill.: New Trier Geology Club, New Trier High School. (1931.)
New Trier Ornithology Club, New Trier High School. (1931.)

SCIENTIFIC SOCIETIES AFFILIATED WITH THE ACADEMY

Botany Club of Joliet, care of H. V. Givens, Midland Ave., Joliet, Ill.
Chicago Academy of Science, Lincoln Park, Chicago, Ill. (1925.)
Chicago Nature Study Club, 3842 Byron St., Chicago, Ill., care of Dr. H. S. Pepoon. (1927.)
Illinois Association of Biology Teachers, Mary R. Earnest, Sec'y, Decatur High School, Decatur, Ill. (1928.)
Illinois Association of Chemistry Teachers, H. L. Slichenmeyer, Bloomington High School, Bloomington, Ill. (1928.)
Illinois Nature Study Society of Elgin, Carl F. Gronemann, President, 310 N. Liberty St., Elgin, Ill. (1924.)
Illinois State Library, State House, Springfield, Ill. (1934.)
Knox County Academy of Science, Galesburg, Ill., C. L. Furrow, President. (1923.)
McLean County Academy of Science.
Normal Science Club, Illinois State Normal University, care of Bessie I. Hibarger, Treas., 200 W. Mulberry St., Normal, Ill. (1923.)
Peoria Academy of Science, Arthur L. Epstein, Pres., Peoria High School, Peoria, Ill. (1931.)
Rockford Nature Study Society, care of Miss Frances S. Dobson, 312 N. Avon St., Rockford, Ill. (1923.)
Sigma Xi, University of Chicago Chapter, University of Chicago, Chicago, Ill. (1925.)
Sigma Xi, University of Illinois Chapter, Urbana, Ill. (1925.)
Sigma Zeta Society, care of Prof. R. K. Carleton, Shurtleff College, Alton, Ill. (1929.)
Southern Illinois Science Club, Southern Illinois State Teachers' College, Carbondale, Ill. (1926.)
Theta Chi Delta, Alpha Eta Chapter, Carthage College, Carthage, Ill. (Chemistry.) (1929.)
Theta Chi Delta, Alpha Chapter, Lombard College, Galesburg, Ill. (1934.)
University of Illinois, Branch of the American Chemical Society, Urbana, Ill.

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Brooklyn Botanic Gardens, Bronx Park, Brooklyn, N. Y.
Butler University, Indianapolis, Ind.
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Carnegie Museum, Schenley Park, Pittsburgh, Pa.
Carthage College, Carthage, Ill.
Cleveland Museum of Natural History, 2717 Euclid Avenue, Cleveland, Ohio.
Cleveland Public Library, Cleveland, Ohio.
Colgate University, Hamilton, N. Y.
Colorado Scientific Society, Denver Public Library, Denver, Colo.
Columbia University, New York, N. Y.
Dartmouth College, Hanover, New Hampshire.
Davenport Public Museum, Davenport, Ia.
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Enoch Pratt Free Library, Baltimore, Md.
Eureka College, Eureka, Ill.
Geological Survey of Canada, Ottawa, Canada.
Greenville College, Greenville, Ind.
Highland Park Public Library, Highland Park, Ill.
Illinois College, Jacksonville, Ill.
Illinois State Geological Survey, Urbana, Ill.
Illinois State Library, Springfield, Ill. (3 copies.)
Illinois State Natural History Survey, Urbana, Ill.
Illinois Wesleyan University, Bloomington, Ill.
Illinois Womans' College (MacMurray College), Jacksonville, Ill.

Imperial Bureau of Plant Genetics, School of Agriculture, Cambridge, England.
Institute de Biologia Vegetal, Jardin Botanico, Rio de Janeiro, Brazil, South America.
James Millikin University, Decatur, Ill.
Kenyon College, Gambier, Ohio.
Knox College, Galesburg, Ill.
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Lewis Institute, Chicago, Ill.
Lincoln College, Lincoln, Ill.
Los Angeles Museum, Los Angeles, Calif.
Louisiana State University (Hill Memorial Library), Baton Rouge, La.
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TRANSACTIONS

OF THE

ILLINOIS STATE ACADEMY OF SCIENCE

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VOLUME XXVII

1934-1935

EDITED BY DOROTHY E. ROSE

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DEPARTMENT OF REGISTRATION AND EDUCATION

STATE MUSEUM DIVISION, CENTENNIAL BUILDING

SPRINGFIELD, ILLINOIS

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VOLUME 27 SEPTEMBER, 1934 NUMBER 1

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TRANSACTIONS OF THE ILLINOIS STATE ACADEMY OF SCIENCE

Volume 27 September, 1934 Number 1

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RECENT DEVELOPMENTS IN THE CHEMISTRY OF THE RARE EARTH GROUP*

BY

B. Smith Hopkins

University of Illinois, Urbana, Illinois

One of the most puzzling problems which confronts this generation of chemists is furnished by the rare earth group. Here is a collection of chemical elements which occupies a unique position in the family of chemical individuals. With properties so similar that they are invariably found in intimate association in nature, making the problem of their separation a task of heroic proportions, they present a challenge to the best efforts of the most courageous. We are far from a complete solution of this puzzle at the present time. Advancement must necessarily be slow in a problem so intricate. But progress must continue, even though the immediate rewards seem to be meagre. There seems to be a definitely growing interest in the scientific relationship of the group. We should like to know more about each member in respect to such items as atomic structure, magnetic forces, and atomic radii. We would like to know more about the relationship of each element to the other rare earths and to all the other elements. It is by no means impossible that when we understand the members of this group better, we shall find in this knowledge the key which will unlock whole storehouses of information concerning our more important commercial elements.

PERIODIC TABLE 1926

0	I	II	III	IV	V	VI	VII	VIII		
	H 1 1.008									
He 2 4.00	Li 3 6.94	Be 4 9.1	B 5 10.85	C 6 12.005	7 N 14.008	8 O 16	9 F 19.0			
Ne 10 20.2	Na 11 23.00	Mg 12 24.32	Al 13 26.97	Si 14 28.1	15 P 31.04	16 S 32.06	17 Cl 35.46			
A 18 39.9	K 19 39.10	Ca 20 40.07	Sc 21 45.1	Ti 22 48.1	V 23 51.0	Cr 24 52.0	Mn 25 54.93	Fe 26 55.84	Co 27 58.97	Ni 28 58.68
	29 Cu 63.57	30 Zn 65.37	31 Ga 70.1	32 Ge 72.5	33 As 74.96	34 Se 79.2	35 Br 79.92			
Kr 36 82.92	Rb 37 85.45	Sr 38 87.63	Y 39 89.	Zr 40 90.6	Cb 41 93.1	Mo 42 96.0	Ma 43 ?	Ru 44 101.7	Rh 45 102.9	Pd 46 106.7
	47 Ag 107.88	48 Cd 112.40	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.5	53 I 126.92			
Xe 54 130.2	Cs 55 132.81	Ba 56 137.37	57-71 Rare Earths	Ct-Hf 72 178.6	Ta 73 181.5	W 74 184.0	Re 75 ?	Os 76 190.9	Ir 77 193.1	Pt 78 195.2
	79 Au 197.2	80 Hg 200.6	81 Tl 204.0	82 Pb 207.2	83 Bi 209.0	84 Po 210.	85			
Rn 86 222.	87	Ra 88 226.	Ac 89	Th 90 232.12	Pa 91	U 92 238.2				

57-71 Rare Earths	La 57 139.0	Ce 58 140.25	Pr 59 140.9	Nd. 60 144.3	Il 61 146.(?)	Sm 62 150.4	Eu 63 152.0
Gd 64 157.3	Tb 65 159.2	Dy 66 162.5	Ho 67 163.5	Er 68 167.7	Tm 69 168.5	Yb 70 173.5	Lu 71 175.0

Fig. 1.

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* Address of the Retiring President, read before the General Session, May 3, 1934.

One of the most puzzling questions concerning the rare earth group is its relationship to the periodic table. Many suggestions have been made for the placing of this group in order to show its relationship to the rest of the elements. Figure 1 shows a common method

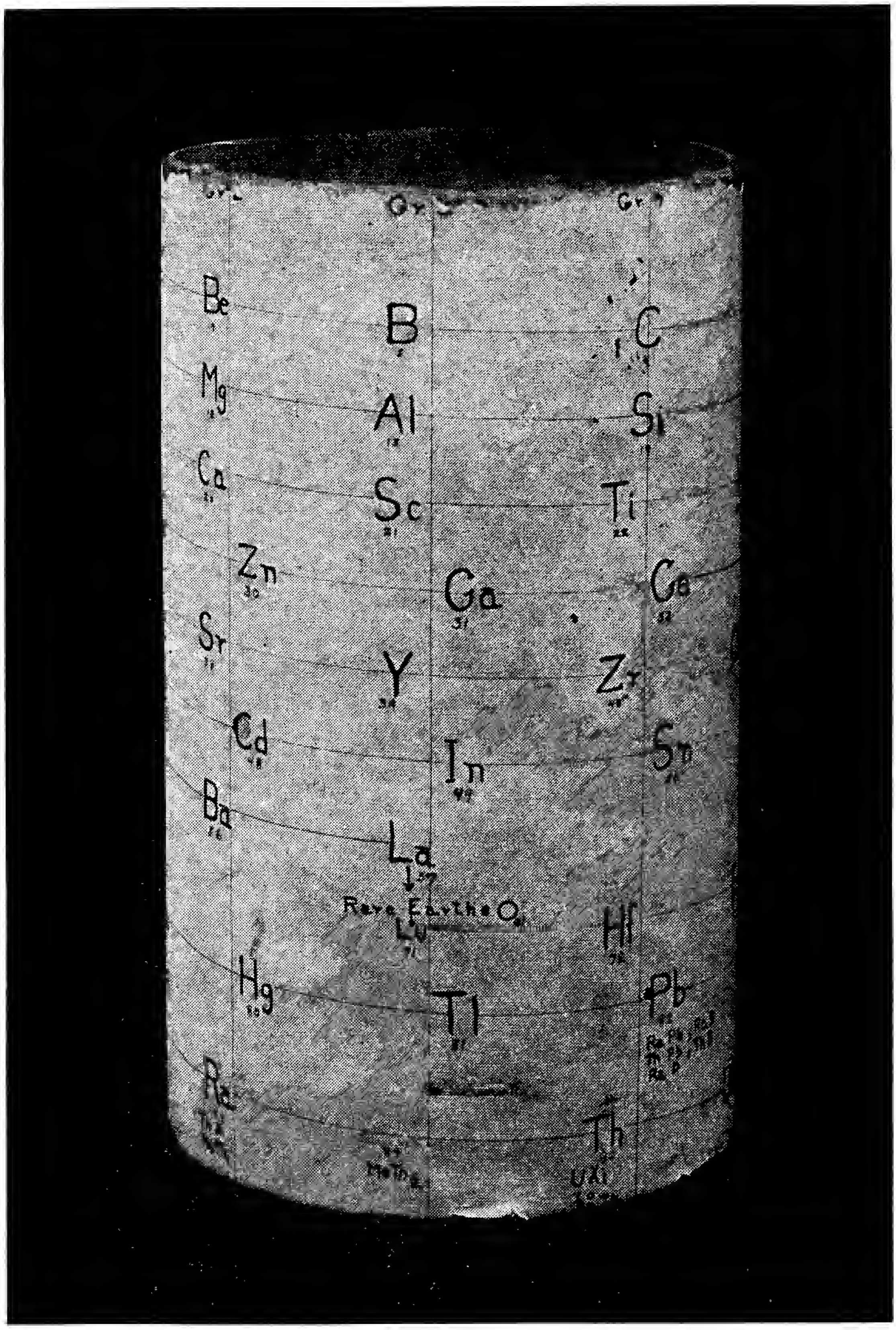

FIG. 2. **Periodic table in cylindrical form.**

of locating this group on a flat surface arrangement of the table. It emphasizes the fact that the rare earth elements have similar properties with a characteristic valence of three. Each could with perfect propriety be placed in the third group between barium (Group II) and hafnium (Group IV). Rather than attempt to crowd the 15 elements into this one space, many authors prefer to indicate that the entire group belongs here and then append a supplementary table showing each individual element in its proper sequence.

Figure 2 shows a similar plan applied to a cylindrical arrangement of the table. In Figure 3 there is an interesting helical plan, with all the elements of the rare earth group crowded into the one space by means of an accordion-like extension. This gives an unusually appropriate setting for the group. Figure 4 shows the sequence of the

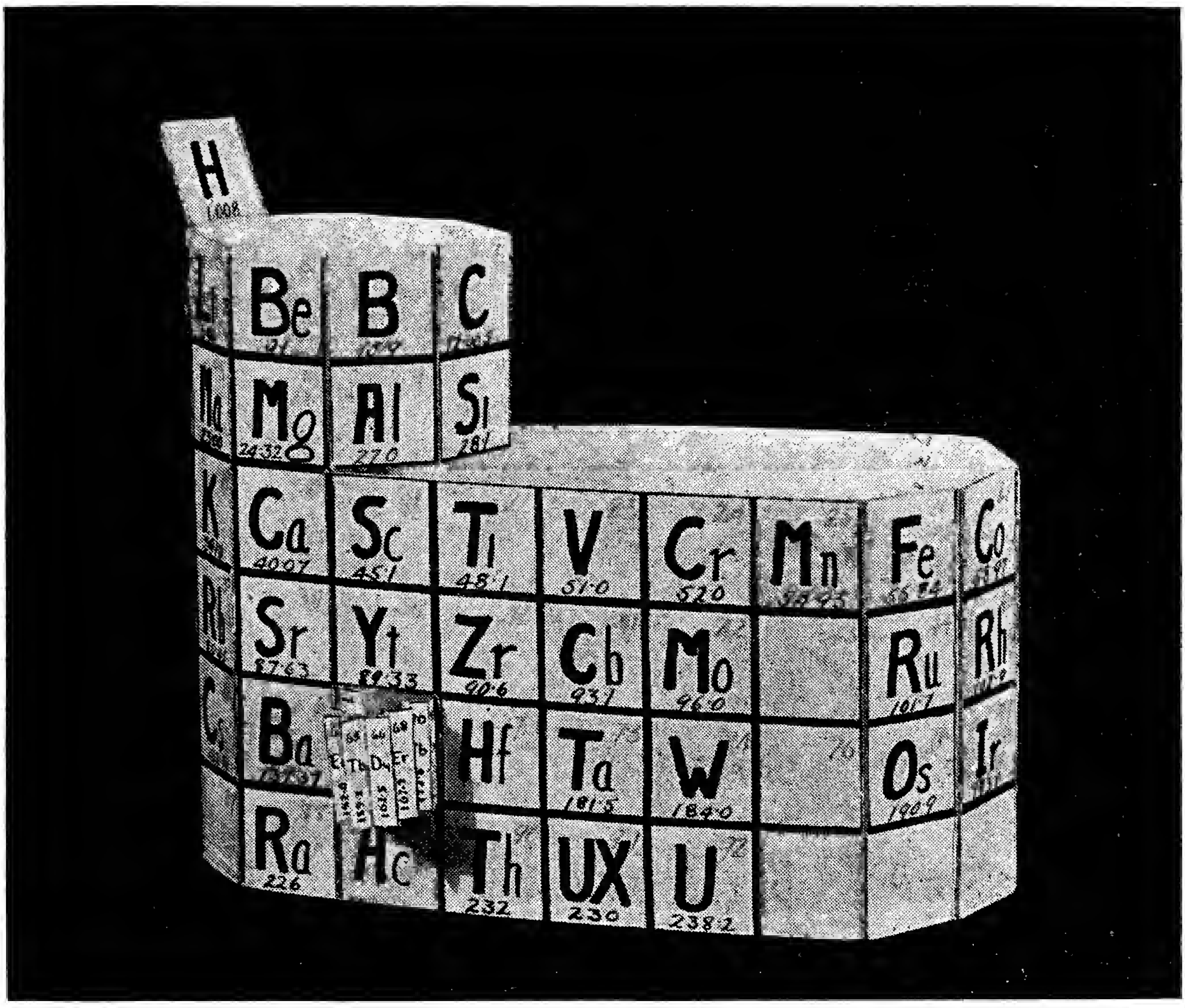

Fig. 3. Periodic table in tower form, after M. Courtines.

elements arranged spirally around a globe. Hydrogen is at the north pole and the short series are conveniently arranged near the pole. As the sequence approaches the equator the longer series fall into position normally. The rare earth group fills the equitorial belt without crowding. While the space adjustments in this arrangement are clever, it brings the individual members of the group into quite unnatural positions with respect to other elements. For example, this arrangement makes it necessary to interpose some members of the rare earth group between such closely related elements as zirconium and hafnium, columbium and tantalum, or molybdenum and tungsten, while other rare earths fall into unnatural positions with respect to the platinum metals and the alkali group. Similar objections can be raised to most of the arrangements in which an attempt is made to give each member of the rare earth group a separate space in the periodic table.

As the scientific interest in the rare earth group increases there is certain to be a greatly increased importance attached to the amount

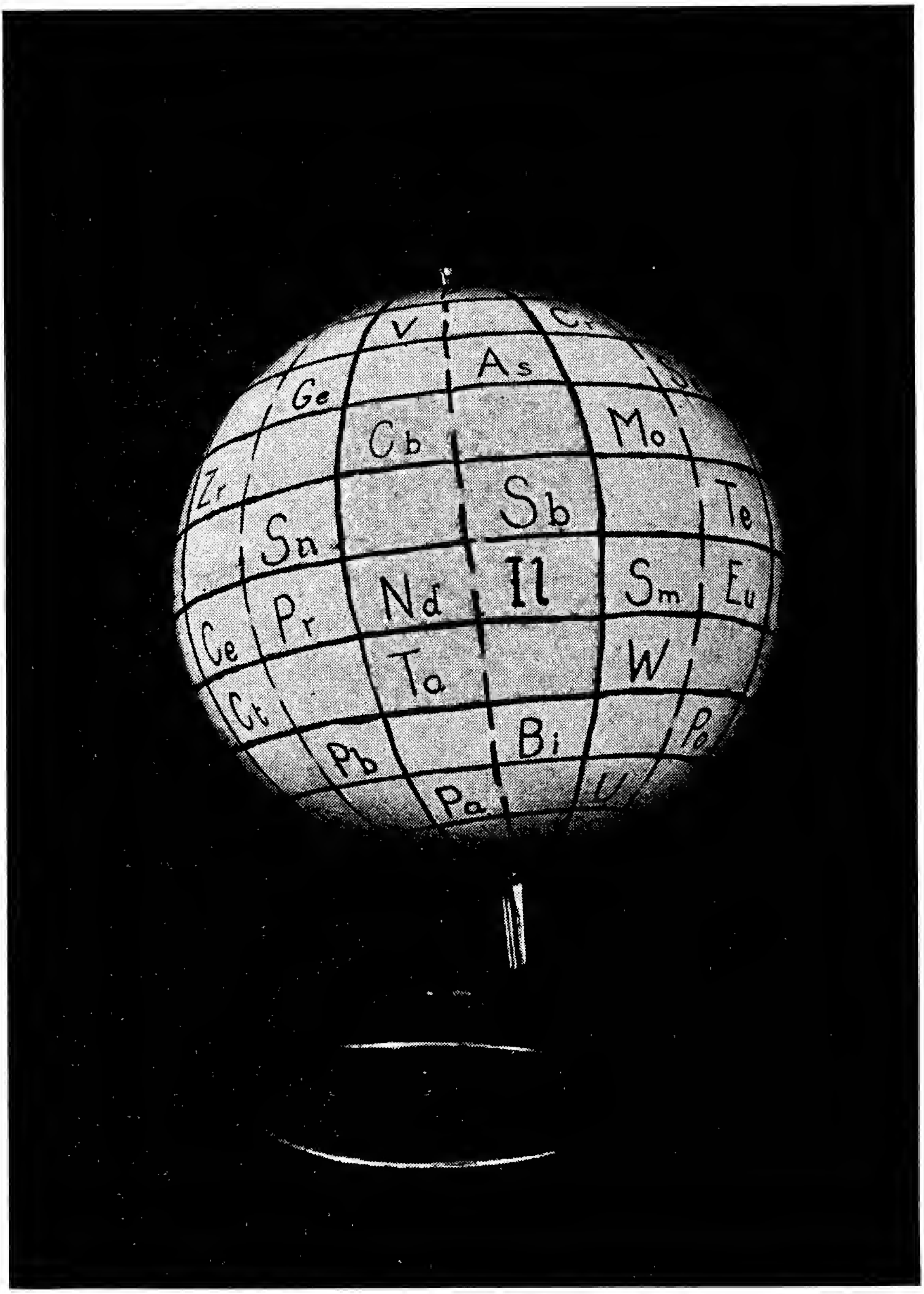

Fig. 4. Periodic table in spherical form.

of material available for the study of each member of the group. Accordingly there is increasing interest not only in the deposits of rare earth minerals themselves but also in the relative abundance of each individual element. Table 1 gives a tabulation which is based on various estimates. The figures in the third vertical column show the average per cent of each individual element in the rare earth content of all available rare earth ores[1]. It is interesting to note that cerium, the most abundant member, makes up nearly one-third of the entire group, while illinium, the rarest member, is not more abundant than 0.02 of one per cent. When these values are plotted against atomic numbers as in Figure 5 we see graphically that the even numbered members of the group are always more abundant than the neighboring odd numbered members. This interesting fact suggests that there must be some reason connected with the structure of these atoms which

TABLE 1.—*Abundance of the rare earths*

Atomic number	Symbol	Per cent of the rare earth group	Per cent in the earth's crust
57	La	7	0.00007
58	Ce	31	0.00031
59	Pr	5	0.00005
60	Nd	18	0.00018
61	Il	0.02	0.0000002
62	Sm	7	0.00007
63	Eu	0.2	0.000002
64	Gd	7	0.00007
65	Tb	1	0.00001
66	Dy	7	0.00007
67	Ho	1.2	0.000012
68	Er	6	0.00006
69	Tn	1	0.00001
70	Yb	7	0.00007
71	Lu	1.5	0.000015
		99.92	

gives greater stability to the groupings with an even number of electrons. At present our information does not furnish a satisfactory explanation.

The last vertical column in Table 1 shows the fraction of the earth's crust that is composed of the rare earth group. These figures are based on Dr. H. S. Washington's statement that the entire group comprises about 0.001 per cent of the earth's crust. While the percentage of the most abundant members of the group is extremely small it is to be noted that cerium is more common than cadmium, tin, mercury, antimony, molybdenum, silver, tungsten, bismuth, gold or platinum. Likewise the least abundant member of the group, illinium,

[1] These figures are furnished by Goldschmidt and Thomassen, Videnskapscelskafets skrifter I Matemat-Naturv. Klasse, Kristiana 1924, No. 5, p. 49. The estimate for illinium is based on the statement of Dr. G. R. Sherwood that illinium in monazite is approximately one-tenth as abundant as europium.

which makes up only about two ten-millionths of one per cent of the earth's crust, is still presumably a thousand times more abundant than radium, whose commercial importance is considerable. Therefore it seems safe to conclude that if any single member of the rare earth group is shown to possess striking individual properties of value, the scarcity of the element will not be an insurmountable obstacle in the pathway of its commercial development.

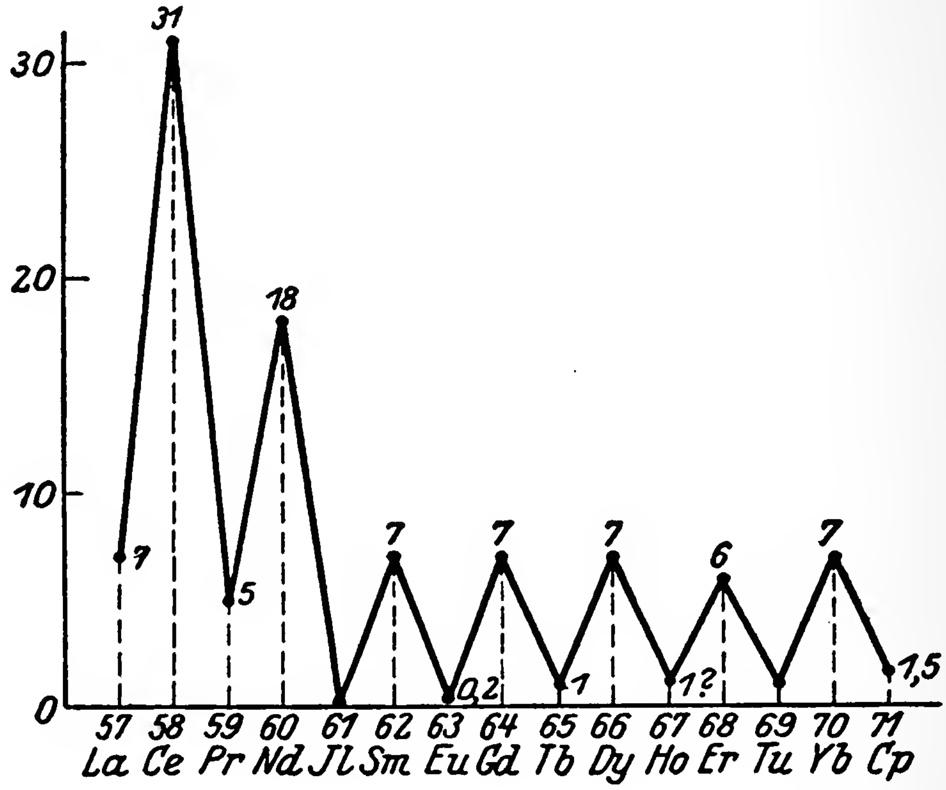

FIG. 5. Abundance of the rare earths against atomic numbers.

A study of the atomic structure of the members of the rare earth group (Table 2), shows the slight differences between succeeding members. For comparison there are also shown the structures of cesium and barium immediately preceeding the rare earths as well as hafnium and tantalum, the first elements following the group. It is to be noted that the valence of the rare earths remains essentially constant and that the only structural differences come from the addition of successive electrons in the 4_4 shell. With such strikingly similar structures, it is natural to expect that these atoms will have similar properties and that their separations from one another will be extremely difficult.

Formerly the valence of the rare earth group was by definitions limited to three, and any member like cerium which showed a valence of four was eliminated as though it were an intruder. While the rare earths are still to be regarded as characteristically trivalent in nature, recent studies have shown that both higher and lower valences exist.

Figure 6 shows these anomalous valences. Quadrivalent compounds of cerium are well known and important. Praseodymium is also quadrivalent, possibly occasionally pentavalent. Quadrivalent compounds of terbium have recently been shown to exist. Since cerium, praseodymium and terbium may be oxidized, it might be logical to expect that dysprosium would also show a higher valence, although no such compounds have yet been reported.

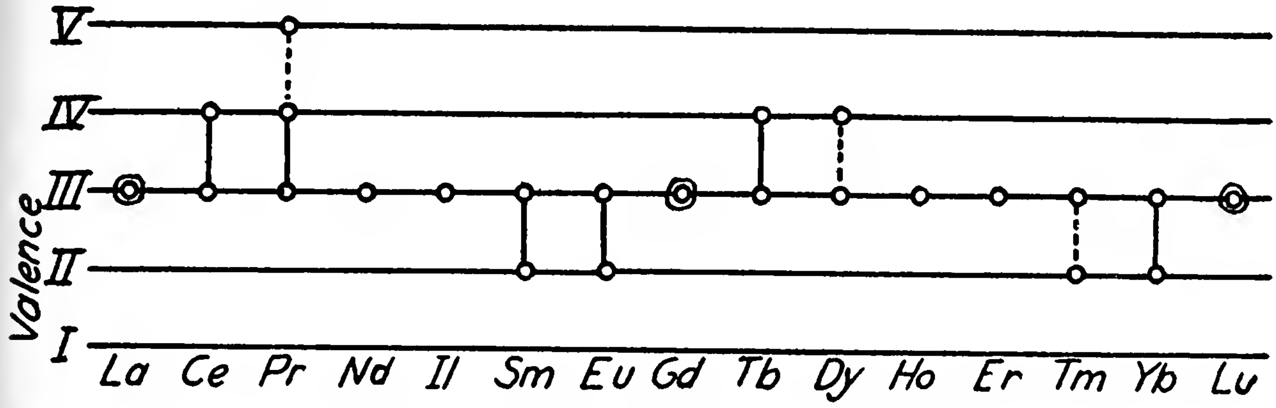

FIG. 6. Valence of the rare earths.

TABLE 2.—*Atomic structures of the elements*

Atomic number	K	L		M			N				O					P	
	1_1	2_1	2_2	3_1	3_2	3_3	4_1	4_2	4_3	4_4	5_1	5_2	5_3	5_4	5_5	6_1	6_2
Cs 55..........	2	2	6	2	6	10	2	6	10	0	2	6	0	0	0	1	...
Ba 56..........	2	2	6	2	6	10	2	6	10	0	2	6	0	0	0	2	...
La 57..........	2	2	6	2	6	10	2	6	10	0	2	6	1	0	0	2	...
Ce 58..........	2	2	6	2	6	10	2	6	10	1	2	6	1	0	0	2	...
Pr 59..........	2	2	6	2	6	10	2	6	10	2	2	6	1	0	0	2	...
Nd 60..........	2	2	6	2	6	10	2	6	10	3	2	6	1	0	0	2	...
Il 61..........	2	2	6	2	6	10	2	6	10	4	2	6	1	0	0	2	...
Sa 62..........	2	2	6	2	6	10	2	6	10	5	2	6	1	0	0	2	...
Eu 63..........	2	2	6	2	6	10	2	6	10	6	2	6	1	0	0	2	...
Gd 64..........	2	2	6	2	6	10	2	6	10	7	2	6	1	0	0	2	...
Tb 65..........	2	2	6	2	6	10	2	6	10	8	2	6	1	0	0	2	...
Ds 66..........	2	2	6	2	6	10	2	6	10	9	2	6	1	0	0	2	...
Ho 67..........	2	2	6	2	6	10	2	6	10	10	2	6	1	0	0	2	...
Er 68..........	2	2	6	2	6	10	2	6	10	11	2	6	1	0	0	2	...
Tu 69..........	2	2	6	2	6	10	2	6	10	12	2	6	1	0	0	2	...
Yb 70..........	2	2	6	2	6	10	2	6	10	13	2	6	1	0	0	2	...
Lu 71..........	2	2	6	2	6	10	2	6	10	14	2	6	1	0	0	2	...
Hf 72..........	2	2	6	2	6	10	2	6	10	14	2	6	2	0	0	2	...
Ta 73..........	2	2	6	2	6	10	2	6	10	14	2	6	3	0	0	2	...

In similar manner samarium, europium and ytterbium may be induced to show a valence of two by electrolytic reduction. Since terbium is the seventh element from cerium and ytterbium is the seventh element after europium, it might be assumed that these anomalous valences occur at uniform distances. If this reasoning is correct, then thullium, the seventh element after samarium should form bivalent compounds. While none have yet been prepared, efforts are being made to find the conditions under which thullium salts will be reduced. Here again is a peculiar situation whose explanation requires an extended study of atomic structures.

These irregular valences are becoming useful in the difficult task of separation. Cerium has long been separated effectively from its neighbors in a single step consisting of boiling the oxidized solution. Ceric salts are easily hydrolyzed and precipitated as a basic salt. Similar methods are being sought for the separation of praseodymium, terbium and possibly dysprosium.

When the rare earth elements become bivalent the solubilities of their salts are like those of barium. Accordingly when europium and ytterbium salts are subjected to cathodic reduction in the presence of the sulfate ion, difficultly soluble $EuSO_4$ and $YbSO_4$ are precipitated. These separations from simple mixtures are nearly quantitative and they mark a distinct advance in rare earth chemistry, because both of these elements have up to the present been almost impossible to isolate. If by modifying the conditions we could devise a method for the isolation of samarium and thullium the work of the rare earth chemist would be vastly simplified.

All metals of the rare earth group are fairly active, but their hydroxides do not furnish a high concentration of hydroxyl ion because of their insolubility. There are considerable differences in the basicity of the various members of the group. Table 3 shows an attempt to reduce these values to a ratio by using the basicity of $Y(OH)_3$ as unity. It is to be noted that lanthanum is much the most basic member of the group and it is safe to say that $La(OH)_3$ is the strongest trivalent base that we know. It is also important to notice that the ratios between these values are relatively large, at least in some cases. For example lanthanum is 11 times as basic as praseodymium while neodymium is nearly 6 times as basic as samarium.

TABLE 3

Atomic number	57	59	60	62	64	39	66
Element	La	Pr	Nd	Sm	Gd	Y	Dy
Basicity ratio..................	1300	80	47	8	3.4	1	0.5

Some of our most useful methods of separation are based upon these differences in basicity. As a consequence the order of decreasing basicity becomes a matter of great importance. In Table 4 we have a tabulation of the order as it is reported by various workers, using various methods and conditions. It is evident that there is little question concerning the order of decreasing basicity in Zones 1 and 3, but in the center the order of basicity is in much doubt. This situation undoubtedly results from the fact that in the center of the group there are less differences in basicity than at either end. Because of the importance of accurate information upon the order of basicity we have undertaken to measure these values for the entire group, using a common method throughout. The hydrolysis of the rare earth nitrite was selected as a suitable method because conditions can be accurately controlled and the method is easily applied to all parts of the group. As

TABLE 4

	A	B	C	D	E	F	G
						Dy	
	La	La		La	La	La	La
	+++	+++		+++			
Zone 1	Ce	Ce		Ce			
	Pr	Pr		Pr	Pr	Pr	Pr
	Nd	Nd		Nd	Nd	Nd	Nd
	Y	Y			Y	Y	Y
		Eu					
		Gd	Gd		Gd		
Zone 2	Sm	Sm	Sm	Sm	Sm	Sm	Sm
	Eu			Eu			
	Gd			Gd			Gd
	Tb	Tb	Tb	Tb	Tb	Tb	Tb
	Dy	Dy		Dy	Dy		Dy
	Ho	Ho		Y			
	Er	Er		Er	Er		
Zone 3	Tm	Tm		Tm			
	Yb	Yb		Yb			
	Lu	Lu					
	Sc	Sc					
	+++						
	Ce						

usually applied this method consists in adding $NaNO_2$ to a neutral solution of the rare earth nitrates and boiling until those elements which are the least basic are precipitated while the elements of greater basicity remain in solution. By filtering off the precipitate there is accomplished a partial separation of the mixture of salts in accordance with the relative basicity of the elements present. We found that the differences in basicity between illinium, samarium, europium and gadolinium, the elements in zone 2, were so slight that the usual methods of procedure were not adequate. Consequently there was devised a method of fractionation by which these slight differences were magnified. Figure 7 shows diagramatically the method used. The solid arrows indicate the way in which the precipitates were combined and the broken arrows the path of the mother liquor. In this way slight differences in basicity were intensified and actual separations accomplished. As a result of this work it has been established that the order of decreasing basicity throughout the rare earth group is exactly the order of increasing atomic number. If yttrium (No. 39) is included in the rare earth group it would form an exception to this statement since its basicity falls between illinium (No. 61) and samarium (No. 62).

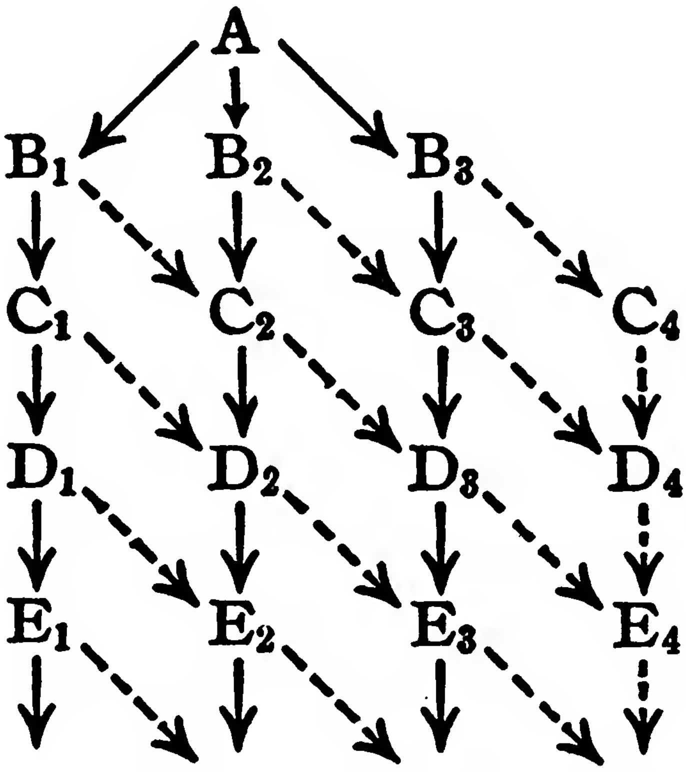

Fig. 7. Plan showing steps in the concentration of the rare earths by intensive bascity method.

The concentration of illinium by methods of fractional crystallization is well nigh impossible because this extremely rare element is always associated with other elements which are vastly more abundant and whose salts differ but slightly in solubility. By applying this new method of intensifying the differences in basicity we have greatly speeded up the concentration of illinium. In Figure 8 the per cent of illinium is plotted against the number of fractionations by the two methods. It is seen that 25 basicity fractionations effect about twice as great a concentration as is accomplished by 2000 fractionations of the double magnesium nitrates.

The metals of the rare earth group are interesting from their magnetic behaviors. When carefully measured it is found that their magnetic susceptibilities show greater variation than can be detected with regard to any other property. The magnetic susceptibility of mixtures is strictly additive. As a consequence in simple mixtures this property furnishes the most accurate means of analysis that we have.

An accuracy of 0.1 per cent has been claimed for mixtures of the compounds of two elements. Figure 9 shows the coefficient of magnetization plotted against the atomic numbers.

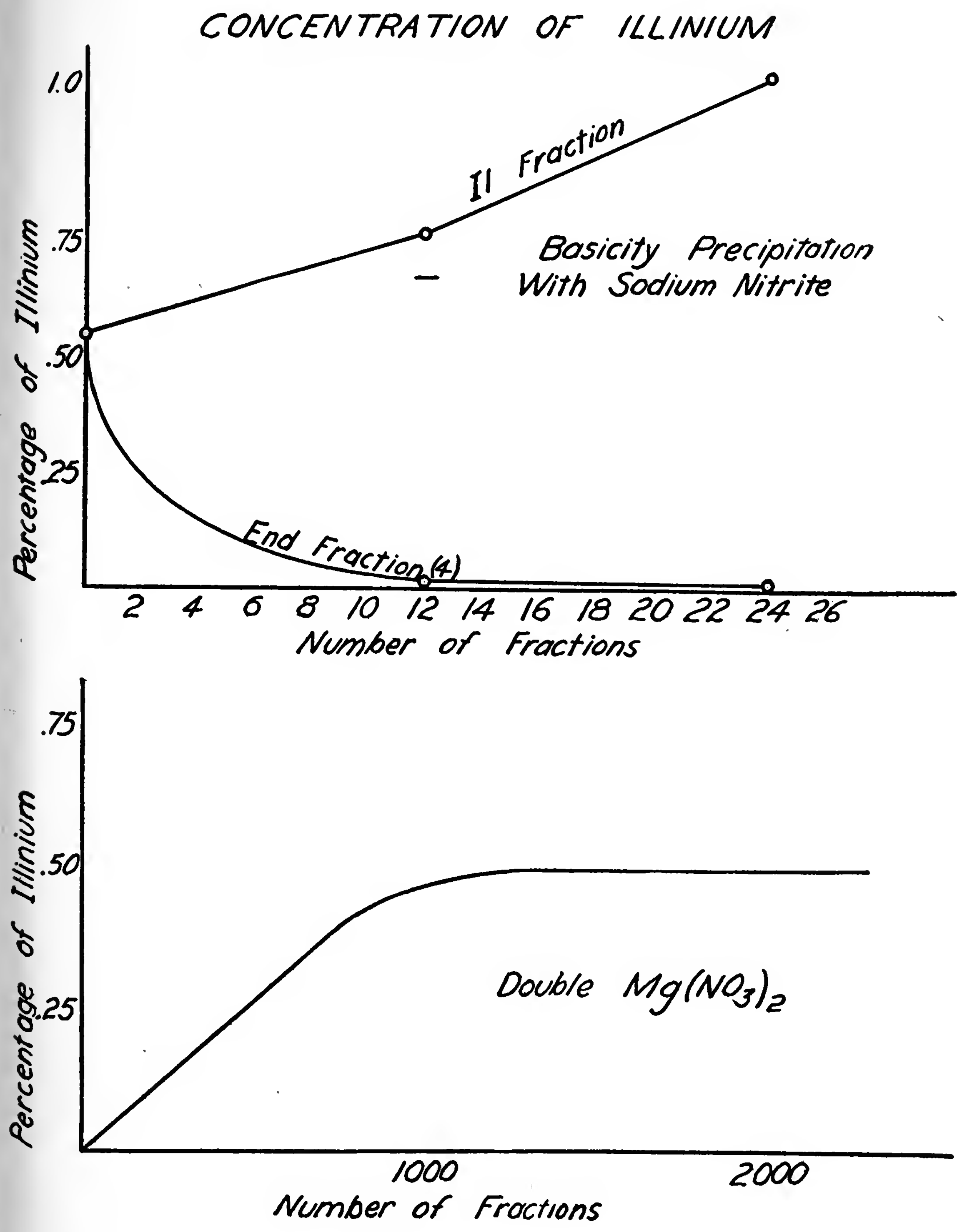

FIG. 8. Fractional crystallization increases the illinium content rapidily at first, but it soon becomes ineffective (lower curve). The upper curve shows that 24 fractionations by intensive basicity precipitation double the illinium content.

A subject of increasing interest in the rare earth field has to do with their utilization. Extensive uses are now made of mixtures of this group and great interest has lately developed in regard to the commercial applications of some of the more abundant members of the group. It is obvious that uses for the pure forms of the less abundant members of the group will be much more difficult to produce. One of the most interesting developments of recent months has been the utilization of the octohydrate of gadolinium sulfate for the production of extremely low temperatures. This work is noteworthy because of the near approach to the absolute zero, because it uses an entirely new principle in achieving this end, and because it uses a single member of the rare earth group which is relatively rare in a high state of purity for a specific purpose.

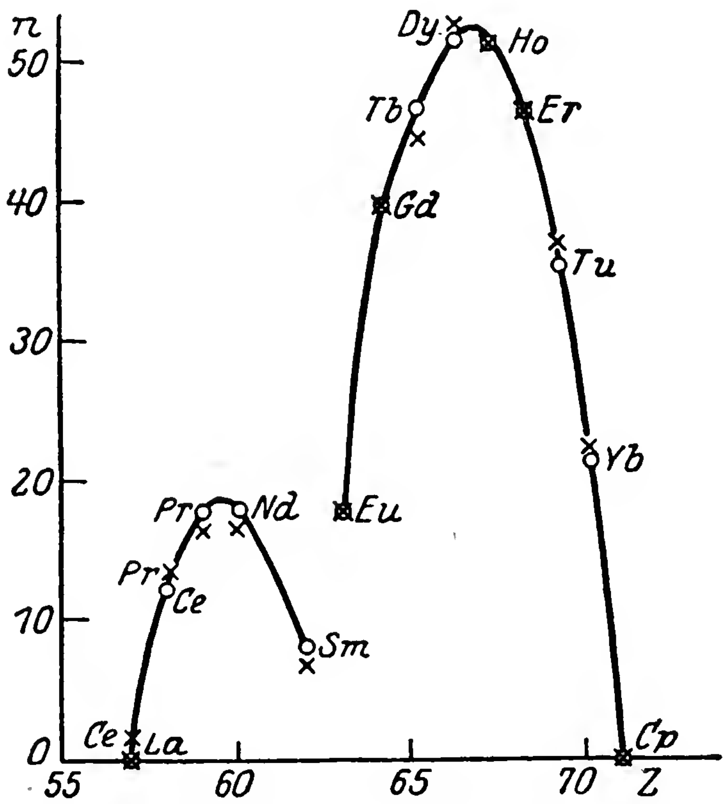

Fig. 9. **Magnetic susceptibility plotted against atomic numbers.**

When $Gd_2(SO_4)_3.8H_2O$ is placed in a magnetic field it transforms some of the magnetic energy into heat and becomes warm. Under ordinary conditions the temperature change is not great. If however the octohydrate is first cooled to the temperature of boiling helium and a magnetic field of 20,000 gauss is used, the thermal transition is relatively large. Figure 10 shows an apparatus for this work. The gadolinium material is placed in a tube suspended from a balance. This tube is placed in a container which is filled with gaseous helium at low pressure, and surrounded by liquid helium. The system is isolated from external heat by two concentrically placed Dewar tubes. When a powerful field is applied to the rare earth material it becomes warm and imparts part of its heat to the helium gas. If this is now pumped off and the magnetic field removed, the resulting temperature must be lower than the initial temperature. This method has yielded temperatures within 0.18° C. of the absolute zero, the nearest approach to that mythical point yet obtained. It is interesting to speculate as to what results might be obtained if alternate magnetizations and demagnetizations were applied in cycle fashion.

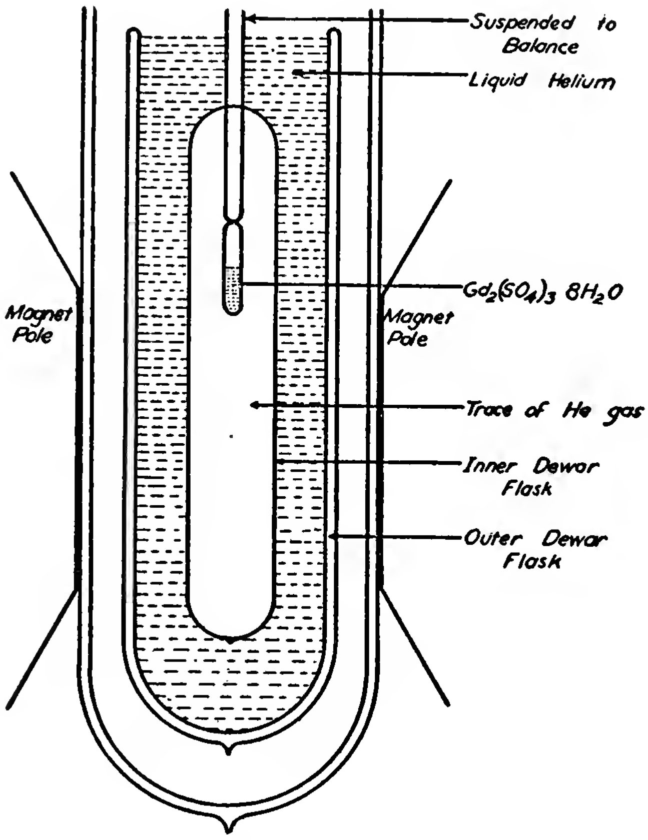

FIG. 10. Diagram of the apparatus used in the production of extremely low temperatures by the use of rare earth salts.

Similar Results have been obtained with the use of $Ce_2(SO_4)_3.8H_2O$. It is quite probable that other members of the group may show similar properties. We should like to know what peculiarities of atomic and molecular structures make this behavior possible. We would also like to learn whether the pure salts are needed for the display of this phenomenon or whether a mixture of rare earth salts would be equally effective.

THE SIGNIFICANCE OF THE CONSERVATION OF LAND RESOURCES

BY

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In these days of much publicized apparent surpluses of some farm products it may seem inappropriate to even suggest, let alone discuss, the significance of the conservation of land resources. On the contrary, such a discussion seems to me to be all the more necessary because of the likelihood of the public in general obtaining erroneous ideas concerning the real situation. It is obvious that it will be quite impossible in the brief time at my disposal to give this important subject adequate consideration.

I shall be forced to make some rather sweeping statements without the opportunity of fortifying these statements with adequate supporting evidence. I must ask my hearers, therefore, to be charitable enough to accept such statements as may be made on the assumption that there is in existence sufficient supporting evidence to warrant them.

There are a few general propositions which may be briefly, and I trust profitably, discussed. They are:

1) That there is not a surplus of fertile land suitable for cropping purposes;

2) that through the processes of nature and the ravages of man, the extent and quality of these lands are rapidly declining;

3) that in the main good lands are perhaps the most valuable basic natural resource that this country, and particularly this State, possesses;

4) that methods have been developed through investigation and research whereby these good lands may be so utilized that they will remain indefinitely a continuing source of wealth; and

5) that the trend is strongly toward depreciation and waste of our land resources and that unless there is a rather speedy change in our practice relating to land use, we shall bequeath to our descendants an unwelcome heritage.

No surplus of fertile lands.—It is generally recognized that the margin of profit in farming under normal conditions is relatively small. Obviously, the less fertile the land, the smaller the margin of profit. The areas of fertile land are relatively small.

[1] This paper was read for H. W. Mumford by C. L. Stewart, College of Agriculture, University of Illinois.

The processes of nature and the ravages of man are rapidly reducing the extent of such land.—Let me remind you that there was a time, and not so many years ago, when it was mistakenly believed that the fertility of Illinois soils was so great that it was inexhaustible. Fortunately, the State has been saved the disaster that would have been inevitable had this mistaken belief prevailed for long. The Experiment Station of the University of Illinois has shown that far from being inexhaustible, the fertility of Illinois soils is rapidly destroyed by unbalanced cropping systems and by erosion. When we think of soil conservation, it is well to recall, too, the report of scientists with respect to the havoc brought by soil erosion in Illinois and throughout the Nation. Their findings show that erosion alone is washing away the farm fields of the United States at the rate of 3 billion tons of soil material a year, that there are in this country 35 million acres of what was once mostly good land which is now waste in so far as crop use is concerned because its top soil has been washed away by erosion. In some systems of faulty cropping, as in straight corn farming, the 7 inches of top soil on a slope as slight as 4 per cent can be destroyed in as short a time as 24 years. Repairing soil damage as serious as this requires between 2,000 and 3,000 years, because it takes nature about 400 years to build a single inch of productive, top soil from raw sub-soil clay.

In the midst of our seeming abundance, it is well to recall that history has recorded how vast tracts of land already have had to be abandoned because they were so badly eroded and otherwise so mistreated that they would no longer support life. If the final pages of history do not record the abandonment of vast additional tracts and an ever-increasing threat of a food supply shortage, it will be because of the type of service which the University of Illinois and similar institutions elsewhere are rendering in soil conservation.

These are times when national and international plans for agriculture are being much discussed. No matter what policy is adopted, if the soils of our farms are not cared for and conserved they will become impoverished, and a successful agriculture and a prosperous nation can not be built on impoverished soils.

From the soil fertility viewpoint, the history of American agriculture to date has been one of exploitation. Several years ago a point was passed unobserved by the general public and by farmers themselves, when further exploitation of the land meant exploitation of the people on the land. I am not blaming farmers for exploiting the land. Neither am I blaming other groups for exploiting the farmers, nor the farmers for permitting themselves to be exploited. Much of this has been more or less unconscious. Only where it has been conscious and preventable is it inexcusable. It is not my purpose to attempt to fix the blame or responsibility. It is much more important to recognize the fact and leave to agricultural education and research the determination of the extent and effect of these conditions, and the methods of ameliorating them. The exploitation of the soil comes mainly from three groups: first, those efficient and intelligent producers who wilfully neglect the fertility of their soils for the sake of immediate gain; second, those who are inefficient producers and either know no better, or knowing, are too indifferent to care; and third, those who care and know how, but can not figure how they can maintain the fertility of the soils of their farms and survive financially. Perhaps if we should attempt to classify farmers with reference to these groups, we might learn something of real value.

A very practical hindrance to the general adoption of programs of soil maintenance is the fact that as long as fertile lands exist here or elsewhere, there will be plenty of men who will exploit them. As long as men exploit them, the products of such lands will come into competition with the products of farms operated with the high purpose of husbanding the resources of the land for posterity.

Good lands, the most valuable basic natural resource of the State. They may be conserved indefinitely as a continuing source of wealth. So far as the future of Illinois is concerned, there is no more valuable and enduring asset than the 30½ million acres in its farms, which comprise 85.6 per cent of its land. This natively fertile soil is perhaps the one major natural resource of the State which may be continued unimpaired for future generations by the application of knowledge which has been and can be worked out through investigation and research.

The most striking evidence of these principles has been obtained on the Morrow plots, America's oldest soil experimental plots, located on the University grounds at Urbana. Three different cropping systems have been practiced uninterruptedly for 57 years, and three soil treatment systems have been practiced for 29 years.

Continuous corn culture, representing the old belief that the fertility of Illinois soils is inexhaustible, has so undermined the land that the yield of corn has dropped to less than 20 bushels an acre. In contrast, a system of crop rotation combined with simple soil treatment, has maintained and built up the fertility of the soil to the point where it is yielding approximately 70 bushels of corn an acre.

The soil on the different plots was all equal when the experiment started 57 years ago. Today, on the basis of profitable crop production, the land on the plot where a crop rotation of corn, oats, and clover has been combined with simple soil treatment is worth 4½ times as much as the land where corn has been grown continuously without treatment.

It is worth twice as much as the land where continuous corn has been grown with simple soil treatment. It is worth $2\frac{1}{3}$ times as much as the land where an inferior rotation of corn and oats has been practiced without soil treatment. It is worth 1 1/5 times as much as the land where the corn and oats rotation has been combined with simple soil treatment. It is worth $1\frac{1}{3}$ times as much as the land where a rotation of corn, oats, and clover has been practiced without soil treatment.

Trend toward depreciation and waste.—Ex-Governor Lowden, reccognized as a thoughtful student of agriculture, in a published interview, is quoted as making some observations that may well form the basis for serious deliberation. In speaking of the tremendous loss of fertility in the Mississippi valley from erosion, he asks, "How long can the land stand this? - - - And while Nature is thus hammering away at our land, we, ourselves, go on speeding up the process of destruction by incessant cropping."

This important question is a challenge to our present generation. I do not wish to leave the impression that nothing is being done to change the trend. As a matter of fact, at no time in the history of our country have well-informed people been more concious of the need for more attention being given to conservation of our land resources, and it is an encouraging sign.

The authorities following me on this program will presumably bring out more clearly and definitely some of the matters I have but briefly referred to here. The National Government is attacking this problem most vigorously, particularly from the standpoint of submarginal lands and the attempt to crystalize public sentiment on the disastrous facts of erosion and the possibilities of its intelligent control. Such constructive policies should be aided in every proper way by scientific societies of this nature.

May I quote here, in closing, from Liberty Hyde Bailey's *The Holy Earth:*

"So BOUNTIFUL hath been the earth and so securely have we drawn from it our substance, that we have taken it all for granted as if it were only a gift, and with little care or conscious thought of the consequences of our use of it; nor have we very much considered the essential relation that we bear to it as living parts in the vast creation. - - - - Most of our difficulty with the earth lies in the effort to do what perhaps ought not to be done. Not even all the land is fit to be farmed. A good part of agriculture is to learn how to adapt one's work to nature, to fit the crop-scheme to the climate and to the soil and the facilities. To live in right relation with his natural conditions is one of the first lessons that a wise farmer or any other wise man learns. We are at pains to stress the importance of conduct; very well: conduct toward the earth is an essential part of it."

CLASSIFICATION OF ILLINOIS LANDS

BY

R. S. SMITH

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> "The shock of the depression has at last awakened us to a new attitude. We no longer regard land as land alone; we regard it as one of the central and controlling elements in our whole national economy. More than that, we realize that upon the manner and character of its use may depend the welfare, not only of our descendents, but of ourselves."—Rexford G. Tugwell, Assistant Secretary of Agriculture.

The widespread interest in land use noted by Doctor Tugwell and the more recently developed agitation for planned land use and removal of less productive lands from production has focussed attention upon the need for land classification.

The approach to the problems of land classification varies somewhat with the training and experience of the one proposing classification. It is proposed in this paper that any classification of land for the purposes of land use should be based on the adaptation, producing capacity, and the capacity for response to fertilizer treatment of the soils making up what we commonly speak of as the land.

Land, as we use the term, comprises the layer of unconsolidated material which more or less continuously mantles the earth's surface and which varies in its adaptation, in its capacity to produce plants, and in its capacity to respond to treatments designed to increase the quantity, or quality of its products or to change its natural adaptation.

If this concept is sound it follows that land is not the same thruout its extent and that, therefore, it must be divided into units of some sort if it is to be understood. The kind of unit will depend on the purpose for which the division is made.

Our task then in developing a land classification seems to involve the creation of soil units. After the creation of these soil units, it is necessary to become familiar with the properties of each unit and then to combine the units into groups which will satisfy our requirements. This sounds simple enough but difficulties arise which only time and an immense amount of work can iron out. One of the chief sources of difficulty is that the soil units must be established and grouped or classified before they have been sufficiently studied and therefore, mistakes are made and revision of earlier work is constantly called for. In short, the classification of soils is an evolutionary process and as knowledge increases changes become imperative and confusion is likely to accompany change. This situation is not peculiar to soil science, but I understand, troubles the botanist, the zoologist, the chemist, the physicist, and probably the workers in every field of knowledge.

I assume that we are interested in the classification of land in Illinois from the standpoint of its use. The use of land is influenced by other factors in addition to those having to do with the character of the soils which make up the land. Economic and social factors cannot be neglected, however, many of these factors are intangible and changeable and some of them may lack the significance ascribed to them by the specialists in the respective fields. It seems that there is need for a clear-cut analysis of the economic and social factors, presumably involved in land use, as to their significance and stability. It is only in this way that we can avoid beclouding the picture by our failure to distinguish between significant factors and those which lack significance and between those which are relatively stable and those which are so unstable as to be incapable of evaluation.

With this brief mention of the factors involved in land classification, other than soil factors, we will pass at once to the soil factors.

Soil units or soil individuals, often called soil types, have come into being because each soil is the product of the environment under which it was developed and environments differ within very short distances. The environmental factors are parent material, atmospheric climate, native vegetation, topography and underdrainage.

The parent materials of the soils in Illinois are almost entirely glacial in origin. Large areas in the state are blanketed by a wind-blown deposit known as loess which is of glacial origin. The loess varies in thickness from a mere film in the east central and northeastern parts of the state to many feet in thickness adjacent to the Illinois, Mississippi, Ohio, and Wabash rivers. It varies in geological age from Sangamon to post-Wisconsin. These variations in thickness and in age are potent causes of differences in the soils developed from the loess. In the east-central and northeastern parts of the state where the glacial drift is the parent material of the soils of the region, the character of the drift becomes of great importance. The drift in certain sections of this region is highly impervious resulting in shallow, relatively poor soils. In other localities in the same region it is excessively gravelly and stony. Soils developed from drift of this character are likely to be droughty. A third type of drift contains enough sand, gravel, and pebbles to insure sufficient permeability to water and plant roots and yet not enough to be objectionable. Soils developed from this type of drift rank well in agricultural value.

Alluvial sediments deposited in bottom lands, terraces, and outwash plains cover a large total area in the state and comprise a third parent material of significance in influencing soil character.

Climate, the second factor mentioned as important in influencing soil character, is relatively less important in a single state than in a large region. However, in Illinois the rainfall varies from about 35 inches in the extreme north to 43 inches in the extreme south and the growing season varies from about 150 days in the extreme north to 190 in the south. Differences in rainfall and temperature of this magnitude operating through long periods of time are reflected in easily recognizable soil differences of great importance in land use.

Native vegetation, the third factor mentioned, is recognized as having important relationships to soil character. In a humid, temperate climate, forest growth always results in organic matter and nitrogen depletion and in accelerated weathering. Forest soils are, therefore, recognized to be inferior to grass land soils in producing capacity and in lasting qualities.

Topography, the fourth factor mentioned, is of primary importance in influencing soil character because of its relation to rate of removal of soil material by erosion and to the development of an impervious clay pan subsoil. Slopes in Illinois in excess of about 3 per cent are subject to injurious erosion. The severity of erosion increases rapidly with increase in slope though there is no universal correlation between severity of erosion and per cent slope because of variation in resistance to erosion shown by different soils. No force is now more active in destroying the soils of Illinois than erosion.

Underdrainage, the fifth and last factor mentioned has had far reaching influence in determining the character of our soils. Excessively slow natural underdrainage has given us impervious clay pan subsoils while excessively rapid natural underdrainage has given us leachy, droughty soils. The recognition of these two conditions is essential in land use studies.

One other factor, that of age or stage of development, should not be overlooked in considering our soils from the standpoint of use. Soils developed in a humid, temperate climate are doomed to depletion because the predominant movement of water is downward carrying with it the loosely held plant nutrients. It is for this reason that in evaluating soils for use purposes, their age or stage of development is an important consideration. With the elapse of time, Illinois soils formed on nearly level surfaces develop an impervious clay pan and soils developed on rolling surfaces become leached and if sufficiently rolling are destroyed by erosion. This is a gloomy picture and it should be said that much can be done to retard these processes. It remains true, however, that soils pass through a life cycle just as certainly as does a human being and that in our environment the ultimate end of all soils is decreased producing capacity.

An effort has been made in the foregoing to point out the necessity for recognizing and dealing with soil individuals when thinking of land use. The farmer does not till the soils of a county or of a township but rather the soils on a farm. To use his soil or soils to the best advantage he must recognize the capacity and characteristics of each soil with which he is dealing.

There are in Illinois something over two hundred soil types now recognized. These soils have been rated in a scale of from one to ten based on producing capacity. In this scale soils rated one are the highest producers and those rated ten are the lowest. This rating constitutes a soil classification based on producing capacity. With it soil maps showing any desired degree of detail can be constructed provided detailed soil maps are available which show the soil types rated.

Several state maps which may be considered land use maps have been constructed. None of these maps make use of the capacity for production rating and therefore, can serve only as guides to regions where certain types of farming or land use may be feasible. The first of these state maps was constructed in 1927, revised in 1929, and is now in need of a second revision. This map shows the soils of the state in 16 groups and while the capacity for production rating is not shown on the map it can easily be applied to it. A second map classifies the state on the basis of the severity of erosion. It will be noted that 9 per cent of the state is subject to destructive erosion and is suitable only for timber, that 8.5 per cent is subject to severe erosion and is suitable only for timber, permanent pasture or orchard, that 36.0 per cent is subject to harmful erosion but is general crop land and that 46.5 per cent is not subject to erosion if farmed intelligently. A third map has recently been constructed for the State Planning Commission, and it will be noted that this map is based on adaptation with little attention being given to relative producing capacity. This map shows that 65.5 per cent of the state is adapted to general farming, 11.5 per cent to pasture or orchard, 10.4 per cent to red top, pasture or meadow and 12.6 per cent to timber only.

Further progress in making available in the form of a state map the large amount of information contained on the detailed county soil maps will involve making use of the capacity to produce rating as well as the adaptation of the various soil types. By grouping the soil types a strictly land use map can be constructed which, if supplemented by the county soil maps, will serve a useful purpose as a guide for individuals in the use of land and as a basis upon which state and Federal agencies can build comprehensive and long-time plans for land use.

OUR SOIL EROSION MENACE

BY

F. A. Fisher

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When we read of a flood and its damages our thoughts are always at the wrong end of the story. We begin to wonder how to protect that flooded area by dikes, levees, dredging and straightening channels. It is a rare occasion if anyone ever thinks of it from how to stop the flood at its source. Maybe this spring we should turn the picture around and think of dust storms. Either one has the same general treatment. Why not reverse the engineer's ideas and go back up the stream to the source of this water and plan by reforestation and revegetation to hold these rains where they fall and let more of the water down through our subsoil and have clear trickling streams feeding the rivers the year around in place of a flood of muddy water every time it rains?

The daily papers always tell us of the damages done by these floods, the crops destroyed, the livestock drowned, the bridges washed out, and the buildings floated away. They never tell of the farmers' loss at the source of the floods in the millions of dollars worth of plant food and soils eroded away. They never tell of how we are rapidly making of our people a nation of subsoil farmers; how unrestrained soil erosion is rapidly building a new public domain in America, an empire of impoverished worn-out soil; land stripped of its rich surface and gullied beyond redemption. You have seen the national erosion toll figures quoted in dozens of magazines, but let me requote so we can readily get the picture before us.

1) An area in the United States the size of the State of Illinois—35,000,000 acres is already so badly gullied and eroded it is doubtful if it can ever be reclaimed.

2) One hundred twenty-five million acres or one third of our remaining good soil in the United States is being sheet eroded so rapidly it will soon be to the subsoil farmer stage. Then gullying starts readily. You can see thousands of such acres here in central Illinois—those yellow gravelly spots appearing on the slopes and tops of the little knolls in our good black soil fields.

3) We lose annually by water run-off 21 times the plant food taken out in crops.

4) Fully 75 per cent of the cultivated land in the United States is subject to some degree of impoverishing erosion when used for clean cultivated crops. One half of this is subject to serious erosion.

5) Our state as shown by the state soil survey map, shows approximately 50 per cent of our soils subject to some degree of harmful erosion. Fifteen per cent of this is now at the serious gullying stage.

6) On the first 1200 acres surveyed in our erosion area, 45 per cent of it showed the surface 6 to 12 inches already washed off, and on 10 per cent the top loessial deposit of 40 inches gone completely. Remember this has happened in a new country where the first plow was used in 1825.

7) The Mississippi River dumps annually 428,715,000 tons of soil at its mouth. This is the equivalent of 2½ townships of soil to a depth of four feet, or the annual destruction of 360 quarter section farms. Farmers operating these farms stripped of their fertility have but the slimmest opportunity to make a satisfactory living, whether prices go up or down.

We have been preaching and worrying about wearing our soils out by continuous cropping and putting nothing back. Hundreds of textbooks have been written on this subject. If I am informed rightly to date no textbooks have been written on soil erosion and only a very few definite erosion study stations set up. I believe we have eleven such fields under the supervision of the United States Department of Agriculture, and I doubt if many here ever heard of them.

America's original wealth, her natural resources, were so vast it is little wonder we started in to be wasteful, destroying some of the world's greatest hardwood forests and celebrating by community log-rollings, burning up these logs to get rid of them. We let lumber companies cut off timbers and not replace them, making $5,000,000 profits while as a result of this, $50,000,000 damages was done to the property down stream due to flood waters from above. Our land seemed to be limitless so as one field was cleared and it washed away, we abandoned it, and cleared another. That policy has come to an end, and we find ourselves today facing the opposite direction in trying to teach our farm people the value of conservation in place of devastation. Our farm people have gone too much on the theory that erosion is a natural process that cannot be avoided.

May I here give you a few brief illustrations of our lax national policy on land utilization. First take the Navajo Indian reservation, with an area of sixteen million acres; fifty years ago we had about 8,000 Indians on the reservation, with only a small amount of livestock. Today we have 45,000 Indians with over one million sheep and goats. Their animal population has grown so rapidly that the grasses and shrubs are kept eaten into the ground and we have no natural cover to hold the soils in place following rain or wind. The Indians are seeing this problem and giving up a large per cent of their livestock.

Along the Rio Grande area is a small canyon 40 miles long through which flows the Puerco River; the soil was mapped a few years ago as a good alluvial soil. After a heavy flood last year almost the entire valley was covered by 1 to 3 feet of sand and sandy loam. Lives were lost, millions of dollars of damage done to personal property. Mr. H. H. Bennett, Director of Soil Erosion Service, investigated the watershed and found the grasses and undergrowth had been so completely eaten off that erosion was easily started and it was impossible to find an area where the original topsoil remained. We people reading that story missed the main point. We saw the property destroyed but never gave a minute's thought to the land destroyed in the two locations: first, the surface in the upland washed away and secondly, the good alluvial bottom-land covered with sand, the fine rich soil being carried out into the larger streams.

We were all startled by the story of the flood in California last December at which time 60 people were killed and millions of dollars worth of property was damaged, roads destroyed, bridges washed out, etc. But very few of us ever heard why this happened, so let me tell the story. Thanksgiving Day in one valley a fire destroyed 5,000 acres of timber with its ground cover. When the December rains came with a waterfall of 12 to 18 inches in thirty-six hours there was no undergrowth or ground cover to hold this moisture—only a hard soil that absorbed water slowly so off went millions of tons of soil and caused the damage. The truth then, is that it was the fire that caused the flood because adjoining valleys where there had been no fire, but which received the same rainfall had no floods. The forestry service in California burned over a small area to note the effect of rains. A 12-inch rain fell and on the burned over area the run-off amounted to 300 buckets of water, on the unburned area of the same size, only eight buckets. I could go on giving these illustrations and not have to go West. We have it here in Illinois. Our greed for crops has forced the breaking up of rolling timbers and pastures and after two or three good crops the soil washes off rapidly and we see through Illinois these gravelly surface soils all gullied and now so poor they can hardly be put back into grasses.

The business man is interested in this program, for he wants to build lakes on our small streams for city water supplies and pleasure resorts. These once constructed at a large expense are filling up rapidly by the careless farming methods at the headwater of all the branches of these streams. Lake Decatur is an example of this rapid silting in. The Government has asked Mr. Bennett, the Director of Soil Erosion Service in the Department of the Interior, to help them develop a revegetation program to keep all this soil from washing into the large lake back of Boulder Dam. The engineers underestimated the silting in rate. Please remember this, don't think of it only as a lake saver, but a soil conservation program.

I mentioned earlier in this paper that through the United States we have eleven Soil Erosion Control stations. I want to quote a little from the Missouri Station, so you will know better what these stations are teaching us about the soil losses we have been talking about.

We have been told that it takes Mother Nature at least 400 years to build an inch of this good, black soil, or about 3,000 years to build our top 7 inches. At the Missouri station the plots with an average slope of 4 per cent are located on a good, black soil. They are arranged so they catch all the run-off of water and soil from these plots. Plot No. 1 is cultivated each season but no crop planted. Under these conditions the water run-off and soil erosion is so great that in 24 years the surface 7 inches of soil would be washed off.

Plot No. 2 is planted to continuous corn. With this plan it would take only 50 years to lose the top 7 inches. This is just the lifetime of the average farmer.

On Plot No. 3 is planted a rotation of corn, wheat and clover; here it would take 350 years to lose the surface 7 inches.

Plot No. 4 in continuous bluegrass, lost soil at the rate of 3500 years for the top 7 inches. In other words, man's methods of farming speeds up rapidly Nature's power to erode soils.

At these fields soil losses are being checked by applying different soil treatments and the growing of legumes. They are also studying checking of soil losses by different methods of farming as strip cropping, contour farming, and terracing.

With a National President who is interested in this great problem of conserving our National resources, soil erosion has come to the front. People are reading about its effects, applying it to land values, and above all asking for help to stop this menace. With this in mind, appropriations were made from P. W. A. funds to develop throughout the United States demonstrational areas on Soil Erosion. Illinois was given one of these projects. The first thought was that maybe it should be in extreme southern Illinois where the menace no doubt is greater. The representatives from Washington, though, disapproved of this plan, saying they were not interested here in Illinois in a reclamation project of poor lands but wanted to go up into the higher-valued lands of the corn belt and put on a conservation project. In this they are right, for it is more important to conserve what good soils we have left than to try to reclaim soils that will cost more to reclaim than their probable production worth.

The area selected for Illinois is located on the Bloomington Moraine in McLean County between Bloomington and Gibson City. The south and east sides of the area are the lower edge of the moraine. The area comprises about 140,000 acres with approximately 700 farm operating units. Our program, built up hurriedly and without the guiding experience of former work, had to take shape as we went along and we have had to make many changes as we progressed.

The first step was a series of educational meetings among the farmers as to just what we were planning to do. As a demonstration we have asked the farmer to furnish the land and we will furnish the other materials necessary for the project. The farmer signs an agreement to go along with us for five years. We have divided our program into four parts.

1) A farm management survey to get information on the cropping system practiced on that farm, and to use as a guide in building a cropping system that will put life back into the soil and using farming practices to conserve soil.

2) A soil survey based on original soil type as nature left the soil and the degree of erosion that has taken place to date.

3) A gully control program to put in erosion control structures such as brush dams, wire check dams, grass bag dams, basket dams, tree plantings and sod strips.

4) A terracing program on slopes averaging from 3 to 7 per cent gradient. This later being done only on farms where the land owner lives or a tenant who has been there for some time and is likely to stay several more years.

You are not interested in the details of this program but what we hope to do is to apply all practical known methods to farms in this area to check our soils from washing away. After all, what can be more important to the future of our nation than the conserving of our soils? May I close with the following little verse, author unknown.

EROSION

Hordes of gullies now remind us
We should build our lands to stay,
And, departing, leave behind us
Fields that have not washed away;
When our boys assume the mortgage
On the land that's had our toil,
They'll not have to ask the question
"Here's the farm, but WHERE'S the SOIL?

UTILIZATION OF ILLINOIS LANDS FOR FORESTRY, WILD LIFE AND RECREATION

BY

T. H. Frison

Chief, Illinois State Natural History Survey, Urbana, Illinois

It is indeed significant and indicative of changing conditions when a subject such as utilization of Illinois lands for forestry, wild life, and recreation creeps into a State Academy symposium. This gathering is assembled, too, in an area of Illinois where until the last few years there has been a relentless and uninterrupted trend towards the removal of the last vestiges of our native woodlands and wild life, and recreation has been essentially something apart and different from the joy of seeing, sensing, and getting into contact with those great living natural resources with which our state was endowed by nature.

There is now, however, much evidence that our awakening to the need of land in Illinois for forests, wild life and recreation is directly correlated with economic factors. So vital are these factors, even in an agricultural area which has been referred to as the bread basket of the world, that we are now being forced to revise the evaluation of our natural and renewable organic resources, pay heed to their preservation, and formulate sound and intelligent policies for their utilization.

Previous speakers in this symposium have called attention to some of the evidence which is causing people everywhere to start thinking of land utilization in its broadest sense. This evidence has been portrayed to you today in word pictures of the great differences which now exist in the soils of Illinois lands and which govern their degree of usefulness and values, the projects now under way to stop further serious losses of desirable soils through various types of erosion, and how the standard of living is reflected by natural resources. A great American, Benjamin Franklin, once said that it does not take long to see the bottom of the barrel if we are always taking out and never putting any thing back in. His words fit the situation in Illinois today and I am glad to say we are beginning to take heed as shown by this symposium. From the standpoint of forests and the larger forms of wild life, however, we have waited until the bottom of the barrel has begun to show.

The utilization of Illinois lands for forests, wild life and recreation is not the simple problem it may seem at first glance. A stream or a wild life area is a complex biological unit of sundry and different organisms. Each is affected by the others and in turn affects the whole. Everyone acquainted with conservation activities throughout the country in past years knows that enormous sums of money have been practically wasted by both public and private agencies in behalf of increasing fishing or hunting. Meanwhile, these essential wild life resources have steadily declined. The launching of programs for utilization of lands in Illinois or anywhere for forestry, wild life and recreation can share this same fate unless each and every program or project rests upon sound and impartial data. Even then, over a long period of time, there will inevitably be some shifting and readjustments from time to time if there are again periods of skyrocketing of prices and then sharp declines.

It is apparent to all who have had anything to do with serious planning for utilization of land for forestry, wild life and recreation that these three phases of utilization are usually directly interwoven or at least can be made to interlace. When we bring back large forested areas, wild life properly encouraged is likely to return to an abundance within the limits of the carrying range, and recreation will and can easily be made to follow. I believe that planning for land utilization in Illinois should have a program broad enough to take in everyone and every type of interest.

There is no doubt that conservation activities in the past have often suffered severely from cliques of well-meaning individuals who could not get together; each pulling for a special type of conservation versus the type or types desired by others. It is significant that within the last three months, and for the first time in this country's history, we have witnessed all brands, sizes, and shapes of conservation organizations backing President Roosevelt's Committee on Wild Life Restoration in their attempt to formulate a national wild life restoration program.

Far-sighted land utilization programs, like conservation in general, should and can be broad enough to take in the lover of our birds and wild flowers, the hunter, the fisherman, the picnicker, and the scientist. I have no sympathy with a program which at great public expense would develop extensive areas of renewable natural resources and then forever lock them up and deny the public who paid the bill its share of their wise utilization or enjoyment. Neither have I sympathy for those short-sighted groups or individuals who would ruthlessly exploit and ruin that which they did not build and that which they would not replace or renew. Each interest in proper land utilization, as in conservation, will greatly profit by united and concerted efforts.

Although I have stated that programs for increasing forests, wild life and recreation are interwoven, each different area must be considered in the final analysis as a special problem with due regard to its former natural state and its present niche in our social and economic order. The Cook County Forest Preserves because of proximity to a large metropolitan area necessarily have heavier recreational demands than would an area of similar extent in the Ozarkian uplift of southern Illinois. In one locality the emphasis must be forestry, in another place upland game, still other areas must cater to migratory waterfowl, fish, recreation, etc. Nearly always, however, one or two major objects can be advanced at the same time. As an example of this I can cite an area near Danville, Illinois, where there is a large acreage of strip-mined land which is now virtually useless. This, if properly developed, could support an abundance of fish and game of a certain type, produce a good stand of a certain type of timber, provide a haven for wild flowers and our feathered friends, and serve as a recreational center for a large number of people. The Illinois River Valley presents another problem, particularly from the standpoint of barriers in the way of restoration. Southern Illinois is mainly a forestry problem with recreational and game interests thrown in.

Studies published by our Survey about eight years ago state that the original forest area in Illinois was over fifteen million acres with an average stand of 4,280 board feet per acre. This had shriveled by 1926 to an area of about three million acres with an average stand of about 1,000 board feet. As the land was cleared of its trees, it was devoted mostly to the raising of corn, wheat, oats, hay and other annual agricultural crops. We are now learning, because of crop yields, erosion, and other results, that the entire removal of the forests on part of this land was a mistake from the standpoint of a long-time land utilization program. Much of this land is truly submarginal and suited only to the production of a forest crop. This is particularly true of large areas in western, south-central and extreme southern Illinois.

A sound program of land utilization for this state should aim at the eventual reestablishment of forests on approximately six million acres of land now waste, cleared or semi-cleared. The present state forest of over 3,000 acres is only a drop in the bucket and the area should be rapidly and steadily increased. The establishment within the last twelve months of two National Forest units in Southern Illinois of potentially 600,000 acres was a big step in the right direction. This acquisition program must not be allowed to lag and in time this area will act as a stimulant to our state forest program. County forest programs and private forestry should not be forgotten and merit our attention. Even our tax laws are in need of revision to open the way for proper utilization of Illinois land through reforestation by private landowners. Proper legislation must be a plank in our utilization program.

All early accounts of Illinois indicate that nature was exceedingly provident in bestowing our geographical area with bounteous wild life resources. An early English traveler once chronicled that "the wealth of Illinois lies in its land." He might well have added "and in its inland waters." The early struggles of the Indians for possession of the Illinois country, the existence of large Indian communities on the banks of the Illinois River and the largest mound builder community in the world near the Mississippi River were not accidents. They are a sure indication of an early abundance of fish and game—resources so essential to primitive peoples.

Reliable statistics concerning yields and values of game and fish are not plentiful. We do know, however, that in 1908 the Illinois River was worth about one dollar per linear foot on the basis of prices paid for fish to the commercial fisherman and about two dollars per linear foot on the basis of prices paid for fish by consumers. The estimates of commercial fishing at this time give us a production in this river from eighteen million to twenty-four million pounds. Together with the income resulting from trapping, duck hunting, sport fishing and general recreation, the Illinois River Valley represented a great source of income to our state and from products, too, for which at the present time there is no overproduction. Although the Illinois River territory accounted for a large amount of our wild life resources, it was not the whole story and the entire state with its forests, prairies, lakes and rivers had its contributions to offer.

A land utilization plan for Illinois must further the improvement of wild life resources. In 1932, with about 350,000 licensed hook-and-line fisherman in this state, we had about one acre of water—good, bad or indifferent—for each fisherman. When we include the number of persons not required to have licenses, such as minors and farm owners, there was probably less than one-half acre of water for each fisherman. It is suprising with this limited water area that our disciples of Izaak Walton were able to average about two pounds of fish for the year. When it comes to upland game, with the possible exception of rabbits, the situation is certainly no better. In 1930-31 there were nearly 350,000 hunting licenses issued in this state. This means that there was about 118 acres of cleared or uncleared land for each hunter. The migratory waterfowl situation is well known to most of you. Much data have been assembled by the U. S. Biological Survey which indicate this resource is in real danger.

The stage of ruthless exploitation of our wild life resources is practically over except for isolated instances; due mainly to the present status and scarcity of wild life. Legislation as a means of saving wild life is not all that many suppose. In spite of laws we have witnessed a steady decline in certain essential wild life resources. Legislation has been helpful and is still needed but we must look to other methods to achieve increase in abundance of the more desirable species of fish and game. The pushing of land utilization programs from the standpoint of forests, aided by the furthering of proper fire protection, cover and feed areas, will surpass incubation methods and be much less expensive. Probably if all the money received from the issuance of game licenses could be devoted to rearing quail under hatchery conditions there would not be one-fifth of a quail per licensed hunter. Cover, feed, and fire protection are the big factors and these have a chance in an intelligent land utilization program, even in the heart of the corn belt territory.

The recovery of bottomlands from the clutches of drainage districts —land that in most places cannot carry the present cost of its overhead— needs to be made an integral and major part of our Illinois land utilization program. Fish hatcheries serve useful purposes, particularly as educational exhibits and as a ready source of stock, but the idea that they alone will bring back good fishing in the type of waters peculiar to Illinois and over large areas is something of a fairy tale. Hatcheries rearing fish suitable for our waters are at best only about five times as productive as good natural areas of like acreage and character. With about 75 acres of water area in state hatcheries it is not difficult to understand that the total output can have but a negligible effect on our approximately 500 square miles of water area. The cost of stepping up fish production through hatcheries so that it would exert a real and tangible effect upon our total fish resources would be exorbitant. The solution of our fishery problem lies mainly in recapture through wise land utilization of those areas taken away from our rivers, particularly the Illinois River, by drainage districts and promotional schemes, and the increase in our state of impounded waters wherever possible. Clean streams and forested river margins are necessary parts of this program. Illinois has at best but a small water acreage as compared with other states and we need every acre of it. At the present time, at least, we apparently do not need so much corn and oats. This water area, also, could be the means of stopping the migration from our borders of many millions of dollars spent elsewhere.

I am not going to take your time recounting ways and means of human beings finding recreation on Illinois lands. Forests, fish, and game all can be translated into terms of recreation. It is for recreation that most people hunt, fish, or visit our woodlands. Although we have a large body of licensed hunters and fishermen, we have a much greater number of people who need land for an opportunity to commune with nature, to stretch their legs and to shake off the dust and mental cobwebs invariably collected by humanity under the pressure of social and economic conditions. This need is becoming of increasing importance and the issue must be met. It is folly to use our best lands for this purpose and equally so not to use our submarginal lands.

I can briefly summarize my ideas of a land utilization program for forestry, wild life and recreation for Illinois as follows:

(1) Reforestation of nearly six million acres of submarginal land through federal, state, county, or private agencies. Much of this area should be in southern Illinois, but smaller units for such a program are available in most sections of the state and must be utilized to accomplish the greatest good from the standpoint of recreational uses. Sand lands, of which we have about 75 square miles, should be included in the forestry program.

(2) Restoration in the interest of fish, game, forestry, and recreation to as natural or improved state as possible of much of the former floodplains and bottomland lakes of our river systems, particularly of the middle and lower Illinois River valley, and the impounding of new water areas wherever useful and practical. Clean waters are prerequisites to the fullest success of this program.

(3) The establishment of game and migratory waterfowl sanctuaries.

(4) Expansion of our state park system whereby all types of areas are included and sufficient acreage is involved to absorb recreational demands without endangering those bits of wild life or flora of special or peculiar interest to scientists and wild life lovers.

(5) Recreational development will follow, or can easily be made to follow the types of land utilization just outlined.

(6) Promotional schemes and attempts to unload on public agencies submarginal lands at exhorbitant prices must be avoided.

Submarginal land is in a sense waste land which, if carefully utilized, can be made productive of forests and wild life crops of which at present there is no overproduction. At the same time these areas can be used in a variety of ways to improve the mental and physical well-being of our citizens.

On top of this I would urge that all land utilization projects should be guided by scientifically acquired data of an impartial character. The data of this character which exists for Illinois today is largely the result of the activities over a period of many years of our State Scientific Surveys and the Illinois Agricultural Experiment Station. I know it has been a source of gratification to these organizations to observe the great increase in public interest and appreciation of the value of these data and to see years of patient labor—sometimes criticized by short-sighted individuals as of no practical value—blossom forth in a new radiance and utility. The Illinois Agricultural Experiment Station and the State Scientific Surveys are research and service organizations and are equipped to supply the leadership in the evaluation and scientific guidance of land utilization problems.

MEMOIRS

JESSE LOWE SMITH
1869-1934

Jesse Lowe Smith, superintendent of schools in District 107, Highland Park, Illinois, died in the Presbyterian Hospital, Chicago, April 21, 1934. The school year that was nearing its close at the time of his death was the thirty-second year of his services as an educator and leader in the life of the community.

He was born in Macon, Illinois, November 23, 1869. After graduation from De Pauw University, he taught in the public schools of Macon, Lexington, and Park Ridge, Illinois. In 1902 he commenced his administrative work in the school system of Highland Park.

In this community his sympathetic interest in worthy enterprises, and his ardor in progressive and creative movements led to multiplied calls for his services. He served for many years on the library board of the city, and took active part, also, in the work of the Highland Park Tree and Parkway commission. He was for some time a director of the North Shore Art League, and served in an advisory capacity in civic and educational enterprises in other North Shore communities. At the time of his death he was engaged in plans and activities in alleviating the problems of unemployment, and in C. W. A. enterprises.

Living in the profound conviction that man's usefulness, and to a large measure even his happiness are commensurate with his intellectual growth, Jesse Smith gave most unreservedly to any movement that promised intellectual upbuilding in his fellow man. He had the utmost sympathy for the forgotten man in the educational sense. In the round of activities engendered by this passion he was called upon to be one of the past presidents of the Chicago Geographic Society, a president of the Audubon Society, and for a long time a director of the Friends of our Native Landscape Society.

It is, however, through his radiant personality and his kindly sympathies that his influence will live the longest in the minds of his fellows and in his community. His extremely active and intense life was motivated by his friendship for people. He loved to take parties of friends and students into the woods and fields for observations, first-hand, and for fellowship. His teaching was effective and most successful, for he had the capacity to open the eyes of the unobserving, and to inspire and enthuse the minds of his auditors with an appreciation for the ways of Nature. His exuberance over the successful outcome of some quest for new knowledge to be gained in outings of that kind was a thing most contagious. Even those physically weary with the tramping found themselves rejoicing that they were in at the finish.

And then, with characteristic self-effacement and humility, he was equally ready to go as a student where the role of an instructor was given to another. But on occasions of this kind, one found himself listening with interest to the appreciative questions and the apt comments of Jesse Smith, the student. And the range of interests and the depth of insight, unconsciously revealed, became items of inspiration to teacher and fellow students. His willingness to receive of the things he prized most highly made his capacity to give all the greater.

The highest tribute to the man, perhaps, can be utterly conveyed in the conviction retained by those who knew him. And that is, that time spent in the presence of Jesse Smith was time well spent, because one retains memories of a gentle spirit, a kindly and generous disposition, a loyal and understanding sympathy. And with those recollections in mind, the whole genius and inspiration of his life are best epitomized, no doubt, in a comment on that life made by a member of his own family—"Every day meant so much to him."

John R. Ball.

OLIVER CUMMINGS FARRINGTON*
1864-1933

Born and pre-professionally educated in Maine, later studying at Yale under Dana and Penfield, where in 1891 he earned the Ph. D. degree, Oliver C. Farrington came west in 1894 after the Columbian Exposition to the position of Curator of Geology in the new Field Museum, which office he held to his death He was both a charter and a life member in the Academy.

Farrington's bibliography includes more than 100 titles, many in mineralogy and geology largely in connection with Field Museum activities, a well-known semi-popular book on Gems (1903), and meteorite studies. These last are what secure his fame in science, not only for the two books which appeared in 1915, the semi-popular *Meteorites* and the large quarto memoir *Catalogue of the Meteorites of North America,* but also for the numerous original papers, among which are the description of the largest known stony meteorite, now in the Field Museum collection, and contributions on the composition, classification, and origin of these interesting members of the cometary family.

The excellence of the present geological collections at the Field Museum is in no small part due to the vision and ability of Farrington, who was also intrumental in securing the outstanding meteorite collection, the leading one as regards number of falls represented.

He is survived by his wife, Clara Bradley Farrington. Although diffident and retiring, his kindliness, tolerance, and humility made him loved of all those who came to know him. It was a great loss, both personal and scientific, that the heart trouble to which he finally succumbed was such a burden on him during his later years.

D. JEROME FISHER.

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* A memorial of Dr. Farrington by S. K. Roy, to whom the writer is indebted for information, appeared in the Proceedings of the Geological Society of America for 1933, 193-209, 1934.

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Papers In Anthropology

Extract From the Report of the Section Chairman

Of the six papers presented at the meeting of the Anthropology Section, only four are here represented. The others were:

"The application of the tree-ring method in dating prehistoric sites," by John C. McGreggor, University of Chicago.

"Basic cultures of the Mississippi Valley and their Illinois representatives," by Thorne Deuel, University of Chicago.

Three of the nine papers on the program were not given.

Average attendance at the meeting was thirty-five.

Bruce W. Merwin, Southern Illinois State Normal University, Carbondale, Illinois, was elected chairman of the section for the 1935 meeting.

(Signed) Thorne Deuel, *Chairman*

ARCHAEOLOGICAL RECONNAISSANCE WORK IN SOUTHERN ILLINOIS, 1933

BY

BRUCE W. MERWIN

Southern Illinois State Normal University, Carbondale, Illinois

During the year of 1933, under the auspices of Dr. Warren K. Moorehead of Phillips Academy, some archaeological reconnaissance work was done in Southern Illinois, primarily in connection with axes and celts already collected. Of secondary importance was the locating of various forms of Indian remains and the collecting of surface material. In connection with the study of the celts and axes, sixteen collections were visited, photographed, and studied; fourteen others were visited and studied, but no photographs were taken; and twenty smaller collections are listed and may be visited later. The work included over two thousand miles of travel and the taking of over two hundred photographs. The summary of the work on stone axes has been submitted to Dr. Moorehead.

All of the study was confined to Southern Illinois, but the matter of locating and visiting sites was largely concentrated about Jackson, Williamson, Johnson, Union, and Alexander counties. As a result of the work, the following remains were located and mapped: large towns—7; village sites or camp sites—168; mounds or mound groups—42; rock shelters—28; workshops—21; "stone forts"—5; burials or burial grounds—58; rock carvings—7; limestone caves—7; flint quarries—5; salt works—3; salt licks—2; trails—3; and miscellaneous—12. Under miscellaneous is included one spring said to have been walled up with rock, and four small areas where there seemed to have been fire for a long period of time. Many of the sites were visited and collections of surface material were made.

Perhaps the most outstanding of the sites visited, and one which has probably never been reported in print, is the Kincaid group of mounds located near Brookport. This group of mounds covers an area almost one-half mile square located along the banks of Avery Lake. The largest of the mounds is about 650 feet long, 250 feet wide and 40 feet high and covers an area of approximately three acres. In shape it is described as a woman's inverted shoe. At the extreme west end, corresponding to the heel, is a sort of truncated conical mound that is about 60 feet across at the top and 40 feet high. About 20 feet lower is a small neck of land 25 feet across, which connects to the sole, which in turn is about 300 feet long, 100 feet wide at its widest point, and 15 feet lower than the heel or 25 feet above the level. Near the toe is a graded way about 40 feet wide leading down southeast toward the center of the village.

The second largest mound is about 375 feet long, 175 feet wide and 35 feet high. It has a flat top on which are located a house, barn, and other buildings. There are two large mounds of the truncated square pyramidal type about 250 feet in diameter at the base and 25 feet high, close to the others already mentioned. There are three slightly smaller mounds nearly one-half mile away at the east end of this village site. The area between has a few mounds some four to eight feet in height and 75 to 150 feet in diameter. This area also contains several large depressions and what appear to be a number of hut-rings. Northwest of the largest mound are three large depressions, the largest being over 500 feet across.

This site seems to represent the same culture as the Angel group near Evansville, Indiana, the Milligan mound in Dogtooth Bend near Cairo, and the Linn site in Union County. It should be studied more in detail, purchased by the state, and preserved as a park.

EARLIEST INHABITANTS OF ILLINOIS

BY

GEORG K. NEUMANN
University of Chicago, Chicago, Illinois

ABSTRACT

In 1930 a mound, designated as F-77, was excavated near Liverpool, Illinois, under the direction of Dr. Fay-Cooper Cole, by the field party of the Department of Anthropology of the University of Chicago. The mound had been previously excavated by amateurs and was found to belong to the Illinois Hopewell variant of the Woodland culture. Upon excavation by the field party, the discovery was made that the mound had been built over an older village site and cemetery of the Woodland culture. Twenty-six flexed or semi-flexed burials were recovered from this ancient cemetery.

The examination of the skulls indicated that the people from this older village site represented a distinct physical type, for they differed from skulls from mound burials of people of the Illinois Hopewell variant of the Woodland culture. The former were long-headed (cranial index of 72.7), with a narrow forehead, broad cheek bones and broad face (total facial index of 83.9, or euryprosopic), a nose of medium proportions (nasal index of 49.5), and a medium amount of prognathism; while the latter were round-headed (cranial index of 84.2), with a broad forehead, broad cheek bones but long face (total facial index of 91.2), a nose of medium proportions (nasal index of 48.4), and a medium amount of prognathism.

KINGSTON (ILLINOIS) FOCUS OF THE MISSISSIPPI CULTURE

BY

ANSON SIMPSON

Peoria, Illinois

The Kingston Indian Village Site is located on a terrace-like rise of ground bordering the north shore of the lake and covers an area of ten acres. The terrace is a black loam from one foot to three feet in depth over a lense-like body of clay from zero to three feet deep. On this body of clay rested the village floor, from which the Indian artifacts were collected.

The many determinants taken from this site point strongly to the Monk's Mound aspect of the Middle Mississippi cultural phase.

Perforated *shell hoes* were very numerous, more than 140 were collected. *Deer jaw hoes* were common and showed much wear at point of hafting and also at point of use. Many *potsherd-hoes* were also collected.

Stone implements consisted of pitted stone, whet stone or sharpener, anchors, sinkers, sandstone mortars or paint stones, and many small celts.

The *projectiles* were the thin triangular edged type of stone. A few were made from deer horn. *Knives* were the thin flaked edged type. *Scrapers* of the bunt variety were numerous. Bone and horn *awls* were very common, over 100 were collected.

Other determinants were beamers, game bones, wooden ear-spools (copper jacketed), skull trophies, discoidals, large effigy pipe (of stone), tempered pottery paste (not fired), wedge tools of horn and bone, bone plaques, pottery tools of the mushroom type, fragments of many bone ornaments, woven fabric of several weaves, carbonized corn and cobs, pecans, walnuts, and hickory nuts, also thin flakes of copper. Copper beads and over 690 shell beads came from one cache.

Pottery of the globular type, smooth and cord-imprinted shell-tempered, decorated and plain were found at all campfire sites and in storage pits. The outstanding characteristic of the sherds procured is the great variety of pots they represent, viz, ollas, plates, shallow bowls, bottle tops, and beakers which vary as to shape of rim, lip, shoulder, decoration, and handles.

Ollas, the globular shaped vessels, have their outer surface textile imprinted or smooth. A few show finger imprints on inner and outer wall. The rims also have a wide range of style, viz: flaring, verticle, rolled and flat. The decorations are mostly of incised geometrical designs on the shoulder of the vessel. Some of the small ollas have effiigy forms on rims and handles.

The *plates* are shallow and of various sizes; black and red in color, and have decorated rims. A few are scalloped.

The *shallow bowls* are of various sizes with a maximum diameter of nineteen inches. They have rimless thick walls ending in a flat lip, and are without decoration. A few show fabric marking on the base.

The *bottle tops* are globular, like the ollas, but have contracted necks and narrow rims and are without decoration.

The *beakers* are the most unique of all the types. The walls are thin, verticle or slightly flared, the base flat, and the pots small compared with the other types. Red and black colors predominate. The decoration consists of scroll work and incised lines and the design covers the outer wall of the vessel. Many have effigy-like forms for handles. The effigy forms of others extend from the vessel lip. The colors are red to black and polished.

Several more traits of these people have been found at the Kingston Site, which point, no doubt, to the Middle Mississippi classification.

PREHISTORIC TIMETABLES

BY

JOHN VOSS

Peoria, Illinois

ABSTRACT

A method now used by the botanist for the determination of the age, changes in forest constitution and climatic conditions during interglacial periods is pollen analysis. In the British Isles (1, 2) the same method has also aided the anthropologist in estimating the age of the artifacts which sometimes occur buried in peat deposits. If careful stratigraphical studies were made of American peat deposits located near former campsites, data could probably be obtained which would be of value in dating the artifacts of the prehistoric American cultures.

1. MOIR, J. R., New evidences of ancient man. Scientific American April 1928.
2. WOODHEAD, T. W., History of the vegetation of the southern Penninines. Jour Ecology 17:1-34. 1929.

Papers In Botany

Extract From the Report of the Section Chairman

All of the seven papers on the Botany program were presented before the members and guests of the section and all but one are here represented. Dr. A. G. Vestal's article, entitled, "Rock ledge vegetation in southern Illinois," was not handed in for publication.

Attendance at the section meeting averaged fifty.

Dr. W. N. Bailey, Southern Illinois State Normal University, Carbondale, Illinois, was elected chairman of the section for 1934-35.

(Signed) E. L. Stover, *Chairman*

BARBERRY ERADICATION IN ILLINOIS

BY

ROBERT W. BILLS

U. S. Department of Agriculture, Bureau of Plant Industry

ABSTRACT

The common barberry, originally from the Himalaya Mountains of Asia, was carried into eastern Europe and from there to America by early colonists. The fight against the rust-spreading plant was begun locally in grain producing regions in France about 1660. The program was soon taken up in Germany and England and in the American colonies as early as 1726. A nation wide campaign was carried on in Denmark in 1903 after a law was passed against this bush. In 1918, the United States Department of Agriculture cooperating with state agencies, started a campaign to eradicate common barberry from thirteen north central grain producing states.

The ability of this plant to multiply and be distributed and to adapt itself to growing under various conditions of soil and moisture has complicated the fight to exterminate it.

One barberry location was referred to near Southborough, Massachussetts, where a spread of rust was reported in 1795 by Timothy Dwight, President of Yale. One bush was accused of causing serious rust damage to a wheat field. Pictures were shown to illustrate how the barberry has multiplied until now there is a wilderness of barberries growing in some of the fields of that region. In this section the bush has become a pasture weed.

A location in Lake County, Illinois, was described as having spread from a planting in Gurnee. Woodlands, fence lines, and roadsides covering about 35 square miles have been infested by the progeny of that one planting. Bushes were most numerous on the H. C. Lake farm about one mile from the original planting. On that farm 48,425 bushes, many of them large, fruiting bushes, were killed from 1923 to 1925. A careful search of the farm netted 5,860 small to medium sized bushes in 1930, and an equally diligent search in 1933 resulted in the destruction of only 435 small bushes. Thus the barberry bushes are being brought under control.

A total of 2,669,411 common barberry bushes and seedlings has been found and destroyed in Illinois from 1918 to 1933. These plants, if they had been equally distributed, would have covered this State at the rate of one to each 13 acres. In the 13 States of the barberry eradication area, 19,107,232 barberry plants have been destroyed. Definite reduction of rust losses has followed the removal of these sources of infection.

The figures compiled by the Plant Disease Survey of the United States Department of Agriculture show that for the thirteen states of the Barberry Eradication area the average annual loss of wheat due to black stem rust during the six years 1916-1921 was 51,279,000 bushels; during the following six year period the average annual loss was reduced to 17,845,000 bushels; and during the last six year period 1928-1933 the average annual loss was brought down to only 3,471,000.

Barberries are known to be growing in many locations where the seeds have been scattered by birds and other agencies from old plantings. Practically all of the planted bushes have been destroyed. Records indicate the existence or probable presence of remaining bushes near locations where old bushes had grown. These records simplify the future search for bushes.

SOME BRYOPHYTES OF MACON COUNTY, ILLINOIS

BY

GLADYS CHARLOTTE GALLIGAR

University of Illinois, Urbana, Illinois

The following list of Bryophytes represents the species found in collections made in April and May of 1933 from woody ravines and banks of the Sangamon River and its tributaries and from roadsides and pastures in Macon County, Illinois. The names used are those found in "Mosses With a Hand Lens and Microscope" and "Mosses With a Hand Lens" by A. J. Grout. The work was done under the direction of Dr. Stella M. Hague of the Department of Botany, University of Illinois.

I. HEPATICAE:

JUNGERMANNIACEAE

Frullania eboracensis Gottsche. Tree.
Lejeuna cavifolia (Ehrh.) Lindb. Tree.
Lophocolea heterophylla (Schrad.) Dum. Stump.
Cephalozia bicuspidata Stump.
Jungermannia lanceolata L. (Liochlaena lanceolata). Stump.

II. MUSCI:

POLYTRICHACEAE

Catharinea undulata (L.) W. and M. River bank.
Catharinea angustata Brid. River bank.

FISSIDENTACEAE

Fissidens osmundoides (Swtz.) Hedw. Ravine.

DICRANACEAE

Ditrichum tortile (Schrad.) Hampe. Ravine.
pallidum (Schreb.) Hampe. Ravine.
Ceratodon purpurens (L.) Brid. Pasture.
Leucobryum glaucum (L.) Schimp. Woods soil.

TORTULACEAE

Weisia viridula (L.) Hedw. Pasture.
Pottia truncatula (L.) Lindb. Pasture.

FUMARIACEAE

Physcomitrium turbinatum (Mx.) Brid. Roadside.

BRYACEAE

Bryum caespiticium L. River bank.
Bryum argenteum L. Stone.
Rhodobryum roseum (Weis.) Limpr. Log.
Mnium cuspidatum (L.) Leyss (Mnium sylvaticum). Log.
Mnium affine ciliare (Grev.) C. M. Log.

LESKEACEAE

Thuidium delicatulum (L.) Mitt. Woods soil.
Thuidium pygmium Br. and Sch. Log.
Thuidium microphyllum (Sw.) Best. Log.
Leskea polycarpa (Ehrh.) Tree.
Leskea nervosa (Schwaegr.) Myrin. Tree.
Anomodon rostratus (Hedw.) Schimp. Tree.

HYPNACEAE

Brachythecium salebrosum (Hoffm.) Br. and Sch. Woods soil.
Brachythecium oxycladon (Brid.) J. and S. (B. Laetum B. and S.). Log.
Brachythecium cyrtophyllum Kindb. Log.
Eurynchium hians (Hedw.) J. and S. Woods soil.
Eurynchium strigosum (Hoffm.) B. and S. Woods soil.
Eurynchium serrulatum (Hedw.) Kindb. Woods soil.
Campylium chrysophyllum (Brid.) Bryhn. Stone.
Amblystegium serpens (L.) B. and S. Stone.
Amblystegium varium (Hedw.) Lindb. Woods soil.
Amblystegium riparium B. and S. Woods soil.
Plagiothecium micans (Sw.) Paris. Base of tree.
Entodon compressus (Hedw.) C. M. Tree.
Entodon cladorrhizans (Hedw.) C. M. Log.
Entodon seductrix (Hedw.) C. M. Tree.
Platygyrium repens (Brid.) B. and S. Tree.

MOSSES FROM THE ILLINOIS OZARKS

BY

STELLA MARY HAGUE

University of Illinois, Urbana, Illinois

The mosses listed in this paper were collected, with a few exceptions, during two visits to southern Illinois, July 17 to 22, 1931, and July 6 to 14, 1932.

The names and arrangement follow that given by Dr. A. J. Grout in Mosses with a Handlens and Microscope and Moss Flora of North America, Vol. III, parts 1, 2, 3 and Vol. II, part 1.

Abbreviations of the counties in which the mosses were collected: S—Saline; P—Pope; J—Johnson; U—Union; W—Williamson; H—Hardin.

SPHAGNACEAE

Sphagnum sp. .... J.

POLYTRICACEAE

Catharinea undulata (L.) W. & M. .... P.J.
Catharinea angustata Brid. .... P.J.
Polytrichum commune L. .... P.J.
Polytrichum ohioense R. & C. .... J.

FISSIDENTACEAE

Fissidens adiantoides (L.) Hedw. .... J.
Fissidens osmundoides (Swtz.) Hedw. .... J.

DICRANACEAE

Ditrichum pallidum (Schreb.) Hampe .... S.J.P.
Dicranum heteromalla var. orthocarpa (Hedw.) .... P.
Dicranum scoparium (L.) Hedw. .... J.P.
Dicranum sp. .... P.
Leucobryum glaucum (L.) Schimp. .... J.P.

GRIMMIACEAE

Hedwigia albicans (Wel.) Lindl. .... S.P.J.
(Hedwigia ciliata (Ehrh.) Hedw.)
Ptychomitrium incurvurm (Muhl.) .... J.
Grimmia apocarpa (L.) Hedw. .... J.P.H.U.
Grimmia ovata W. & M. .... S.
(Grimmia commutata Hueben.)
Rhacomitrium sudeticum (Funk) B. & S. .... S.J.
(Rhacomitrium heterosticum var. sudeticum (Finch) n.e.)

TORTULACEAE

Weisia viridula (L.) Hedw. .... S.J.U.
Didymodon rubellus (Hoffm.) B. & S. .... H.
Tortella caespitosa (Schwaegr.) Limp. .... S.
Desmatodon plinthobus Sulli. & Lesq. .... H.

ORTHOTRICHACEAE

Drummondia clavellata Hook. .... J.

FUNARIACEAE

Physcomitrium turbinatum (Mx.) Brid. .... W.
Funaria hygrometrica (L.) Sibth. .... S.J.

AULACOMNIACEAE

Aulacomnium heterostichum (Hedw.) B. & S. .... S.J.
Aulacomnium palustre Schwaegr. .... J.U.

BARTRAMIACEAE

Philonotis fontana (L.) Brid. .... J.
Bartramia pomiformis (L.) Hedw. .... S.J.P.

BRYACEAE

Pohlia nutans (Schreb.) Lindb. .... S.P.J.
Mnium cuspidatum (L.) Leyss. .... S.J.
Mnium affine var. ciliare (Grev.) C.M. .... J.
Mnium rostratum Schrad .... S.J.
Mnium punctatum elatum Schimp. .... J.

LESKEACEAE

Thuidium delicatulum (L.) Mitt. .... S.P.
Thuidium recongnitum (Hedw.) Lindl. .... J.U.
Thuidium pygmaeum B. & S. .... S.
Thuidium minutulum (Hedw.) B. & S. .... U.
Leskea polycarpa Ehrh. .... S.J.P.U.
Leskea gracilescens Hedw. .... S.
Leskea obscura Hedw. .... S.J.
Anomodon minor (P. Beauv.) Fuern. .... J.
Anomodon apiculatus B. & S. .... S.J.P.
Anomodon viticulosus (L.) Hook & Taylor .... J.
Anomodon attenuatus (Schreb.) Hueben. .... S.P.
Anomodon rostratus (Hedw.) Schimp. .... J.U.

HYPNACEAE

Thelia hirtella (Hedw.) Sull. .... J.
Brachythecium salebrosum (Hoffm.) B. & S. .... S.U.
Brachythecium oxycladon (Brid.) J. & S. .... J.
Brachythecium acutum (Mitt.) Sulli. .... U.
Ciriphyllum Boscii (Schwaegr.) Grout .... P.J.
Climatium Americanum Brid. .... P.J.
Climatium Kindbergii (R. & C.) Grout .... S.J.
Porotrichum Alleghaniense (C.M.) Grout .... J.S.
Drepanocladus exannulatus (Guemb.) Warnst. .... J.
Amblystegium serpens (L.) B. & S. .... P.J.U.
Amblystegium Juratzkanum Schimp. .... P.
Amblystegium compactum (C. Muell.) Aust. .... P.
Amblystegium varium (Hedw.) Lindb. .... U.
Amblystegium irriguum (Wils) B. & S. .... J.
(Hygroamblystegium irriguum)
Amblystegium riparium var. trichopodium B. & S. .... S.
(Leptodictyum trichopodium (Schultz) Laubm.)
Hygrohypnum ochraceum (Turn.) Loeske .... P.
Hypnum curvifolium Hedw. .... J.P.
Plagiothecium elegans (Hook) Sulli .... U.
Plagiothecium micans (Sw.) Paris .... P.U.
Amblystegiella confervoides (Brid.) Loeske .... S.
Entodon cladorrhizans (Hedw.) C.M. .... P.J.U.

LEUCODONTACEAE

Platygyrium repens (Brid.) B. & S. .... S.J.P.
Leucodon julareus (Hedw.) Sulli .... J.
Leucodon sciuroides (L.) Schwaegr. .... S.

FONTINALACEAE

Fontinalis Lescurii Sulli. .... S.

NEW METHODS IN PALEOBOTANICAL MICRO-TECHNIQUE

BY

A. C. NOÉ

University of Chicago and Illinois State Geological Survey

The old method of examining a coal ball for interesting plant material which it might contain was to quarter it with a rotary diamond saw and then to prepare thin sections along the horizontal and vertical cuts. These thin sections had to be sliced off with the diamond saw and ground with at least three different grades of carborundum powder until microscopic thinness was obtained. The grinding was done either on glass plates or on rotating laps driven by motor power. To produce a good thin section mounted on a glass plate with Canada balsam took approximately one and a half to two hours; it took about one day to prepare a single coal ball for the preliminary tests.

Since 1928 when Walton and Koopmans published their cellulose peel method great progress has been made in the testing of coal balls in my laboratory. If the coal ball is sufficiently hard and not too porous all adherent coal and other mineral matter is removed with a hammer and the coal ball is dipped into a 10 per cent solution of hydrochloric acid. The latter is allowed to remove the surface of the uncut coal ball until any enclosed plant material becomes visible. Usually stem or root pieces, possibly also seeds which touch the surface can be seen and the orientation of the cuts can be planned. In accordance with the surface indications, the coal ball is now cut with the diamond saw into two, four or more blocks. The next step is to smooth the cut surfaces with carborundum powders in the successive grades of 120, 220, and 600, treating with a 10 per cent solution of hydrochloric acid until the plant organs are clearly visible. The cuts are carefully washed with water and dried. Their surfaces now present a very fine velvet of carbonized plant tissues from which, to a depth of perhaps 50 to 100 micra the matrix of calcium carbonate has been removed. This velvet is now soaked in butyl acetate and a 10 per cent solution of nitrocellulose in butyl acetate is poured over the moist surface. The use of nitrocellulose dissolved in butyl acetate has been worked out by one of my students, Roy Graham, who published his method in Stain Technology, April, 1933, pp. 65-68. The nitrocellulose solution is most satisfactory. We have tried solutions of parlodion or of pyroxilin in ether and alcohol, or of cellulose acetate in acetone, or of purified collodion. The nitrocellulose solution produces a satisfactory film which does not curl but sticks closely to the surface of the coal ball until removed with a safety razor blade. It also gives a very transparent film which does not need to be cleared with xylol or with Eycleshymer's clearing fluid. It is usually necessary to apply several coats of nitrocellulose. The successive coats can be applied as soon as the previous coat begins to harden. I found that three coats are usually necessary to produce a very coherent film. The films can be filed in paper envelopes to be examined at any convenient time. For the examination I use a binocular microscope with a magnification of about 25 or 50. If the film discloses interesting details, squares are cut out of it with a safety razor blade and mounted on glass slides in Canada balsam. The drying of a film takes 6 to 8 hours but it is easy to prepare a dozen coal balls in a day and have the films dry during the night. Nitrocellulose solutions in butyl acetate are not very sensitive to moisture and sufficient drying of etched coal balls can be accomplished in an electric oven in a few minutes. The new method is at least ten times faster than the old one. The same advantages prevail when it comes to the minute study of selected material for research purposes.

THE EFFECT OF ULTRA-VIOLET LIGHT ON THE FERMENTING ABILITY OF YEASTS

BY

FRED W. TANNER AND J. ROY BYERLY

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Problem: This problem was suggested by the discordant reports in the literature concerning the effect of ultra-violet on the fermenting ability of yeasts. Some workers report that ultra-violet light accelerates the fermenting ability of yeasts, while others report that ultra-violet light greatly inhibits their fermenting ability.

Method: In view of the differences of opinion on this question, it was decided to repeat and extend some of the experiments. More refined methods have been developed which allow more reliable results. Four different modifications of technique were used as follows: (1) irradiation of dextrose-broth cultures, (2) irradiation of aqueous suspensions of yeast before inoculation, (3) irradiation of fermenting cultures, (4) irradiation of dextrose broth before inoculation. Each experiment was carried out in duplicate and in some cases many times.

The source of ultra-violet light in this experiment was a Cooper-Hewitt lamp operated at 110 volts and 5 amperes (D. C.) at a distance of 25 cm. A fairly constant temperature was maintained during irradiation by means of an electric fan directed toward the light. A fermentometer described by Rahn (1929) was used to determine the rate of fermentation. This method of measuring fermentation has the advantage of determining the rate for very short intervals of time immediately after exposure, thereby eliminating the possibility of fermentation by cells which were never exposed to the light. The gas pressure in the fermentometer was produced against mercury in the open arm. The record of the pressure was kept in millimeters of mercury. All irradiation was carried out in quartz flasks.

Saccharomyces cerevisiae and Fleischmann's commercial pressed yeast were the principal yeasts used in this experiment.

Conclusions

(1) Yeasts are destroyed when exposed directly to the effects of ultra-violet light.

(2) Irradiation of dextrose-broth cultures of fermenting yeasts in quartz apparatus for periods of time totaling 1 hour and 20 minutes seriously inhibited their fermenting ability.

(3) Exposure of yeasts in aqueous suspension to ultra-violet light destroyed so many cells that no gas was formed in 24 hours; very small amounts were formed in 31 hours. The non-irradiated controls showed regular active gas formation.

(4) Exposure of dextrose-broth cultures to ultra-violet light after fermentation had begun, greatly inhibited gas formation.

(5) Dextrose broth irradiated for a long time before inoculation tended to ferment more slowly than the non-irradiated control media.

(6) No observations were made to indicate that exposure of yeasts or media to ultra-violet before inoculation increased the amount of gas formed.

A STRATIGRAPHICAL STUDY OF THE MANITO SWAMP

BY

JOHN VOSS

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East of the city of Manito, Mason County, Illinois, may be found a portion of an abandoned channel which during Late Wisconsin times was probably occupied by the Illinois and Mackinaw rivers. The channel is filled with peat averaging 6 feet in depth and contains important records of value in the reconstruction of the postglacial history of the Illinois valley. Unfortunately much of that record has already been destroyed through drainage and by the removal of some of the peat for commercial purposes. Although the removal of the peat has destroyed some of the buried records, it has, nevertheless, made it possible to collect macroscopic material which otherwise could not have been obtained by the common method of drilling.

The origin of the sand upon which the peat rests is attributed to the period when the Kankakee Torrent was at its height. The water originated from the exceedingly rapid melting of the ice of the Michigan, Saginaw, and Erie glacial lobes and entered Illinois River via the Kankakee. So rapid was the melting that, according to Ekblaw and Athy (*2*), the glacial river in northeastern Illinois varied in width from 5 to more than 12 miles. A wide channel also occurred south of the city of Pekin and extended south to Meredosia, Morgan County. In that channel the raging flood waters at first deposited coarse material, and later, as the water subsided, deposited sand. Subsequent to the decline in water level, peat accumulated in the undrained portion of the former channel.

The peat collected for laboratory study was obtained from the eastern margin of Section 26. At that point the Manito Chemical Company had removed all the organic soil to within a foot of the sandy bottom and thereby exposed excellent profiles of the peat beds. The material was black throughout, varied considerably in texture, and the top soil was loose and granular owing to drainage and subsequent aeration. The profiles showed the peat to be typical of that generally found in shallow undrained depressions. Such peat accumulates very slowly and for that reason samples were taken every inch from the bottom to top. Although pollen grains were found in most strata, their sparsity, due to the nature of the peat and the resultant effect of drainage, would not give a true picture of the vegetation succession.

The height of the water table is, according to Dachnowski (*1*), the principal factor governing the type of plants to be found on bogs. Laboratory studies revealed that at the outset, the water in the section of the swamp from which the samples were taken, was shallow. This was indicated by the occurrence of many seeds of *Menyanthes trifoliata* and sedge remains in the first four inches of the bottom peat. This stratum was also characterized by the abundance of leaves, lateral spurs, and cones of *Larix*.

Five inches above the bottom there occured a thin band of inorganic soil consisting of a mixture of sand and clay. This may have been deposited either by wind or water. Upon this layer and associated with *Larix* leaves were many specimens of the mosses *Drepanocladus revolvens intermedius* and *Campylum stellatum*.

Immediately above the mineral soil the water doubtless was shallow as indicated by the occurrence of *Menyanthes* seeds. Four inches above the silty layer *Sphagnum* occurred. Its presence together with the appearance of much *Picea* and *Larix* wood signified that the surface of the bog was built up above ground water level. *Picea* and *Pinus* pollen were also abundant in the *Sphagnum* stratum.

Above the Sphagnum layer the macroscopic material indicated a change in water level which brought about the destruction of Sphagnum by submergence. From the 9-inch level to the 18, the material consisted chiefly of sedge remains and the leaves of *Larix*, the latter probably having grown on the more elevated portions of the bog. *Salix* pollen occurred at the 10-inch level; *Picea*, *Quercus*, and many *Pinus* pollen at the 11-inch level. *Pinus* pollen was also common in the upper part of the layer and at the 17-inch level *Quercus* pollen was the most abundant.

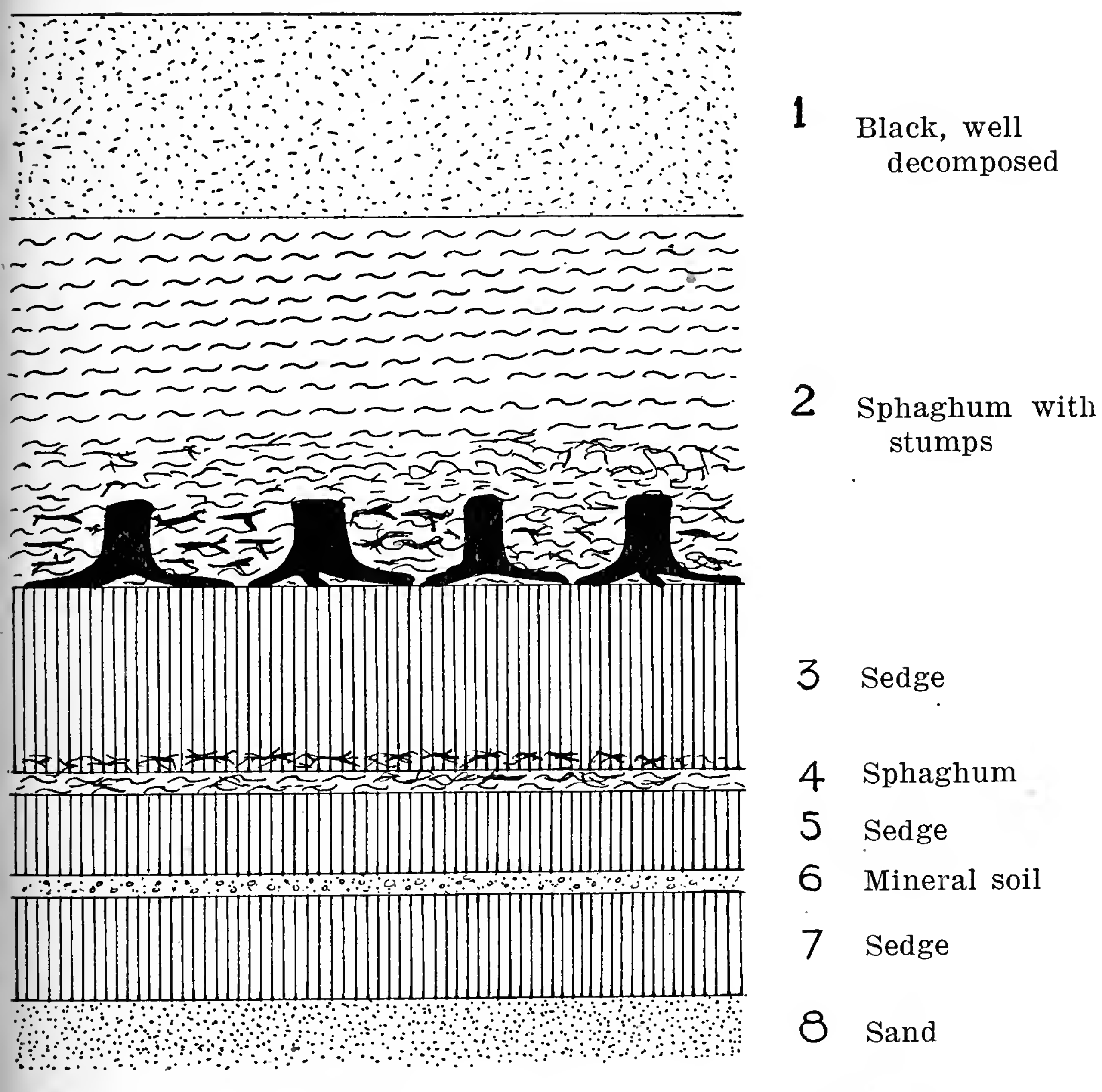

FIG. 1. Diagram showing structure of peat bed. *(Cut supplied by author.)*

As the surface of the depression gradually became higher owing to the deposition of peat, the water table at the 18-inch level became low enough to permit the growth of Sphagnum. Sphagnum persisted from the 18 to the 36-inch level as one of the important peat forming agents. At the 20-inch level *Menyanthes* seeds were common, and 21 inches above the bottom numerous well preserved roots and stumps of *Larix* and *Picea* were present indicating again that the surface of the bog was above ground water level. Woody peat accumulates very slowly and its thickness indicated that the swamp forest of spruce and tamarack remained for a long period. The presence of *Betula* pollen, leaves of *Betula pumila*, and annuli of *Polypodiaceae* in the upper portion also suggested maturity. Pine pollen was found throughout indicating that the tree probably grew either on the bog or on the surrounding sandy soil. Conditions with reference to the surrounding sand cover may have been similar to those of northeastern Illinois (*3*) where the oak is gradually superseding the pioneer pine.

From the 36-inch level to the top, the soil, owing to drainage, was black, well decomposed and contained practically no material of value in the reconstruction of vegetational history.

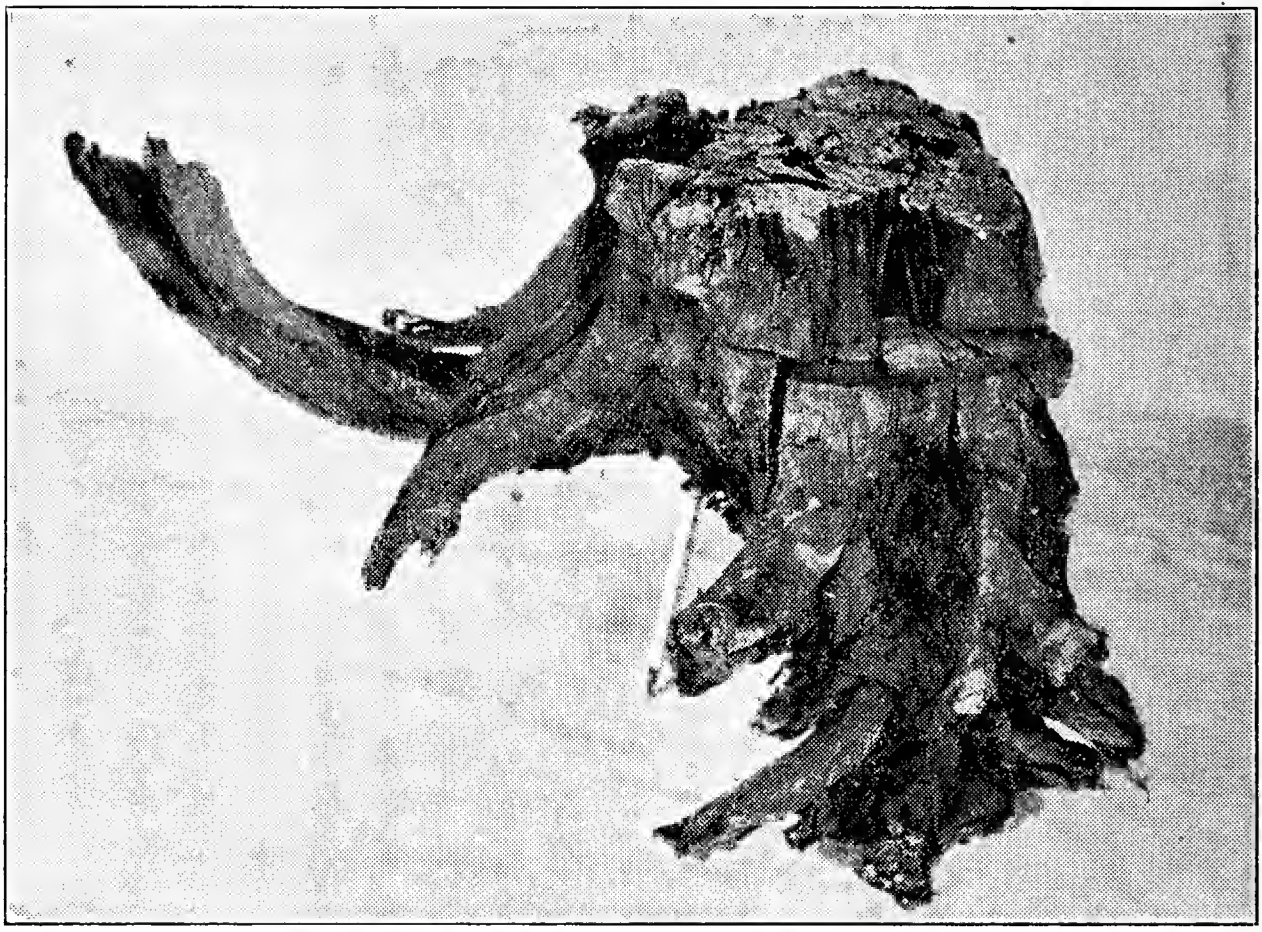

FIG. 2.—Tamarack stump found 21 inches above the bottom.
(Cut supplied by author.)

SUMMARY

The stratigraphy of the Manito swamp indicated that as soon as the channel was abandoned by the Mackinaw and Illinois rivers, the edaphic conditions favored the growth of boreal shoal water plants together with *Picea* and *Larix* on the more elevated parts of the channel floor. Several fluctuations of water level occurred during the history of the swamp as shown by the alternating layers of sedge, sphagnum, and woody peat. During at least two distinct periods of the swamp's history the surface was dry enough to support the growth of *Larix* and *Picea.* The last swamp forest persisted for a long time and doubtless passed through the same successional stages as found on some of the mature bogs in northeastern Illinois. What the final stages were is difficult to say owing to the destruction of the plant remains by drainage and subsequent aeration. All evidence thus indicated that the abandoned channel served as one of the pathways for the northward movement of plants which had previously been forced in the opposite direction by the advancing ice.

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PAPERS IN CHEMISTRY

EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN

Of the ten papers on the Chemistry program, only eight are here represented. One was not given, two were read by title, and the following, although given at the meeting, was not presented for publication:

"Some metathetic reactions of iodine mono-chloride," by H. W. Horrabin, Western Illinois State Teachers College, Macomb, Illinois.

Average attendance at the meeting was fifty-five, maximum was sixty-five.

The present chairman was re-elected to serve for 1934-35.

(Signed) FRED A. DYKINS, *Chairman*

A NEW AERATION PROCESS FOR THE PREPARATION OF WHIPPED CREAM

BY

C. A. GETZ WITH G. F. SMITH

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The preparation of whipped cream by the process of mechanical whipping has a number of disadvantages. Cream of relatively high butter fat content, preferably 32 per cent, is required. The cream should have been separated from the milk for approximately 24 hours and should be whipped cold. By this process the volume of whipped cream produced is twice the volume of cream used. This is known as a 100 per cent overrun.

The whipping of cream involves a reversible reaction of aeration. During the first part of the whipping air is introduced in the form of minute bubbles which accounts for the expansion of the cream volume during whipping. Continued beating of the cream then tends to decrease the expansion due to the incorporation of air to such an extent that an equilibrium is attained. Beyond the equilibrium point as much air is beaten out of the cream as is incorporated into the cream by the beating process. Oftentimes this equilibrium point is not attained without the formation of butter globules and if the process is continued much beyond the equilibrium stage butter is the inevitable result.

Mechanical devices have been manufactured and distributed to produce a higher overrun in the mechanical whipping of cream than is ordinarily the case. The ordinary whipping process is supplemented by the introduction of a stream of air under presure through the body of the cream during the whipping operation. Essentially the same requirements for the compressed air process must be fulfilled as for the ordinary whipping method and the results obtained are noteworthy in that as much as a 200 per cent overrun can be obtained. In other words, the ordinary whipping operation is made more efficient in attaining a larger volume for the final product by shifting the previously described equilibrium in the direction of greater absorption of air throughout the body of the cream.

The process described in connection with this outline represents an entirely new principle of aeration. Cream of any age and varying in butter-fat composition between 22 and 36 per cent is treated under pressure with one of a possible series of soluble gases in a special container. The whipped cream can be delivered in large or small quantities under the gas pressure employed in charging the cream and all the advantages previously described for the improved aeration by the air pressure method are greatly augmented. Higher overruns are obtained; any portion of the cream treated can be delivered at a given time; and the butter-fat content of the cream treated can be varied over a much wider range.

Gases suited to the newly described aeration process should have the following characteristics:

1. Their solubility in water should equal that of one volume of gas per unit volume of water at ordinary temperatures.
2. The gas should be colorless, odorless, and tasteless.
3. The gas should be obtainable in a high state of purity in storage cylinders, the internal pressure of which is in excess of that required for the charging of the gas into the cream at the desired pressure.

The gases which satisfy these characteristics are four in number, namely: carbon dioxide, nitrous oxide, dimethyl ether, and dichlor-difluor-methane.

Of these, carbon dioxide leaves the whipped cream with a carbonated beverage taste. For some uses this quality is not objectionable, but for others this is not satisfactory. Nitrous oxide is the practical equivalent of carbon dioxide and has none of its objections. It is obtainable in large quantities in steel cylinders under 800 lbs./sq.in. pressure. The purity of the gas is beyond question and its physical characteristics are perfectly adapted to the process involved.

The specific operation of the process using 26 per cent cream is as follows. A half-pint of cream is placed in the pressure bottle which is provided with a siphon tube, a pressure valve of the Schrader type and a delivery nozzle. Nitrous oxide is charged into the cream with gentle shaking until the pressure has reached 80 lbs./sq.in. The pressure is then automatically cut off by the Schrader valve and the delivery nozzle is inserted on the bottle. The cream may then be delivered, intermittently or continuously, by operation of the valve until the contents are used. It is found that the overrun thus obtained is approximately 260 per cent. The drainage from this cream is no greater than that obtained from the same volume of cream whipped by the old method. If desired, the cream may be sweetened and flavored before charging with gas in the bottle. By this process almost a quart of whipped cream is obtained from one-half pint of 26 per cent cream.

It is proposed to market this cream in pressure bottles. The cream will be sweetened and flavored and charged with the necessary quantity of gas and will be distributed to the consumer by much the same process as the consumer now receives the daily supply of milk and cream. After the contents have been used, the bottle with the delivery nozzle detached is returned to the milk distributor and replaced by a full bottle. In case all the contents are not used at one time, the delivery nozzle may be removed from the bottle and the remaining contents stored in the ice box under ordinary conditions until required for further use. The delivery nozzle can be washed by the housewife in the usual fashion but the empty container is washed and sterilized by the dairy manufacturer engaged in this distribution. Cream thus charged has been kept in a refrigerator for one week without deterioration. After this time, the cream delivered has been as satisfactory as that obtained on immediate use. This process has been protected by patent application and sufficient illustrations of the principles involved have been provided to constitute general protection from infringement by imitators.

THE OCCURRENCE OF A PECTIN MATERIAL IN ARTICHOKE SIRUP

BY

H. E. HARRISON WITH D. T. ENGLIS

University of Illinois, Urbana, Illinois

The preparation of a palatable sirup from Jerusalem artichokes has been previously described (*1*). In this connection it was pointed out that the manufacture of the sirup was in a sense a preliminary step in an attempt to produce pure levulose by a direct crystallization from the raw sirup. Further work toward the major objective has been concerned with the constituents of the extract which might cause inhibition of crystallization.

Since levulose is extremely soluble, a very high concentration is necessary to reach a saturation value. Nevertheless, the crystallization of the sugar from an aqueous solution of the pure compound can be accomplished with a fair degree of ease. The difficulties encountered with the raw sirup emphasize the great significance of the impurities.

It was believed that one of the factors contributing to inhibition of crystallization was the high viscosity of the sirup at the necessary percentage of solids. It appeared reasonable that pectic substances might be present and responsible for this condition. These substances are found widely distributed in plants. The deposit of jelly-like masses in cans of the artichoke sirup which had been allowed to stand for some time pointed to the existence of some material of pectic nature.

For the isolation of the material samples of sirup were diluted to a sirup of about 50 per cent solids and 95 per cent alcohol added until the concentration of alcohol in the mixture was about 70 per cent. The jelly-like precipitate was removed, redissolved in water and reprecipitated several times.

The purified material had a specific rotation of 105, which is in the lower range of values reported for pectic materials. A portion of the sample was hydrolyzed (*3*) and finally tested for galacturonic acid. The crystalline character of the compound, temperature at which it discolored, and melting point confirmed its presence.

The quantity of apparent uronic acid in the pectic substance was determined by measurement of CO_2 evolved under regulated conditions (*4*). Values obtained were of the same order as those obtained with a pure citrus pectin under identical circumstances.

Enzymes of the pectin system were prepared from *Rhizopus nigricans* and the artichoke material was subjected to their action. Reduction in amount of available pectic acid, as determined by the method of Carre and Haynes (*2*), was indicated. The rate of saccharification of the sample by the pectic enzymes was similar to that obtained with citrus pectin.

Through the kindness of Mr. R. R. Sterrett and Mr. R. A. Stegeman, X-ray diffraction photographs were made of the artichoke material and citrus pectin. These photographs showed some relationship between the artichoke material, citrus pectin and polygalacturonic acids, but the work has not yet progressed to the stage at which definite conclusions can be drawn.

Further work is in progress to furnish additional information concerning this interesting constituent of the artichoke sirup.

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THE EFFECT OF POTASSIUM CYANIDE UPON AMYLASE ACTIVITY

BY

J. O. PAGE WITH D. T. ENGLIS

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Many interesting studies (*2*) have been reported concerning the effect of cyanides upon various enzymes. Hanes and Barker (*3*) mention that under suitable conditions they increase the activity of malt amylase. Prompted by certain phenomena occurring as a result of chemical treatment of dormant potatoes, Denney (*1*) investigated the influence of KCN upon potato amylase. Small amounts of the reagent did markedly increase the activity of the undialyzed juice but after dialysis little or no effect was noted. Denney also observed that the increase due to cyanide decreased as the pH of the medium increased.

These experiments were of particular interest in connection with some work in progress in this laboratory upon barley amylase. This enzyme shows its optimum activity at a much lower pH than potato amylase and it seemed desirable to establish the effect of KCN under varying conditions upon the former. Both ungerminated barley and barley malt were used as sources of the enzyme. The materials were finely ground and sieved. Portions were then allowed to soak in distilled water over night and the clear liquid introduced into the substrate material. The substrate was prepared from soluble starch according to the general procedure of Sherman and Thomas (*5*). The control and treated solutions were prepared separately. In the case of the treated samples the appropriate amount of KCN solution, previously adjusted to the desired pH, was introduced into the substrate before making up to volume.

In selecting conditions for experimentation a pH of 4.56 was selected as being near the optimum for barley amylase and pH of 7 as one less favorable to the action of the enzyme. The solutions were buffered to maintain the desired pH. The substrate was first brought to a temperature of 40° C. and the amylase introduced and the mixture held at 40° C. during the progress of the reaction. At regular intervals portions of the mixture were withdrawn and the rate of saccharification determined by the method of Lane and Eynon (*4*). With undialyzed enzyme preparations containing 10 mg. of KCN per 100 cc. of substrate in the treated sample very little difference in rate of reaction was noted between treated and control when the pH was maintained at 4.56. When the pH was increased to 7 the rate of saccharification was much greater for the KCN treated samples. However, the rate for the latter was practically identical with that observed for a pH of 4.56. This seems to indicate that the cyanide tends to make the enzyme less subject to change in activity due to change in pH. Reduction in normal activity by increase in pH from 4.56 to 7 seems to be prevented by addition of the KCN.

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THE USE OF CERIC SULFATE FOR THE DETERMINATION OF CUPROUS OXIDE OBTAINED BY THE ACTION OF REDUCING SUGARS ON FEHLING'S SOLUTION

BY

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Existing methods for the volumetric determination of cuprous oxide, especially as applied to standard procedures for the estimation of reducing sugars, fall quite generally into two classes—iodometric and manganimetric. All fail to fulfill the essential requirements of convenience, accuracy, and low costs. Iodometric methods are based upon an equilibrium which, under correctly controlled conditions, can be made to proceed in either direction (*5*). While good results can be obtained, accuracy is usually sacrificed by modifications tending to lower the cost of the procedures. Manganimetric methods (*1, 2, 3*) have proved rather unsatisfactory, due to the high oxidation potential of permanganate which causes it to oxidize adsorbed organic material, as well as to the difficulty of detecting the permanganate end-point in a blue copper solution.

Ceric sulfate (*6*) offers advantages which adapt it to the determination of cuprous oxide. It is exceptionally stable, even in the presence of quite variable concentrations of sulfuric acid. It can be used in the presence of hydrochloric acid, which is often suggested to assist in the solution of cuprous oxide. The valence change is simple and there is no danger of the cerous sulfate formed being reoxidized by exposure to the air. Its oxidation potential is less than that of permanganate, which minimizes its effect upon the adsorbed organic matter. It can be obtained commercially or easily prepared at low cost. Its former disadvantage, the lack of a suitable indicator has now been overcome by the introduction of orthophenanthroline ferrous complex, a reversible indicator (*7*).

A stoichiometric relationship is found to exist between Ce^{++++} and Cu^{+}. This is made use of by separation of the cuprous oxide from the reducing solution, solution in a known amount of standard ceric sulfate solution, and titration of the excess ceric sulfate with ferrous sulfate, using orthophenanthroline ferrous complex as indicator. The color change at the end-point (orange-red to blue-green) is easily distinguished. The method can be applied to all reducing sugar determinations involving separation of the cuprous oxide from the reducing solution. Good results are obtained over a variety of conditions.

A comparison of the method with similar methods involving permanganate and dichromate was made, dichromate having been suggested and used by Jackson and Mathews (*4*), whose procedure, however, required an electrometric end-point. The permanganate method selected was that of Bertrand (*1*), modified by the application of orthophenanthroline ferrous complex as an aid in detecting the end-point. Dichromate was used in the same manner as ceric sulfate, using barium diphenylamine sulfonate as internal indicator. Ceric sulfate proved superior to both, permanganate giving consistently high results, in spite of the fact that the use of orthophenanthroline ferrous complex reduced the error, while dichromate, using indicators now available, necessitates the application of an end-point correction which varies with the volume of solution used.

The procedure for the determination of cuprous oxide using ceric sulfate as outlined appears to offer advantages which should permit its wide application to reducing sugar determinations.

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A FEW SUGGESTIONS ON THE TEACHING OF FUELS IN ELEMENTARY CHEMISTRY

BY

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ABSTRACT

The usual study of the composition and source of ordinary fuels such as coal, coke, alcohols, gasoline, etc., is recommended. The study of heat values is practical chemistry applied to human needs and human progress. Emphasis is placed upon the teaching of quantitative relationships, although in doing so criticism may develop from the inability of the learner to include all factors in making conclusions. This may lead to partial and even misleading ideas. It is pointed out that the nature of the subject of chemistry is such that the use of pure mathematical methods has its limitations. The growth of ideas is necessarily slow. If, during the acquisition of fundamental concepts, wrong ideas for a time enter there should be no cause of worry. The growth of the individual in generalization is analagous to that of the race. With the limited knowledge of the race of fifty years ago it is perfectly natural that the learner should think as the learner of that time. The important thing is that the learner continue the ability to modify his general notions as he acquires new facts.

It is recommended that the pupil be led inductively through the development of such ideas that fuels with a large percentage of hydrogen by weight have high heat values. This may be developed by taking the heats of formation of carbon dioxide and water from standard publications and calculating in each case the calorific value per gram of these elements. The application of these facts to the estimation of heat values from percentage compositions is recommended. The effect of oxygen in fuels is easily taught.

Gaseous fuels are composed of a few simple units, by studying the heat values of which the learner is prepared to estimate the heat values of these fuels from their composition. An opportunity is offered in this study of reviewing such topics as the meaning of a formula, law of combining volumes, and the Avogadro principle. The idea that hydrocarbons are decomposed into elements, which burn as uncombined substances is noted. The law of heat summation is used as a matter of common sense without any attempt to formulate the law in terms of mathematical symbols.

The oxygen required for the combustion of fuels is studied in relationship to heat values. Equations are written showing that for the combustion of one atomic weight of carbon (twelve grams) one volume of oxygen is needed, while for the combustion of an equal weight of hydrogen three volumes of oxygen are needed. Numerous equations involving the combustion of various elementary units of which fuels are composed are recommended as project work. Attention is called to the oxygen needed for combustion and the luminosity of flames.

Attention is called to the need of teacher explanations that such studies are more or less idealistic to the extent that because a fuel has a high heat potential is no sure indication that it is being realized in practice. The efficiencies of heaters and calorimeters are compared. Calculation furnishes the goal to be attained in future methods of manufacture; it should encourage invention.

EXPLOSIVE REACTION OF PERCHLORIC ACID WITH METALLIC BISMUTH

BY

D. G. NICHOLSON AND J. H. REEDY

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In studying the use of perchloric acid as a solvent for alloys, violent explosions were met in the cases of alloys containing bismuth. Muir[1] has reported that bismuth is soluble in dilute perchloric acid forming the insoluble bismuthyl perchlorate. Fichter and Jenny[2] worked with concentrated perchloric acid and obtained soluble bismuth perchlorate. They state that the reaction is often accompanied by explosions due to chloric acid and chlorine dioxide formed by the reduction of the perchloric acid.

There is no apparent reaction of bismuth with 70 per cent perchloric acid at room temperature. Upon heating to 105-110° centigrade the metal becomes coated with a brown-to-black layer which explodes upon either continued heating or a sudden shock such as dropping, with terrific violence shattering the vessel and throwing the hot acid for surprising distances. After such a decomposition the metal again takes the bright appearance as before. The same procedure may be repeated indefinitely as long as the crystal of metal remains of suitable size. The fact that after explosions the metal is badly shattered, suggests that the acid had penetrated the cleavage planes of the crystal prior to the explosion.

The violence of the reaction is reduced by alloying the metal with other metals. High temperature or sudden shock favor the decomposition, while on the other hand the activated metal loses its dark color and activity if allowed to remain in air for some time. A convenient and less hazardous method of preparing the explosive metal is to dip a fragment in the acid by means of tongs, and carefully heat above a Bunsen flame.

The unstable nature of the material made a chemical analysis impossible. Analysis of the products formed by the decomposition showed them to consist largely of bismuthyl chloride. The ratio of chloride to bismuth ions present in this residue was approximately three to eight. This indicated that there was direct solution of the metal, in all probability to the normal perchlorate, as well as the formation of the metastable material. The presence of the bismuthyl chloride was verified by X-ray analysis.

Proof has been established to show that this unstable material is not an amphoteric form of bismuth, it is not due to impurities in the metal, and it is not due to formation of anhydrous bismuth perchlorate. Electrolysis of a solution of this perchloric acid using bismuth electrodes resulted in an explosion at the anode, while the cathode was coated with a fine very stable layer of bismuth. Thus it must be an oxidation product of bismuth in some metastable condition. One possibility would be pentavalent bismuth, although sodium bismuthate is stable when mixed with 70 per cent perchloric acid.

Plunging the darkened metal into water results in the solution of the dark colored material with no further reaction. Aqueous solutions of perchlorates are without reaction with the metal. Dilute perchloric acid likewise gives no explosive material. Plunging a blackened piece of the metal into potassium iodide solution liberated no free iodine.

The explosions are not due to reduction products of perchloric acid as tests for chloric acid with aniline sulfate were negative.

[1] Chem. News. *33*, 15 (1876).
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THE TECHNIQUE OF MICROCHEMISTRY

BY

J. H. Reedy

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Micro methods in analytical chemistry were first developed as a separate art by Behrends in 1880 at the University of Delft, in Holland. Since then it has grown rapidly, and has been differentiated into specialized forms, as the micro methods of Emich, the spot tests of Feigl, the quantitative procedures of Pregl, and the microscopical procedures of Chamot.

Qualitative procedures may be roughly classified as (1) test tube methods, using approximately one cubic centimeter of solution, and (2) spot methods, using drops placed on slides, plates, or filter paper. Microanalysis requires special technique in such operations as heating, evaporation, precipitation, washing of precipitates, sublimation, and so forth.

The substitution of micro methods for the usual macro methods of qualitative analysis is not desirable in elementary classes, since the reactions employed are too largely organic. Furthermore, there would be a tendency to stress technique instead of the fundamental chemistry.

CHANGES IN THE HYDRATION OF THE SERUM COLLOIDS AS A GENERAL FEATURE OF DISEASE

BY

KAMIL SCHULHOF

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The importance for individual therapy of the blood changes investigated by J. E. R. McDonagh made it desirable to obtain more objective measures of some of them, especially the hydration of the proteins. Since this association of the water (more correctly salt and sugar solution) with the proteins is apparently only of a physical nature, the obvious chemical methods fail. The equation:

$$\frac{(1 + \phi) \text{ log. nat. } \eta/\eta_0)}{\phi \ (1 + \text{log. nat. } \eta/\eta_0)} = K$$

(in which η is the relative viscosity of the system; η_0 the relative viscosity of the dispersion medium; ϕ the relative volume of the disperse phase; K a constant which depends on the nature of the dispersion medium, disperse phase and temperature) is valid for erythrocyte suspensions. It is also valid for a large majority of solutions (practically through their range of solubility), as well as for blood sera, but in these cases ϕ is a multiple of the concentration ($\phi = \text{nc}$). Consequently it is permissible to say that these solutions behave *as if* each unit of the solute occupied a space corresponding to η.

Both the η and the k vary in serial dilutions of different sera but are sufficiently interrelated to permit the equation:

$$n = \left\{ \frac{113}{c} - 1.52 \right\} \log_{10} n/1.015 - 0.66$$

which is valid for all the sera examined and for temperatures from 20° C. to 40° C. For instance a serum containing 7.5 per cent proteins and having at 40° C. a viscosity of 1.70, behaves according to the equation, as if each gram of its proteins occupied or influenced a space of 2.37 cc. Multiplying the n by the coefficient necessary to make it 100 in the average normal human serum, we obtain the VP Index. Thus, a VP Index of 120 means that the examined serum behaves *as if* each gram of its proteins occupied a space by 20 per cent larger than it seems to occupy in a normal serum. In an analogous way, if the concentration of all the colloids of the serum is expressed by their refractometric index, we obtain the VR Index. The VP Index is more sensitive to pathological changes, the VR Index more foolproof, because the determination of the refractometric index is simpler and more reliable than the protein determinations. The standard deviation of the VR Index in health is only ± 2.5 per cent (including the probable error of the method), while its range in disease was found to be from 82 to 157 in the 1500 examinations presented. These sera were obtained partly from the author's own patients with internal diseases, partly from all other branches of medicine, as other physicians gradually learned to value the results. In conjunction with other methods—and never without a clinical examination—they proved useful in revealing the presence of disease, in excluding some diagnoses and in a more precise statement of the therapeutic indications established by McDonagh. Heuristically, the method lead to an extension of the liver treatment to a group of patients who were not anemic but whose blood serum resembled that in pernicious anemia and to the recovery of a patient with the hitherto fatal combination of agranulocytosis with jaundice.

THE MECHANISM AND APPLICATION OF THE FRIES ISOMERIZATION

BY

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ABSTRACT

At the present time, the Fries reaction is the best means of obtaining the hydroxyaryl ketones which are important in a variety of organic syntheses. Fries and Finck,[1] in their study of the homologs of Cumarone, observed that when the chloroacetates of phenols were heated with aluminum chloride a rearrangement occurred readily and smoothly to the hydroxy-*omega*-chloro-acetophenones.

This rearrangement of the aryl esters of carboxylic acids to hydroxyaryl ketones, as has been indicated by a large number of investigators, may also be accomplished by employing anhydrous ferric chloride and zinc chloride. However, it is apparent that anhydrous aluminum chloride is the most effective reagent for the conversion.

The technique of Fries and Finck was used until Rosenmund and Schnurr[2] recently announced that the Fries method could not be put to general application because of several complications and also observed that when the rearrangement is carried out in nitrobenzene solution a more rapid conversion occurs and in many cases with a better yield of product.

The reaction was generally assumed to be an intramolecular rearrangement of the phenyl ester into the hydroxyaryl ketone until recently when Rosenmund and Schnurr suggested that the reaction must be bimolecular. When they heated a mixture of o-chloro-p-cresyl acetate and p-cresyl benzoate with aluminum chloride for fifteen minutes at 150° C. they obtained all four possible products. An intramolecular change should produce only the two normal compounds o-acetyl-o-chloro-p-cresol and o-benzoyl-p-cresol. The subsequent work of Rosenmund and Lohfert[3] apparently gave further evidence that the Fries shifting does not occur within a single molecule. Auwers and co-workers[4] refuted these arguments and presented evidence to indicate that the Fries reaction is not a saponification and a subsequent resubstitution but a molecular rearrangement. It was reported recently by Cox[5] that some acetyl chloride was obtained when aluminum chloride acted on 2, 4, 6,-trichloro-phenyl acetate. This observation would support the contention that the reaction is bimolecular and that when the phenyl ester is acted upon by aluminum chloride, the free acid chloride is produced, which subsequently reacts with the phenol giving a ketone.

Fries and his co-workers[6] indicated that the reaction is a valuable synthetic method and the work of Auwers and his students[7] not only confirmed this but extended its usefulness to the preparation of a large number of monohydroxy-aryl ketones. Interesting syntheses in the poly-hydroxy-aryl ketone series were accomplished recently by Mauthner[8] employing the Fries method of transformation. It was shown by Fries[9] and later by Lederer[10] that when *alpha*-naphthyl acetate is rearranged by heating with aluminum chloride, 2-aceto-1-naphthol is formed. In the same manner the isomerization of *beta*-naphthyl acetate with aluminum chloride yielded chiefly 1-aceto-2-naphthol.

The Fries reaction has the possibility of becoming important in the commercial preparation of intermediates for antiseptics[11] and dyes.[12] It is also of theoretical interest because of its still uncertain and disputable mechanism.

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[12] E. P. 248 791 Chem. Zentr., *1927,* (II) 336.

Papers In Geography

Extract From the Report of the Section Chairman

All of the eight papers on the Geography program were given at the section meeting but the following were not presented for publication:

"The relation of topography and drainage to farm-type regions of Illinois," by W. E. Powers and E. C. Dapples, Northwestern University, Evanston.

"Growing broomcorn in Coles County, Illinois," by Rose Zeller, Eastern Illinois State Teachers College, Macomb, Illinois.

Attendance at the meeting averaged forty; maximum attendance was fifty.

Mr. F. W. Cox, Carbondale, Illinois, was elected chairman for 1934-35.

(Signed) Alfred W. Kasel, *Chairman*

DECATUR, ILLINOIS: A STUDY IN URBAN GEOGRAPHY*

BY

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There are definite reasons for the location of every city, and most settlements are the result of certain physical conditions. A century or two ago the reasons were more definitely geographical than they are today, because, owing to many and varied inventions man is now able to overcome natural drawbacks, or rather turn what at one time were considered obstacles, to his account. We are all familiar with physical features which have led to the development of a city, such as water power in falls or rapids, as seen at St. Paul and Minneapolis; a portage between two waterways, as at old Fort Dearborn; a convenient site for bridging a river, as at St. Louis. There are many other reasons for settlements, some strategic, as seen in

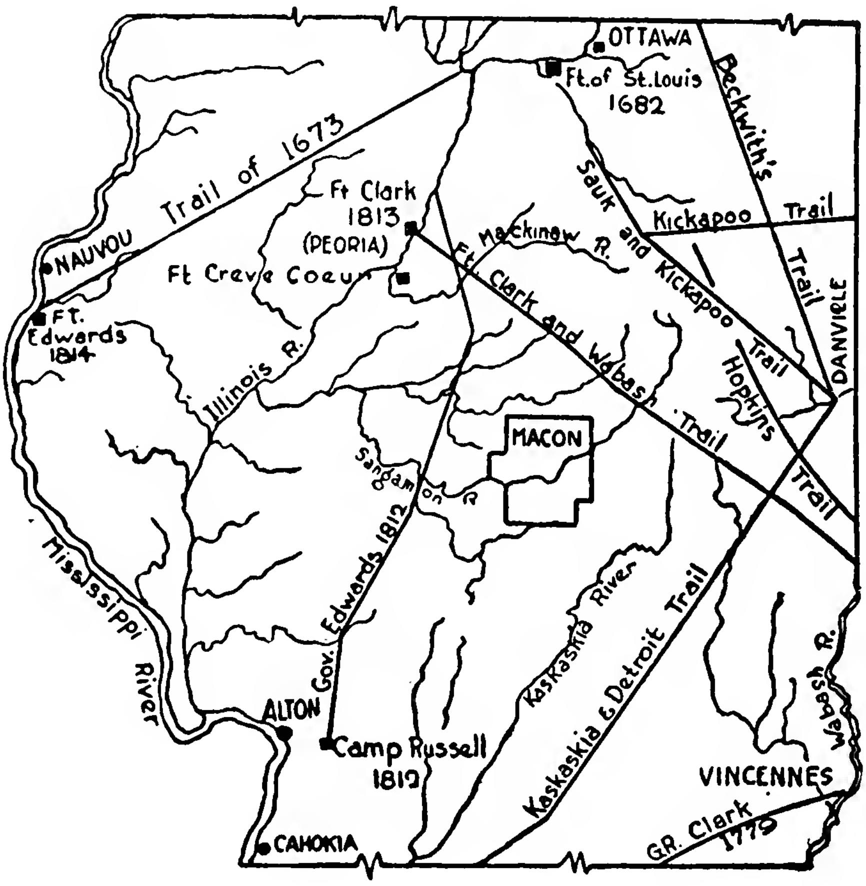


FIG. 1.—Illinois Indian trails *(After Richmond, Mabel E., Centennial History of Decatur and Macon County, p. 12.)*

the site of Quebec, others at the tidal limit of a river as seen in London which was also the lowest point at which the river Thames could be bridged. Oxford was the point on the upper Thames where the river could be forded by oxen. In some cases minerals were the attraction as at the site of Danville, Illinois, where Indian trails converged on salt supplies and on deposits of vermilion clay from which a rich red coloring matter was obtained.

* The writer wishes to acknowledge the valuable assistance of Mr. Royal B. McClelland of the Decatur Association of Commerce, and access to the Association's files. Mr. M. E. Lockhart of Niantic supplied the writer with first-hand information on land utilization and early development of the Decatur area.

In central Illinois there is such a sameness in the natural landscape and so few outstanding physical features that it is not always easy for the geographer to account for the location of settlements. The pioneer, however, was on the lookout for certain necessary requirements in choosing a site

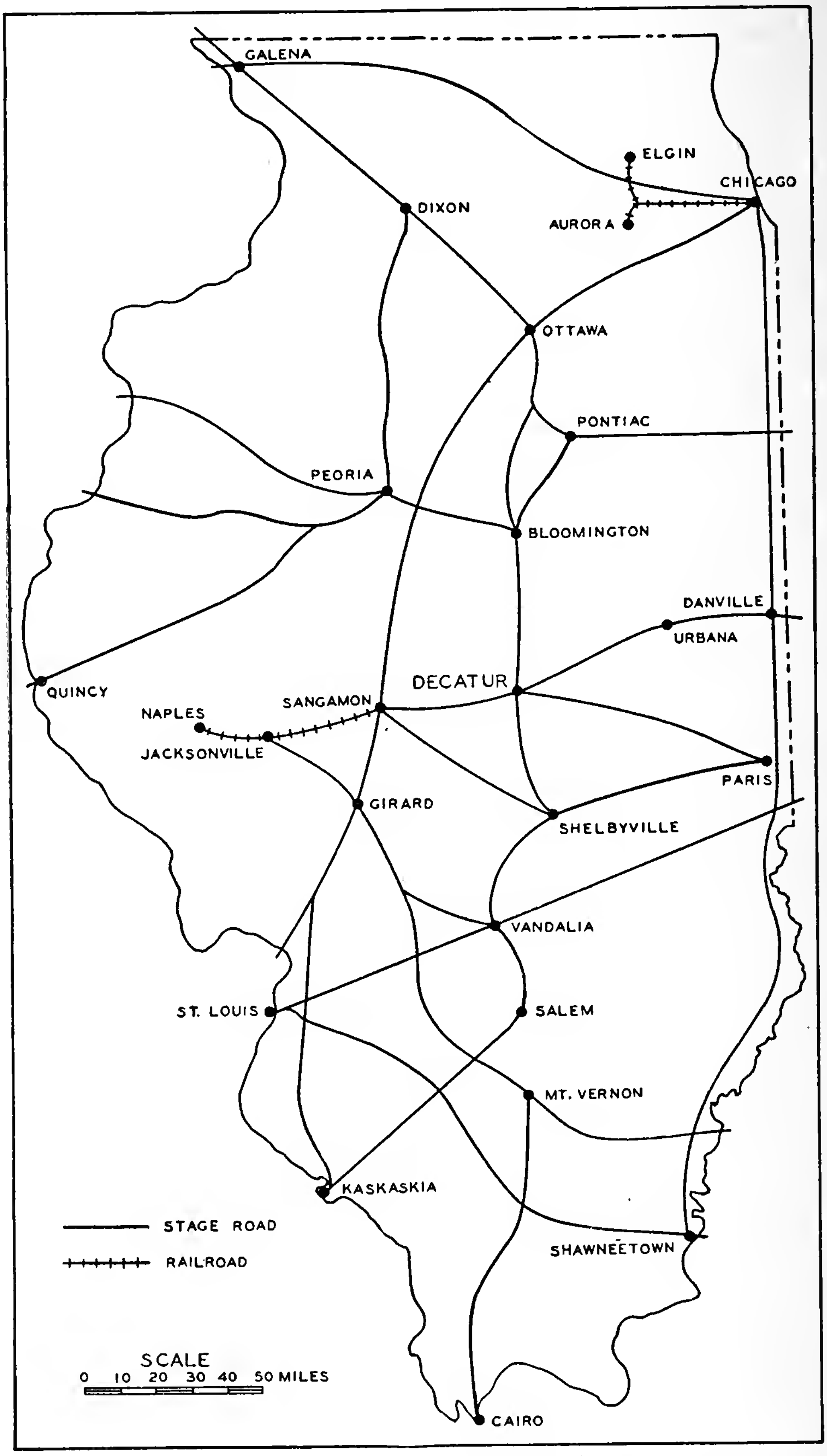


FIG. 2.—Stage routes in 1851 *(After Richmond, Mabel E., Centennial History of Decatur and Macon County, p. 98.)*

for his homestead, for example, a supply of good drinking water besides water for domestic purposes, timber for buildings, and fuel. If in addition to these there was good land for grazing and crops, access to means of transportation and power supplies, the site was considered especially attractive.

In any urban study the first consideration is an attempt to account for the original location of the settlement in question; so in the case of Decatur, we begin by consulting the historian and noting, very briefly, the chief steps which led to the establishment of the town site.

Early Location and Development of the City Pattern

Illinois was admitted to the Union in 1818 with a population of about 35,000. Settlement was mainly along the wooded stream banks where there were supplies of timber for building material and for fuel, together with shade for cattle and a good water supply. On account of poor drainage the prairies were often inaccessible and unhealthful; so that even the Indian trails (Fig. 1) avoided them.

John Stevens settled three miles northwest of Decatur on the stream named for him about 1822. About 1824 the Ward family from Kentucky settled not far from the Sangamon River, to the south of where Lake Decatur lies today. Several families soon joined the Ward settlement, so that a little hamlet started here on the banks of the Sangamon. After Illinois was admitted to the Union the General Assembly began establishing roads. In 1824 men were named to "view, survey and locate" the first road to cross

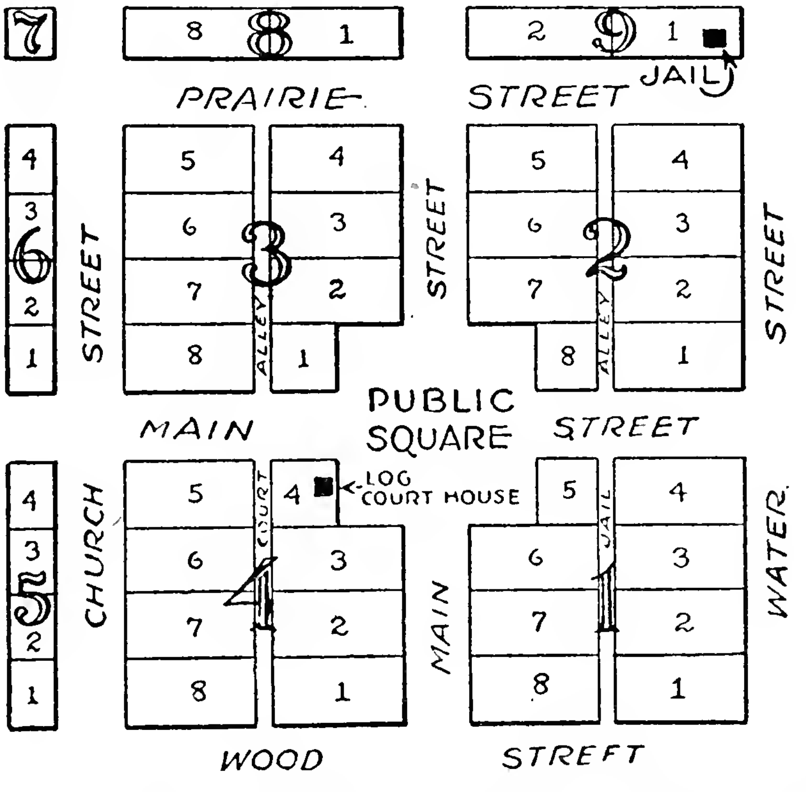
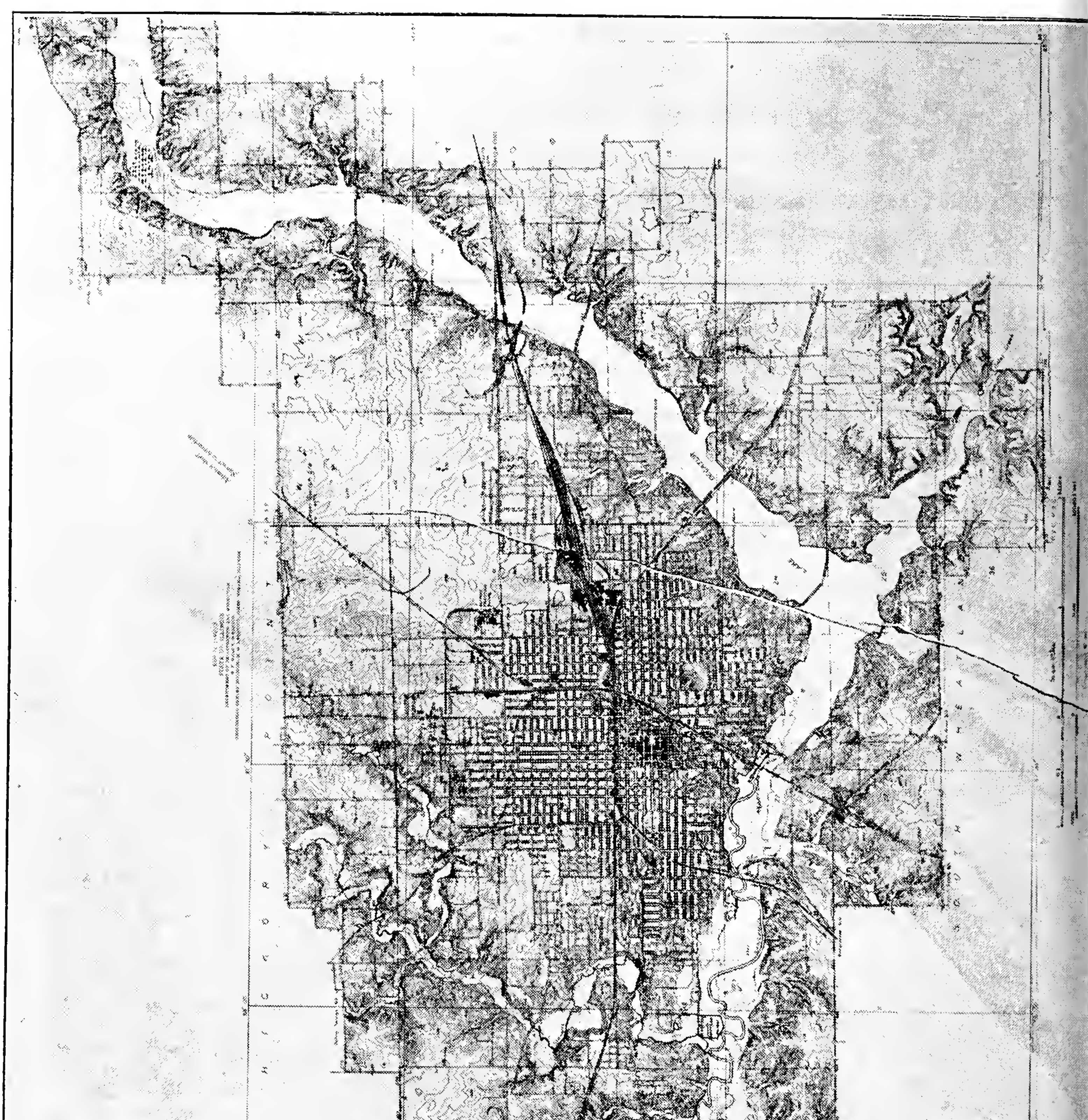


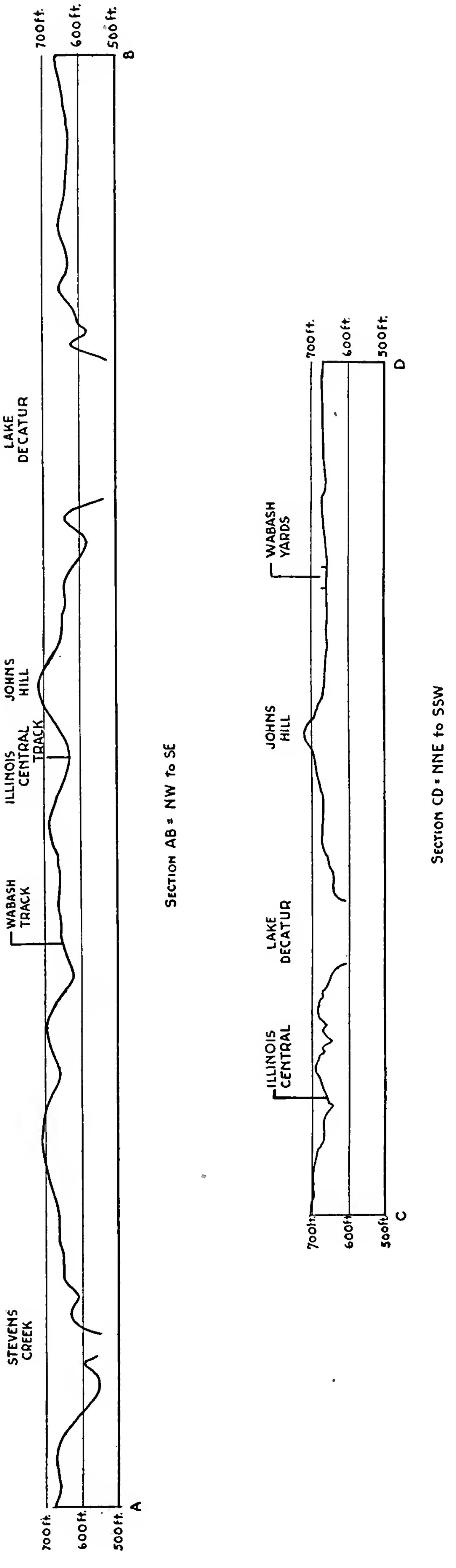
Fig. 3.—Plat of Decatur *(After Richmond, Mabel E., Centennial History of Decatur and Macon County, p. 26.)*

Macon County, which was the Springfield-Paris road. It ran several miles south of Decatur; but the route was changed, and in 1833 the Decatur-Springfield Road, which corresponds approximately to West Main Street and Route 10 of today, was laid out.[1]

In 1829 the route for a second road in this area was surveyed. This was from Shelbyville through Ward's settlement and thence across Tazewell County to the mouth of the Big Vermilion on the Illinois River.[2] The laying of east-west and north-south roads which crossed at Decatur gave an impetus to settlement so that many families were established there by the end of 1829. The territory now known as Macon County was at that time attached to Shelby County, and the county seat was Shelbyville. With the increase in the number of newcomers on either side of the Sangamon it

[1] Richmond, Mabel. Cent. History of Decatur and Macon County, Decatur Review, Decatur, Ill., 1930, p. 15.
[2] *Ibid.*, p. 21.

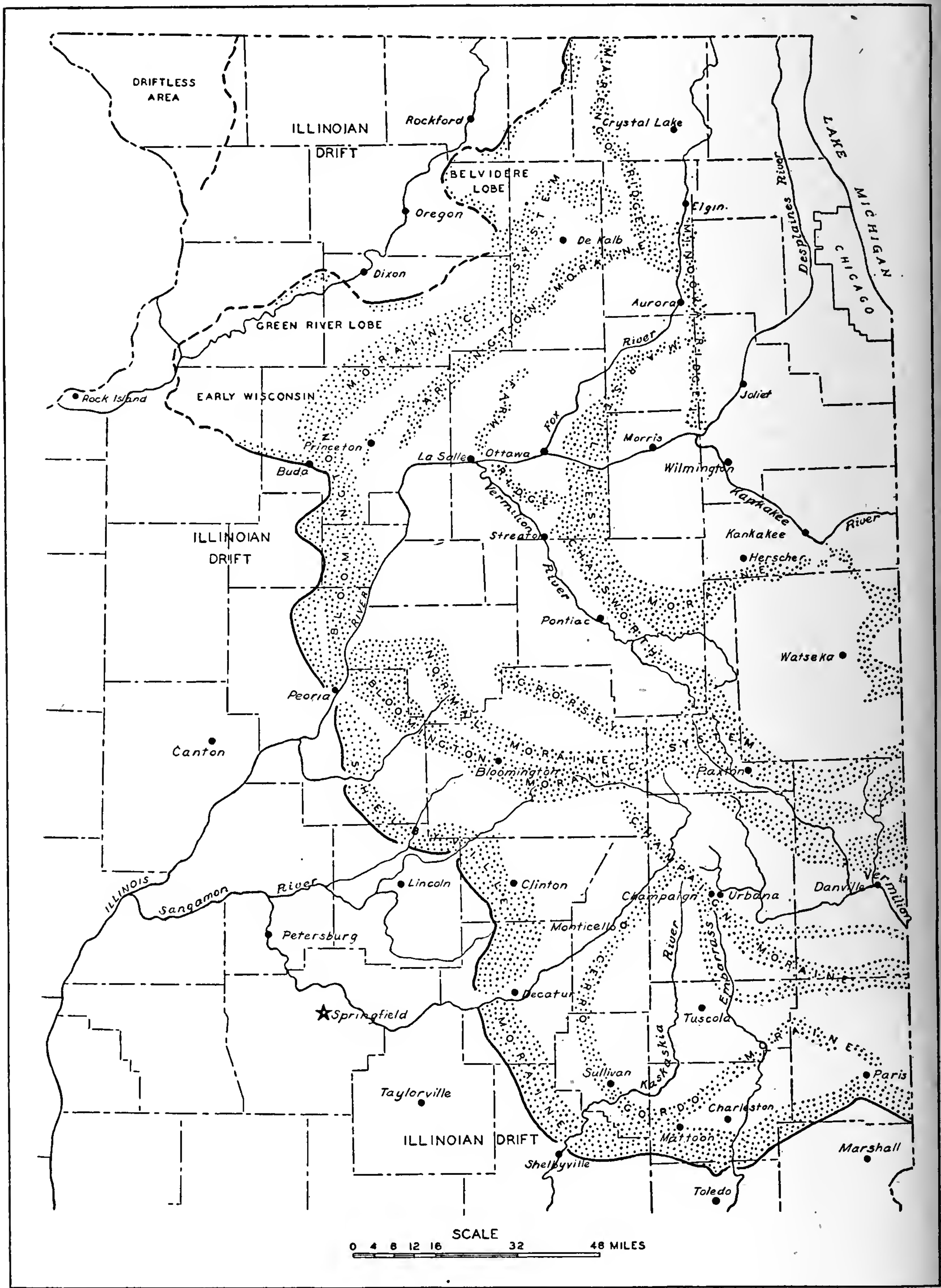




SECTIONS ACROSS DECATUR

FIG. 5.

was decided to form a new county and to have a county seat nearer home. So it came about that the original town of Decatur was platted after the



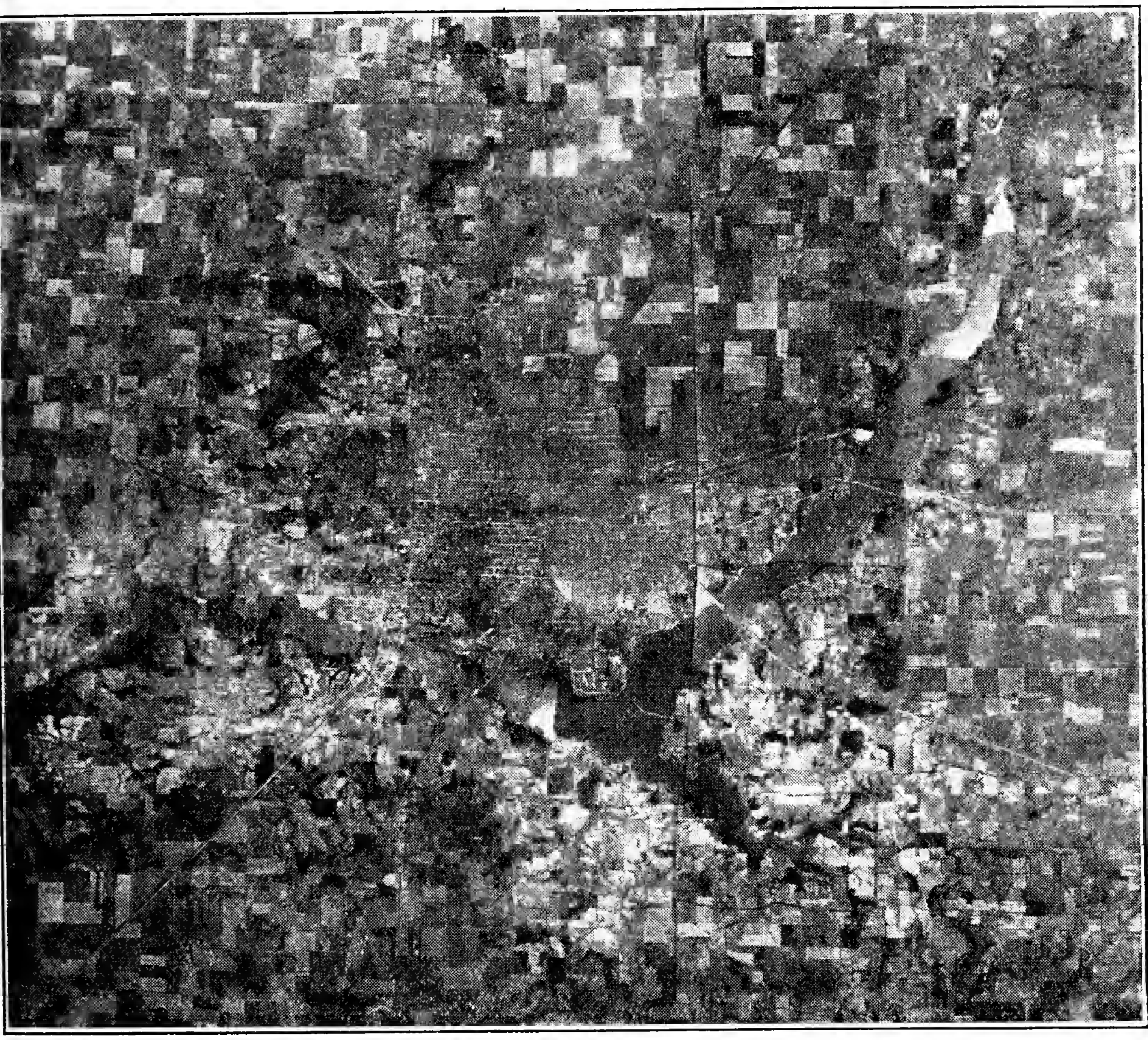
—*Courtesy Illinois State Geological Survey.*

FIG. 6.—The glacial moraines of northeastern Illinois.

form of Shelbyville (Fig. 3). The names of the boundary streets, Wood Street on the south and Prairie Street on the north, were significant, the edge of the timber reaching to Wood Street.[3]

[3] *Ibid.*, pp. 24-26.

A casual glance at the topographic map might cause one to ask why the original plat was not laid nearer the river, but closer inspection of the surroundings makes it clear that the best site was chosen. It is comparatively high, on rich soil, just to the north edge of the belt of rough timber soil which slopes down to the present lake. Much of this land is not utilized for buildings even today, and can be seen in Lincoln Park, Greenwood Cemetery, Decatur Park District, and so on (Fig. 4, Topographic Map, and Fig. 5, Profiles).



—*Courtesy Decatur Association of Commerce.*

FIG. 7.—Airplane map of Decatur and vicinity.

PHYSICAL BACKGROUND

1. Soil.—In studying the early development of Decatur the physical background is of primary importance as the most valuable natural resource—the soil—is the result of the physical conditions. These conditions are really an epitome of the glacial history of this part of the country. A discussion of the glacial geology of the Decatur area is outside the scope of this paper; it will be sufficient to state briefly that Decatur is situated on the eastern border of the Shelbyville Moraine which forms the southern and western boundary of the Wisconsin glaciation in the state (Fig. 6, Map of the Moraines of the Wisconsin Glaciation). The Sangamon valley swings round the east and south of the city, and Stevens Creek joins the Sangamon River to the west of the present residential section (Fig. 7, Airplane View of Decatur and Fig. 4, Topographic Map).

Macon County is, geologically speaking, very young, the Wisconsin ice sheet being the last to come down over the state. The soil retains a large proportion of plant foods originally present in the parent soil, and limestone, which is readily leached, is still present in abundance in the subsoil. The county soil map shows that Decatur is situated on the Upland Prairie soil of the Wisconsin glaciation. The less fertile timber soils extend along the banks of the rivers.[4] As we have seen, the early town plat avoided these and the pioneers who settled first along the streams moved on to the better prairie soil soon after the town plat was laid.[5]

The land values in Macon County are among the highest in Illinois. In 1920 when land values reached the highest peak and the average for the State was $164.20 per acre, the average for Macon County was just under $300.00 per acre ($298.99). Even in 1930 when the State average had dropped to $83.24 per acre, Macon County average stood at $142.59. Only three counties, Cook, DuPage and Lake, all of which are in the Chicago area, have higher land values than Macon County.[6]

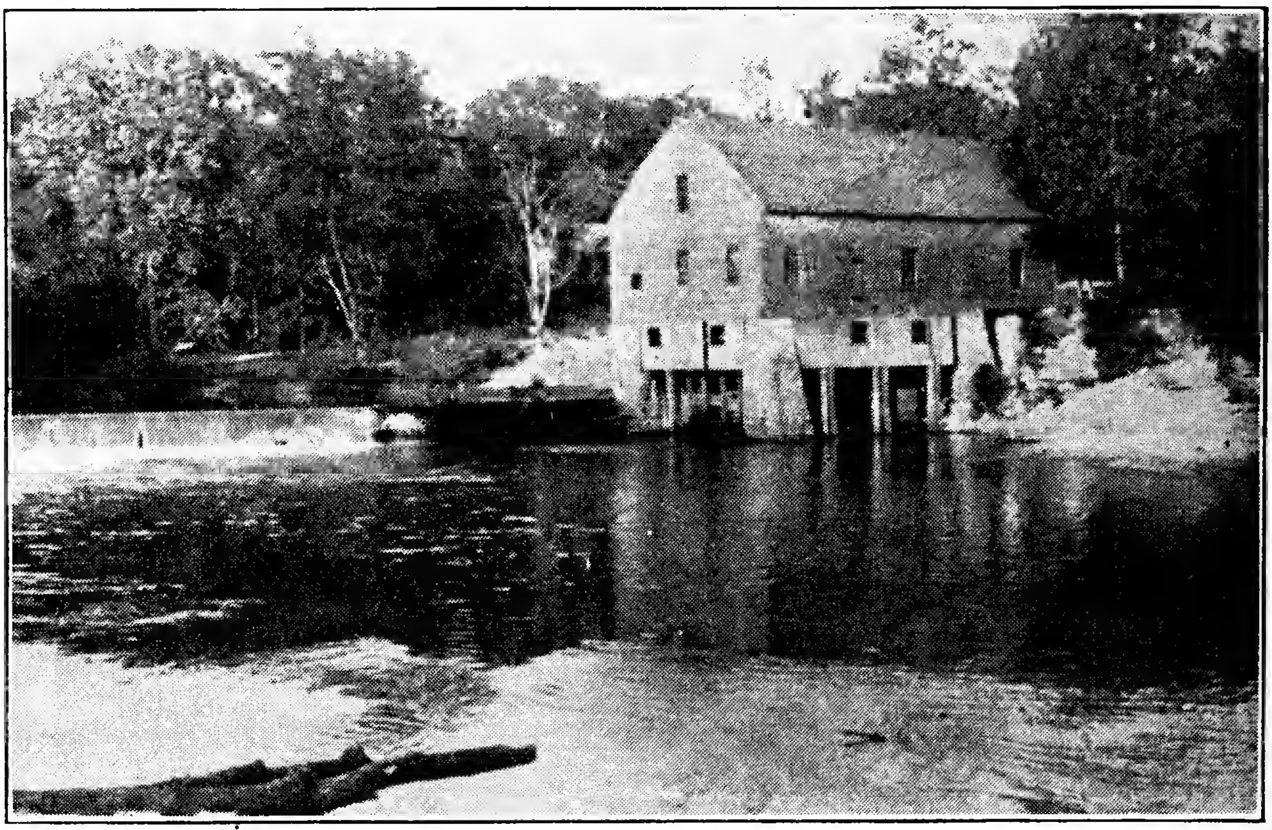


Fig. 8.—Smith's Mill.

2. *Water Supply.*—(a) *Domestic.* Decatur owes much to glaciation; in addition to the rich morainic soil put down by the ice, the glacial sands are the source of pure drinking water. There is an especially good supply of underground water in the west section of the town along the Wabash tracks, which the Polar Ice Plant and the Decatur Ice Cream Company tap. Inhabitants speak of there being an "underground lake" here, but well borings have proved it to be a lense of glacial sand and gravel. Water was also pumped from the river but towards the end of the 19th century the available supply was not sufficient for the increased needs of industrial plants in the city. Projects were considered for the damming of the river to form a lake. The floodplain of the Sangamon, 150-200 feet wide, which had developed in the sand and gravel of a valley train left by the glacial waters, was dammed in 1923 to form a lake 13 miles long, which is now the chief source of the city's water supply, as well as being of great value for recreational purposes. Enough water is impounded in this way to last the city two years without a drop of rain.

[4] U. of I. Agric. Exp. Stat. County Soil Report. No. 45, 1929.

[5] Interview with Mr. Clarence Deakins, James Millikin University, Decatur, Feb., 1934.

[6] Fifteenth Census of U. S. 1930.

(b) *Power.* Waterways were of importance to the early settlers, not only on account of the adjoining woodland but also for power, as coal was not mined until 1881. The streams were sluggish and there were no falls, so that dams were built to supply power for the mills. There were several of these for grinding grain. Smith's Mill on the Sangamon, near Mt. Auburn, about half a mile from the old Lincoln Trail, now the Springfield Post Road, ground corn and wheat (Fig. 8, view of Smith's Mill). Coulter's Mill about three miles above the headwaters of the present Lake Decatur, and remembered by some of the oldest inhabitants, was also a grist mill. There were many other small establishments of this kind along the river banks.

3. Minerals.—Mineral wealth, so great in other parts of the State, was not an early attraction in the Decatur area. At first the local timber supplies were sufficient for building material and fuel. As the village increased in size, bricks were hauled in, mostly from St. Louis and Edgar County. In 1852, however, William Martin began the manufacture of brick in Decatur.[7]

The lime and clay deposits of Decatur were accessible and sufficient for local needs until rail facilities made it possible to obtain a greater variety of bricks from Danville and stone from out-of-state quarries. Coal was first discovered in Decatur in 1874, but shafts were not sunk until 1881, when the Decatur Coal Company was organized.[8] At present the Macon County Coal Company works the one mine in Decatur, and supplies coal for domestic purposes in the city; some is also shipped out to nearby towns. The one shaft which is 625 feet deep, is at 700 South Main Street where the coal seam is 4½ feet thick.[9] The output has decreased somewhat in recent years. In 1927 it was 128,220 tons and in 1931 it had dropped to 82,274 tons. It did not operate in 1932 but now is working full time and employing 340 men.[10]

4. Native Vegetation.—Until 1830 the prairies were unsettled. In the decade 1830-1840 prairie land was commonly sold for $5.00 per acre and often less, and woodland for $35.00 per acre, as at that time timber was the only building material and supply of fuel. During this decade, however, the value of the prairies for cropland came to be realized; this fact did not affect the need for timber and the value of woodland, but by 1856, owing to the development of rail and water transportation, coal, wood and other building materials could be brought to the prairies, and land values were reversed—prairie land advanced to $50.00 per acre and the $50.00 timberland dropped to $25.00 per acre. Woodland came to be regarded as an encumbrance, and was used for grazing or cleared for crops.[11]

Growth of Decatur Before the Railroads

1. Agriculture and Early Industries.—Although the population of Decatur was scarcely 600 at the time, by 1839, several industries had been started. One of the most interesting was the ox mill for grinding corn, located where the Town Branch now crosses East Prairie Street at Broadway. An establishment which was saw mill, grist mill and carding factory, all in one, was opened in 1839. There was also a saddlery and harness shop, a distillery, and a chair factory. These few examples are sufficient to show that the early industries in Decatur grew out of the needs of the settlers in the immediate locality. Lack of transportation in the thirties made it almost impossible to obtain these necessities, much less any luxuries, from a distance. Apart from these little factories and shops, most of the people worked on the land. Crops and livestock were of primary importance, and each household had to be self-sufficient.

Review, Decatur, Ill., 1930, pp. 189 and 191.

[8] *Ibid.*, pp. 287 and 328.

[9] Interview with Mr. D. W. Beggs, General Manager, Macon County Coal Co.

[10] Information supplied by Mr. E. T. Benson, Ill. State Geol. Survey, Urbana, Ill.

[11] Telford, C. J., Third Report on a Forestry Survey of Illinois. Ill. Nat. Hist. Survey, Urbana, Ill., 1926, pp. 6 and 7.

As we have seen, it was in the decade 1830-1840 that the great fertility of the prairie came to be realized. In 1833 the first plow was invented which could cut the prairie sod. John Deere started making these, using old steel

[7] Richmond, Mabel. Cent. History of Decatur and Macon County, Decatur

saws for plow shares. He established the factory at Moline which still bears his name.[12] Crop yields of corn, wheat, barley, oats and flax were high and the indigenous blue stem grass and white clover were fine fodder for cattle; fruit and vegetables were plentiful, and from all accounts the Decatur farmers in 1840 were well fed and prosperous, so much so that they were continually agitating for means of transportation to market an increasing surplus of their farm products.

2. *Transportation.*—In the forties, Illinois had various detached beginnings of the railroads, but owing to the lack of funds none of these was completed, except the Northern Cross Railroad from Meredosia, on the Illinois River, to Jacksonville, which was extended, by private capital, to Springfield in 1842.[13] As the schemes for railroads and waterways had failed, highway travel increased with the increasing agricultural surplus. The roads, however, were very poor and there was no system for maintaining or improving them (Fig. 2, map of Illinois showing stage routes in 1851).

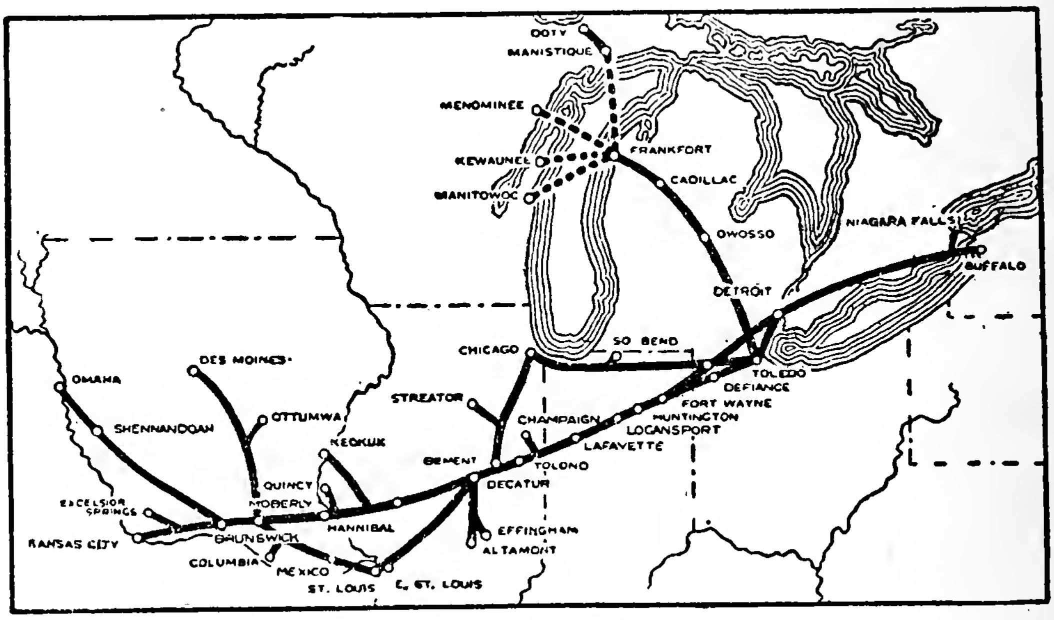


FIG. 9.—Map of Wabash Railroad.

THE COMING OF THE RAILROADS

1. *Two Main Lines Cross at Decatur.*—In 1854 the entire population of Decatur turned out to witness the coming of the first railroad train. The greatest need of this town for twenty-five years had been transportation, either water or rail, and at last its hopes were realized! The coming of that Wabash train had been eagerly anticipated for months. Two railroads had been racing to Decatur, each the extension of a large railway system. They arrived almost simultaneously, the Wabash and the Illinois Central.

As we have seen, railroad history in Illinois began with the Northern Cross Railroad in 1837, which reached Decatur in 1854. During these years another pioneer railroad was pushed to the southwest out of Toledo. The two roads were ultimately brought together and incorporated as the Toledo, Wabash and Western and was finally known as the Wabash Railroad (Fig. 9, map of Wabash Railroad).

The Illinois Central Railroad Company was incorporated in 1851, and a few years later the road was completed and in operation between Cairo and Dunleith on Mississippi River. When the first train on the Illinois Central

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[12] Information supplied by Prof. R. I. Shawl, Dept. of Agric. Engineering, Univ. of Ill., Urbana, Ill.

[13] Richmond, Mabel. Cent. Hist. of Decatur, p. 79.

line entered Decatur, the city became the crossing place of these two great lines, the Wabash and the Illinois Central. The Union Depot was built at the point of intersection, to be used by both companies. Decatur was established as a railroad center and her future was assured.

2. *Immediate Effects of the Railroads.*—The immediate effect of the railroads on the growth of the city may be seen in the population increase in the decade 1850-1860, from 600 to nearly 4,000. This increase began a few years before the railroads were started when it was rumored that the lines would pass through Decatur. The years 1856 and 1857 marked the arrival of two men whose names were to loom large in the industrial history of Decatur. These were David S. Shellabarger, who developed the milling industry, and Hieronymus Mueller, who opened a small gun shop on West Main

FIG. 10.—First map of Illinois Central Railroad (*After Richmond, Mabel E., Centennial History of Decatur and Macon County, p. 211.)*

Street where he made and repaired guns. His flint-lock gun was soon much in demand as Macon County was then well supplied with game, the materials used for gun construction being brought by rail from the Middle Atlantic States.[14] The success of these two concerns was largely due to the transportation facilities which made it possible for products of the Shellabarger Mills to be easily and cheaply marketed, and enabled Mueller to obtain materials for his gun shop, to which he soon added plumbers' repairs and hardware.

[14] Roche, J. W. Industrial Relations in Three Decatur Plants—Staley's, Mueller's and the Wabash Shops. M. A. Thesis in Economics, Univ. of Illinois., 1932, p. 3.

3. *Progress of Industry Backed by Agriculture.*—By 1860 Illinois had become the center of the agricultural life of the nation. During the Civil War the demand for foodstuffs for the Union armies, together with poor European harvests, served to stimulate prices. There was a withdrawal of a quarter of a million workers, mainly from the farms of the State, to joint the Union forces, so the use of farm machinery increased greatly.[15] Decatur, being in the midst of the richest farming section, it was there that several inventions in connection with farm machinery were made or improved at this time. Haworth invented the check rower and corn planter. Barber and Hawley opened a plant for the manufacture of gang plows, cultivators and other agricultural implements. John Beall invented his corn sheller in 1864 and started its manufacture. In 1867 a linseed oil mill was started which, together with other smaller concerns,[16] based on agricultural products and aided by good transportation, showed that industry was progressing steadily with agriculture. While the farmers were selling the products of the soil, the manufacturers were busy providing the farm implements.

The Present Day City

1. *City Expansion and Increase of Industries.*—In 1900 the population of Decatur was nearly 21,000 and by 1930 it had increased to 57,510. The population curve is a normal one, as seen in comparison with those of other U. S. cities of the same size, for example, Cedar Rapids, Iowa, and Springfield, Missouri. Along with the increase in population the city pattern has become star-shaped as a result of what is termed "axial growth."[17] During the periods of city expansion there have been adjustments to the physical conditions which have resulted in elongated star points to the east and west. A comparison of the maps of the electoral divisions of the city for 1907 and 1927 brings out this east-west extension: the industrial section on the east and the residential section on the west.

The old Union Depot, as we have seen, was built at the intersection of the Illinois Central and Wabash lines, near what was then (1855), the eastern boundary of the city. Later the Wabash roundhouse and shops utilized, as an ideal site, the level stretches of land east of the depot, along the Wabash tracks (Figs. 4 and 5). Attracted by the railroad facilities, Staley's, Mueller's, the Mississippi Structural Steel, the Decatur Brass Works, and many other industrial concerns, built their factories in this section, which is now fringed with the small dwellings of the industrial workers.

In 1900 James Millikin presented Oakland Park, on the western edge of the city to Decatur as the grounds for the university which was named after him. Later the Anna B. Millikin Home and the Art Institute were built in this district. These fine buildings with their beautiful grounds drew residents to this section who could afford to build comfortable homes in attractive gardens. Farview Park and the wooded banks of Stevens Creek add beauty to this western extension of the city, and owing to the direction of the prevailing winds, the west of the town is cleaner than the east side, the smoke and soot from the factories being carried eastward away from the city, so the star points extending out to the west and northwest are today considered the best residential sections.

2. *Growth of Industries.*—The Census of Manufactures in 1929 gave reports of 100 Decatur industrial establishments, with products valued at more than $52,000,000. Of these concerns the three that employ the largest number of workers are the Wabash Locomotive and Car Shops, the Mueller Manufacturing Company, and the Staley Manufacturing Company. As be-

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[15] Poggi, E. Muriel. Settlement and Development of the Prairie Province of Illinois. Ill. State Acad. of Sci. Trans. V. 24, No. 2, 1931, pp. 401-409.

[16] Richmond, Mabel. Cent. Hist. of Decatur, pp. 265-266.

[17] Dorau, H. B. and Hinman, A. C. Urban Land Economics, Macmillan, 1928, pp. 62-64.

fore stated the Wabash Railroad reached Decatur in 1854 and the line from Decatur to St. Louis was built in 1869. In that year the first Wabash roundhouse was built in Decatur. In 1884 the Wabash Car Shops were moved there from Peoria. Since that time Wabash interests have increased in Decatur, which has since been called "the hub of the Wabash" with spokes radiating to Kansas City, St. Louis, Chicago, and Buffalo. Through Decatur important freight is routed from Kansas City to Buffalo without entering the congested terminals of Chicago or St. Louis.

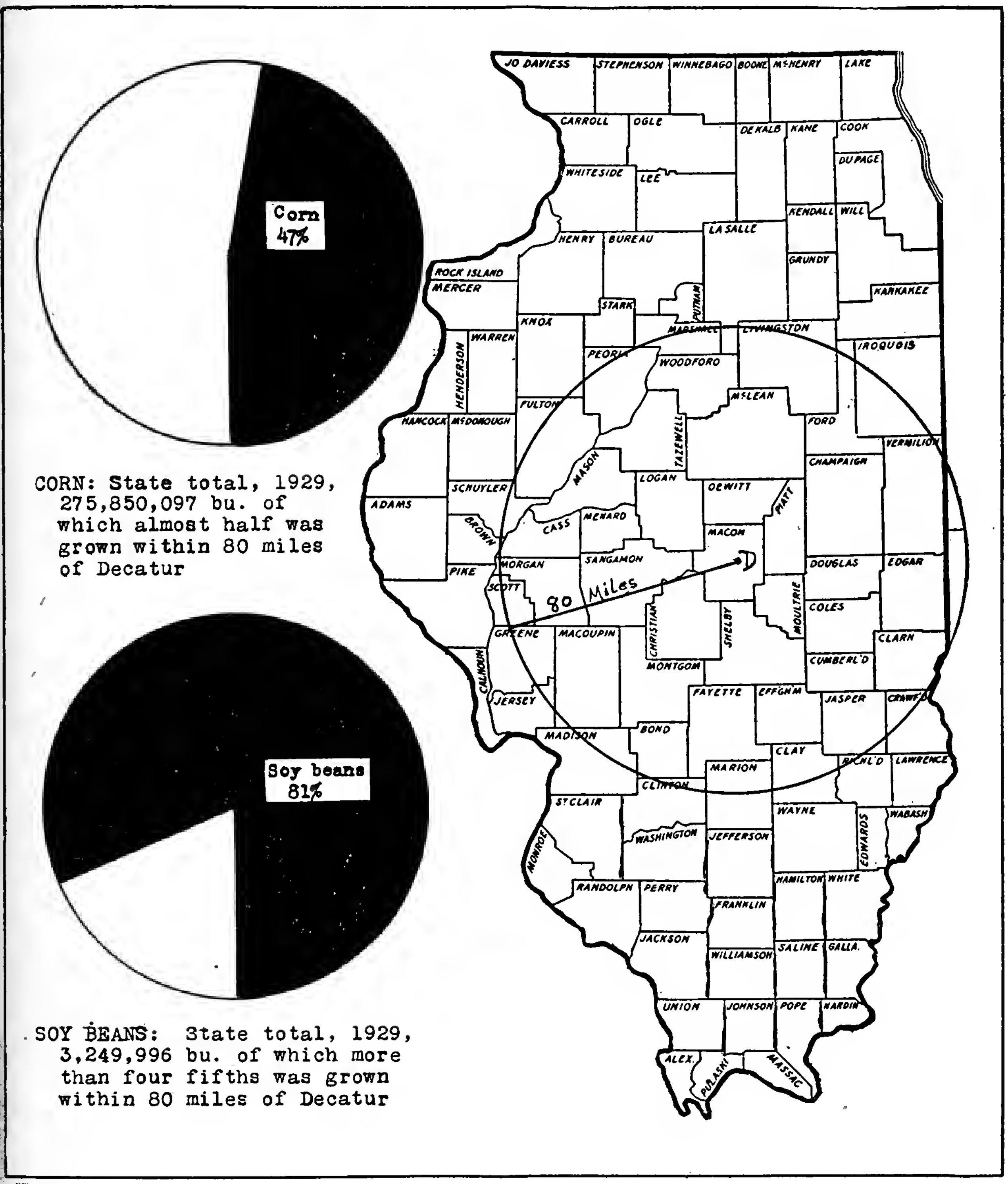

FIG. 11.—Map showing corn and soybean production within 80 miles of Decatur.

Hieronymus Mueller established his gun shop in Decatur soon after the railroads reached the city. It is largely due to the transportation facilities that this little business has become the great manufacturing plant that it is today. From gun repairs, plumbers' supplies, hardware, to his water main tapping machine, gas main taps and all kinds of faucets, the variety of products has increased, the large section which manufactures vitreous ware being one of the company's latest additions. The Mueller Company supplies what are termed "capital goods", that is goods made for long service, and requiring a small amount of material but much skill. Fuel supplies and raw materials are assembled from many distant fields, but the value added by manufacture together with favorable freight rates makes this profitable. The tonnage of incoming freight to Muellers is about nine times as great as the outgoing freight.[18]

The Staley Company was founded much later than the Mueller Company and under different circumstances. Mr. A. E. Staley bought a bankrupt factory in Decatur in 1909. Before he did this, however, he was familiar with the city and the agricultural resources of the surrounding country.[19] The original plant covered only a small acreage, but at the present time the company owns 382 acres in Decatur and 72 acres in Peoria.[20] In 1912 corn grinding operations began with a capacity grind of 1,000 bushels a day, the manufactures being pearl and powdered starch, crude oil and gluten feed. Since then other products have been added until today with a grind capacity of 50,000 bushels per day they are manufacturing, packing and shipping 70 or more varieties and fluidities of starch alone, to say nothing of many other products, such as corn sirups, sugars, paper mill products, salad and cooking oils, soy bean products, and candies.[21]

The location of the Staley plant is an excellent one from both geographic and economic points of view. The Bureau of Census Reports show that for the past 40 years the center of corn production has been in the state of Illinois, and within a distance of 60 miles of Decatur.[22] The accompanying map (Fig. 11) shows the part of the state within a radius of 80 miles of Decatur. This area produced 130,911,403 bushels of corn in 1929, or almost one-half of the corn produced in the state for that year.[23]

The manufacture of soy bean products is a recent development. It is an adaptation to the trend towards greater diversification of crops in the Corn Belt. The recent increase in acreage and production of the soy bean in Illinois is very marked. The production for the whole state in 1919 was only 23,812 bushels; in 1929 it had risen to 3,249,996 bushels, more than two-thirds of which (2,643,462 bushels) were raised within a radius of 80 miles of Decatur.[24] The grind of the industry would have been considerably higher during the last few years if the bean crop had been larger.[25]

Staley's has in operation an elevator with a storage capacity of over 4,000,000 bushels of grain; in addition transportation facilities are such that Decatur can receive shipments from all the grain receiving centers within a maximum of three days. Should there be a shortage in the local supplies, the markets of St. Louis, Chicago, Indianapolis and Peoria can supply grain to Decatur within 24 hours, while Omaha is but three days distant.

3. *Decatur as a Grain Market.*—Decatur is one of the four leading markets for Illinois corn; Chicago, St. Louis, Peoria being the others. This

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[18] Interview with Mr. E. H. Langdon, Mueller Co., Decatur, Feb. 17, 1934. Some of Mueller's supplies and their sources are as follows:

Coal obtained chiefly from Pana, Ill. and Kentucky.
Coke obtained chiefly from Indianapolis and West Virginia.
Fuel Oil is piped from Texas.
Copper from the Great Lakes Region.
Iron from St. Louis and Chicago.
Abrasives from Niagara.
Tin from Malaya via London.
Ball Clay from England.
Kaolin from Georgia.
Flint from N. Illinois near Ottawa.

[19] See Pamphlet by Staley Manufacturing Co., "To Our Better Acquaintance," pp. 1-5.

[20] Roche, J. W. Industrial Relations in Three Decatur Plants. U. of I. Thesis, 1932, pp. 7 and 8.

[21] *Ibid.*

[22] Wylie, Clifton J. Decatur as a Location for a Corn Cereal Mill. Thesis, School of Commerce and Finance, James Millikin University, Decatur, 1925.

[23] Fifteenth Census of U. S., 1930.

[24] Fifteenth Census of U. S., 1930.

[25] Information supplied by Mr. E. K. Scheiter, Pres. Staley Sales Corporation, April 10, 1934.

is largely due to the fact that Staley's Plant is located here, and also to the city's development as a distributing point for grain. Decatur was reported as handling about 25 per cent of the corn shipments from the central area during each year, as well as a considerable quantity of corn from conveniently located points in other areas, as the results of transportation facilities and low freight rates.[26]

4. *Decatur as a Route Center.*—In spite of the fact that poor transportation was the greatest drawback to the early development of Decatur, the city has become a railroad center of considerable importance in the state. Five railways serve the city; the Wabash, the Illinois Central, the Baltimore and Ohio, the Pennsylvania, and the Illinois Terminal System (electric). As we have seen, the main lines of the Illinois Central run from north to south across the state, while the Wabash lines extend generally in an east-west direction. Taking the records for a day in February, 1934, the total of all Wabash trains entering and leaving Decatur was 85.[27] On the Illinois Central lines the total number of trains passing through Decatur daily is scheduled as 22.[28] Decatur is on the lines of five state paved road routes. Two of these are Federal Routes, one being part of the U. S. Highway 51, from Lake Superior to the Gulf, and others being sections of U. S. Highway 36, from Colorado to the Atlantic.

In 1830 the farmers of Decatur were clamoring for more and better roads. One hundred years later the communication lines which converged on Decatur proved to be the city's greatest asset. Man's adjustment is seen in his development of the nodality of this rich prairie section to such an extent that industries were established that were not necessarily dependent on products of the prairie, but were attracted to, and made prosperous by that nodality.

Conclusions

It cannot be said for Decatur that its location is the result of any of the interesting physical conditions that were referred to in the opening paragraphs, but it may be claimed that the site was the result of a "geographic accident". There were no doubt many locations in the strip of prairie surveyed by the Illinois Central Company that were just as suitable for settlement as Decatur, but when the east-west line of the Wabash crossed the north-south line of the Illinois Central in 1854, Decatur received an impetus to development that was denied to the villages to the north or south.

This route convergence added value to the fertile cropland, making it possible to market an increasing surplus of grain. As industries based upon agriculture, and later, manufactures independent of agriculture, have developed, it appears that Decatur's prosperity is more dependent on the railroads than on anything else. Some cities of Decatur's size have recently become less dependent on the railroads owing to the development of bus and air transportation: Decatur cannot do this to any extent. Owing to her type of industries, the railroads are essential.

The city has suffered more than many others during the depression because of the important part played by the railroads in its economic life. Even the corn-products plant, the location of which was the direct result of the geographic environment, is now just as dependent on the railroads as any of the other industries, as it has outgrown the corn supplies of the immediate locality, and, together with the other industrial plants, depends largely upon the railroads for its existence. So although Decatur is served by an excellent system of hard roads and has the beginnings of two airports, the railroads have been, and still continue to be her salvation.

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[26] Stewart, C. L. et al. Market Destinations of Illinois Grain. U. of I. Agric. Exp. Sta. Bull. 315, 1928, p. 86.

[27] Fifty-five manifest freight, 18 local freight, 12 passenger trains. Interview with Mr. Harold Eislie, February 17, 1934.

[28] Four passenger, 4 local freight, 14 manifest freight. Information supplied by Mr. L. C. Snell, I. C. Railroad, Decatur.

THE RETARDED DEVELOPMENT OF ALASKA

BY

EMMA AYRS

Northwestern University, Evanston, Illinois

Despite the glowing accounts of Alaska's rich resources, they remain undeveloped, and the geographer naturally looks for the underlying causes.

Undoubtedly, Alaska is rich in natural resources. During the forty years preceding 1925, $500,000,000 worth of fish were caught in Alaskan waters, and up until the end of 1929, $616,000,000 worth of minerals had been mined in Alaska.

Furs constitute a third important source of wealth, wild game alone furnishing about $2,000,000 annually. Fur farming also seems to hold out unusual possibilities. The reindeer herds are increasing at the rate of 39 per cent a year and it is estimated that when the full capacity of the northern herd is reached, there will be available each year for market approximately 200,000,000 pounds. The fur seals of the Pribilof Islands are also steadily increasing in numbers.

In 1932, the timber stand was estimated to be 85,000,000 board feet and lumber cut from the National Forests on a sustained yield basis amounts to about 40,000,000 to 50,000,000 board feet per year.

Because of these resources, the outlook for the Territory has been considered brighter than that for more fully developed European countries lying in approximately the same latitude. But are these indications that Alaska is actually progressing?

In the vast area, 586,000 miles in extent, there are but 59,278 people (51 per cent of whom are Indian and Eskimo, and more than 3/5 of whom are found in the southern part of the country). In 1930, there were the same number of native whites as in 1910 and only half as many foreign born inhabitants. Native stocks alone showed an increase. Hence one questions whether conditions in Alaska are suitable for a permanent people.

Alaska as a whole has 64,000,000 acres available for agriculture and grazing, and Alaskan soils and climate permit crops of potatoes, hardy vegetables etc. It therefore seems that a closed economy might be possible though there is little hope for developing a market economy. However, if Alaska cannot attract immigrants and no dependence can be placed in the slow increase of native stocks, the development of the country will have to be exploitive.

Yet before accepting as inevitable such a distasteful prospect as mere exploitation, it is worthwhile to consider why Alaska has failed to come up to expectations. Is it because of the inaccessibility of resources, poor governmental management, the wrong type of publicity, or the character of the inhabitants?

Since each of these considerations, and perhaps others, may have some bearing on Alaska's present situation, what is a fair and impartial attitude to take? Alaska's position in the far north off of all established trade routes, its great distance from the more densely populated sections of the United States, and the great mountain range preventing easy access from the south combine to form what is probably Alaska's greatest hindrance, isolation. Nevertheless, there is no apparent reason why slow, but long continued growth should not culminate in the ultimate development of the Territory in the future when it may be much needed as an essential aid in supplying world demand.

TEN POINTS OF EMPHASIS IN THE GEOGRAPHY OF ILLINOIS

BY

W. O. BLANCHARD

University of Illinois, Urbana, Illinois

Problem: The economic importance of the state is far greater than its area would suggest. Of only average size, it is third in population and third in value of annual output of goods among the states (1933). The output is almost equal to the total of the three Pacific states and more than all six New England states combined. Why?

1. The state occupies a bridge between two of the world's greatest inland waterways, and has the lowest portage joining them. It has (1) 1,000 miles of navigable water and (2) access to the ocean via either of the two routes.

2. Its wealth and its transit position help to give the state high rank in transport facilities by land, water, and air. It ranks second in railway mileage in proportion to area, as well as in total mileage. In proportion to area and population it exceeds Germany or France. It ranks high in mileage of hard road with 10,600 miles of concrete; its roads are used by 1.6 million cars. Deep waterways projects via Mississippi and via St. Lawrence promise much greater use of the waterways. Chicago is the leading center for U. S. air line transport.

3. Topographically it is (1) level and (2) low. Third flattest state, and it averages only 600 feet, with small relief. This is important to (1) agriculture, (2) transport, (3) climate, (4) drainage.

4. The climate is favorable for people and agriculture—especially for corn. Note influence of (1) relief, (2) continental interior location, (3) latitude, (4) cyclonic storm track. Within the state variations of climate are dependent upon latitude; the southern part is warmer and wetter. A difference of 50 days exists in the average growing season from north to south in the state.

5. Soil is by far the most important resource. It is exceptionally fertile in north and center, due to (1) youth, (2) rich parent stock, (3) favorable climate. Soil in the southern part is less fertile.

6. Illinois is rich in coal, clay, sand and gravel and limestone, with modest quantities of petroleum, lead, and fluorspar. Coal underlies ⅔ of the state, accounts for over 4/5 of the total mine and quarry products, and in production usually ranks third among all states. The reserves are some larger than those of Great Britain. Though of non-coking grade, the coal is fundamental to the industrial and commercial activities. A declining petroleum production is now equivalent to over a million tons of coal a year, the water power to less than one-half million tons of coal.

7. Illinois is one of the leading agricultural states. In total agricultural output it ranks third; in proportion of the state cultivated it is second. A favorable climate, level surface, and fertile soil supply a remarkable combination.

Corn dominates the farm economy covering over 2/5 of the acreage and over ½ of the value of all the crops. Oats occupy 20 per cent, hay 15 per cent and wheat, 11 per cent (1929). These support vast numbers of swine and cattle. Dairying, confined chiefly to the north, constitutes ¼ of the cash income of all the state agricultural activities.

8. Illinois ranks third among the states in manufacturing with a net value almost twice as much as that of Canada. Manufacturing employs over twice the number of people and yields over three times the returns of agriculture.

Easy access to a great variety of raw materials and power resources as well as to great markets favored this development. The agricultural setting shows its influence in the importance of slaughtering and meat packing, farm implements and milling.

The concentration of manufacturing in the northeast, especially in the Chicago area is notable. That city accounts for about 60 per cent of the total for the state.

9. Chicago is among the four or five largest cities of the world and second only to New York in the New World. Its rapid growth has been remarkable. A century ago it was a village of about 20 houses. Almost one-half of the population of the state is in the city and it has more people than such whole states as Wisconsin, Minnesota, Iowa or Kentucky.

Its location at the end of Lake Michigan has been all important as well as its general location in a highly productive section of the United States. It is primarily industrial but commercial interests are well developed. It is the world's greatest grain, live stock, produce and lumber market as well as the leading railway and air line center.

10. Last, but not least, the presence of an intelligent, energetic population capable of exploiting the resources and improving the environment to fit man's need. Contrast the status of the region with the same environmental lay-out, but an Indian population. The possibilities for further improvement are enormous, especially in our agricultural and mining methods.

THE GEOGRAPHY OF THE TOBACCO REGION OF SOUTHERN WISCONSIN

BY

H. O. LATHROP

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Tobacco as a commercial crop in Wisconsin is a surprise to most people because the production of tobacco is usually associated with warm climates and long growing seasons. The southern Wisconsin tobacco region is an island of tobacco situated in the midst of middle latitude grains, which, in turn, are supplementary and basic to the dairy industry. The region is a small area of 500 to 600 square miles. In no part of the area is a major portion of the land in tobacco, 8 to 10 per cent being the maximum devoted to it.

Tobacco production and dairying are the primary interests of the farming population of the region. The two interests appear to work well together in their division of labor. The greatest demand for labor in the tobacco fields is in the middle of the day while the dairy industry requires most attention in the morning and late afternoon. In many ways tobacco and dairying are supplementary to each other rather than competitive.

The topography of the region varies considerably in detail in different parts. The northeast portion is characterized by low, scattered, ovoid drumlins, between which lie extensive peat bogs and marshlands. Drumlins are an inconspicuous element of the landscape in the southwestern part of the area. Much of this portion is gently rolling except that portion which extends across the hilly terminal moraine of the Green Bay Glacier. Large areas of original prairie lands are conspicuous by their dark colored soils. The gentle slopes of these prairie soils are the best tobacco lands. About 84 per cent of the land is in crops or rotation pasture. Most of the remainder is in permanent pasture and there is little idle land.

The attention of the farmer is occupied by tobacco from the building and planting of the seed beds in early spring until the tobacco is finally marketed the following winter or spring. Most of the tobacco is of special quality and is produced for cigar binders. Thin tough leaves of uniform quality and color are demanded for this purpose. Such quality tobacco is produced only when careful attention is given to the soil and topography upon which the crop is grown and to the methods of harvesting, curing, and processing the tobacco.

Labor, more than any other one factor, appears to be responsible for the present importance of tobacco in this region. The large amount of hand labor necessary in the production of tobacco and the expert knowledge and skill required to supervise the work appear to be the chief factors which fasten tobacco production on this region. At an early date numerous Norwegian immigrants settled in the region. These people were ignorant of tobacco culture. They had little money, however, to start farming for themselves. Hence, they were employed as laborers or share-men on the tobacco farms which were already in existence. In this way they learned the industry. They have been willing to do the hard, exacting, patient work required by tobacco culture in order to obtain the large returns which it gives. Today, tobacco culture is largely co-extensive with the area occupied by people of Norwegian ancestry.

ITEMS IN THE HAITIAN PATTERN OF OCCUPANCE

BY

ROBERT S. PLATT

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ABSTRACT

This is a report of reconnaissance in Haiti, focussing attention on two spots selected as typical items in the rural pattern of occupance.

One of these spots is on the coastal lowland near Léogane. Here on a shore terrace at the foot of low hills is a farm of two and a half acres. The soil is fertile alluvium. The temperature is always high, averaging about 80° F. for every month. An annual average precipitation of 45 inches is concentrated mainly in the half year from April to September. During the other half year rainfall is light and the landscape brown and dusty.

More than half of the farm is occupied by tree cotton. In appearance it is more like a thicket than an agricultural field, growing year after year without replanting. The crop is irregular in quality, but is marketable as a cash product. Another patch of ground is occupied by grain sorghum, providing the main item of food. There is also fodder for a few goats, and chickens.

The only building is a one-room hut occupied by the negro farmer and his family. Here life is reduced to simple terms, with slight provision of shelter and clothing and a semi-wild crop entering world trade.

The other example of rural occupance is in the highlands above Pétionville. It is at an elevation of 2500 feet where temperatures are lower than at Léogane, and rainfall is heavier. Here in a narrow valley is a farm of four and a half acres.

The valley bottom and part of the slope are covered by a dense growth of trees and bushes—giant forest trees, below these a mixed stand of fruit trees, and still lower an undergrowth of coffee bushes. The grove has the semblance of a thicket quite as much as does the cotton field of the lowland, although here it is green and shady even in the drier season. The coffee bushes have been planted but are perennials receiving little care. The crop is treated by the simple dry method, and is sold for export. Part of the slope is occupied by grain sorghum and there is incidental fodder for several pigs and chickens.

A house of two rooms is occupied by the negro farmer and his family. Here also life is simple with slight provision of shelter and clothing and a semi-wild crop entering world trade.

Thus two spots represent present occupance in a country of varied agricultural resources, where a highly organized colony of sugar plantations under slavery has been superseded by a less organized nation of small farms occupied by descendants of the plantation slaves.

PATTERN OF THE PORT OF VANCOUVER, BRITISH COLUMBIA

BY

LEAH STEVENS

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The Port of Vancouver, British Columbia, legally includes all of the tide water opening off the Strait of Georgia and to the east of a line drawn through Point Grey and Point Atkinson. The shoreline measures 98 lineal miles. The harbour may be divided into Inner and Outer harbours.

INNER HARBOUR

Inner Harbour, which is almost completely land-locked, is entered from the west by Lion's Gate, 2,000 feet wide. From this First Narrows the harbour widens to 2½ miles and then narrows again to 2,100 feet at the Second Narrows, approximately five miles farther east. Beyond stretches the narrower part of Burrard Inlet with Indian Arm branching northward from it.

Central Port, Harbour Proper—The Harbour Proper, which is the part of Burrard Inlet that extends to Second Narrows, is the only portion of the harbour that is being developed for deep-sea shipping. Along the south shore, from west to east, are located the major piers, wharves, docks, and elevators. Factories are scattered in the district of the major piers; sawmills and shingle mills are in the outer, eastern part.

The Canadian Pacific Railroad Company controls a frontage of 7,200 feet in the west end of the harbour from Mill Ruins to Evans, Coleman, and Evans piers near Main Street, and three of its piers, A. B-C, and D have the choice position on the waterfront. Pier H is only a little less favorably located to the east. Behind the piers are the railway yeards, approximately 700 feet wide. The station is just back of Pier D but at a higher level. In front of the tracks, extending from Pier D to Pier H are extensive quay wharves that cover about one third of the C. P. R. frontage. This company also owns a narrow strip of land and trackage paralleling the south shore of the Inlet from Port Moody on the east to Mill Ruins on the west.

Vancouver Harbour Commissioners own much of the waterfrontage east of the Canadian Pacific property. They own the old Hastings Mill site, Ballantyne Pier, Numbers 1, 2, and 3 Elevators, Lapointe Pier, and a right-of-way between the Canadian Pacific tracks and the Inlet. This property is occupied by the Terminal Railway of the Harbour Commissioners. On the north shore the commissioners own a booming ground and lumber wharf.

Private piers and slips are scattered between the Canadian Pacific property and that owned by the Harbour Commissioners or lie east of the latter property. Most of the slips are crowded into Coal Harbour in the extreme west end, a part of the harbour too shallow for large boats.

The seven exporting elevators, late in development, occupy the east half of the Harbour Proper, all but one on the south shore.

On the north shore is one elevator, one wharf, a few scattered sawmills and shingle mills, and two drydocks.

Inner Burrard Basin and Indian Arm—Inner Basin and Indian Arm are even less developed than the north shore of the Inlet. The hazards of shipping through the bridge at Second Narrows and the steep sides of the inlet, as well as the distance from the sea, have tended to restrict this part of the harbour to scattered lumber and shingle mills and oil refineries.

Outer Harbour

The Outer Harbour consists of English Bay and an arm of the sea, False Creek. English Bay has a rather uniform width of five miles but is open to the west wind so that construction of port facilities would be costly. At present it is used merely as a roadstead and pleasure bay.

False Creek is really the industrial port of Vancouver. This S-shaped arm of the sea cuts off the business section of Vancouver from the principal residential section and suburbs. The east shore has been reclaimed and is used for terminal yards and depots of the Canadian National and Great Northern Railways. The north shore is occupied mainly by the British Columbia Electric yards in the east part and by the Canadian Pacific yards in the west part. The south shore is used almost exclusively by eleven lumber and shingle mills.

Papers In Geology

Extract From the Report of the Section Chairman

Fourteen of the seventeen papers on the Geology program were presented at the section meeting. Of those given at the meeting, manuscripts were not presented for publication for the following:

"The age of the so-called Permian beds near Danville, Illinois," by Harold R. Wanless, University of Illinois, Urbana.

"Migmatization in the Sawatch Range, Colorado," by J. T. Stark, Northwestern University, Evanston, Illinois.

"The geological and biological significance of coal beds," by Louis C. McCabe, Illinois State Geological Survey, Urbana.

Average attendance at the meeting was thirty-five, maximum forty-five.

Dr. E. S. Bastin, University of Chicago, Chicago, Illinois, was elected chairman for the year 1934-35.

(Signed) Chas. H. Behre, Jr., *Chairman*

RESEARCH ON PALEOZOIC FORMATIONS IN VIRGINIA

BY

ARTHUR BEVAN
Virginia Geological Survey

ABSTRACT

Paleozoic formations are among the most important as well as most interesting rocks in Virginia. They cover more than one-fourth of the State, contain its most valuable mineral resources, and are replete with problems of great scientific and economic importance.

In recent years, the Virginia Geological Survey, partly in cooperation with the United States Geological Survey, has been attacking some of the major problems and attempting to obtain fundamental data of value to science, to industry, and to well-planned community living.

Field work on the first stages of several significant lines of research has been partly completed. A geologic map of the Appalachian Valley in Virginia, on a scale of 1:250,000, was published in 1933. It shows about 60 formations having a total maximum thickness of about 55,000 feet. Several interesting structural features and patterns have been discovered. A comprehensive report is being prepared. Detailed studies have been made in several widely separated districts in the Valley, resulting in much additional information on stratigraphy, structure, sedimentation, ore deposits, and other resources. Many important problems, chiefly of a research nature, are still to be carefully investigated and solved.

Some research studies have been made upon the remnants of Paleozoic sedimentary formations and upon Paleozoic igneous rocks in the Virginia Piedmont, with new interpretations of paleogeography, geologic history, and ore deposition.

A FOUR-HUNDRED ACRE LAKE DISAPPEARS

BY

Clarence Bonnell

Harrisburg Township High School, Harrisburg, Illinois

The geolological map of Hardin county, Illinois, shows alluvium deposits covering an area of approximately 700 acres lying mainly in sections 2 and 3 of Township 12 South, Range 9 East. Bulletin No. 41 of the State Geological Survey, "The Geology of Hardin County, Illinois," says, "in a considerable area northwest of Cave in Rock, * * * the drainage is underground through sink holes. * * * It is dotted with sink holes which must connect with underground stream channels which find their outlet through numerous small springs in the county."

Many of these depressions lie in view from the main highway for the first five miles of the distance from Cave in Rock toward Elizabethtown. They may be seen on either side of the road. Others are out of sight in the area lying between this public road and Ohio River which is two and a half miles away. Some sinks are dry, others are dry in some seasons of the year, while still others are permanent ponds or small lakes. Some are small pits as deep as they are broad and many are several rods across. About forty small lakes are shown on the map in addition to the many dry holes through which the rainfall goes directly.

The alluvial area in sections 2 and 3, lying three miles northwest of Cave in Rock, occupies a depression which at times is drained through sinks within it. After a time these outlets become clogged, so that a body of water collects and forms a lake estimated to have an area of 400 acres and a depth of ten to twenty feet. The lake frequently persists through the greater part of a year, sometimes two years, although there are seasons when a crop of corn may be grown on the fertile lake bottom.

In the autumn of 1933, the water drained out completely after remaining for quite a long period. Several truck loads of fish were gathered up and taken to more permanent waters. Catfish predominated, though quite a number of good sized bass were taken and returned to a mine reservoir from which they are thought to have escaped.

My own observations, made at intervals over a period of twenty five years, are that the lake has been in evidence most of that time.

Following the complete emptying of last autumn, it began to fill in midwinter and occupied 80 to 100 acres by April first. Word received near the end of April from a resident whose land is overlapped by the lake was to the effect that the water was going out again.

If this basin would remain permanently dry, some fine corn land would be reclaimed. If it would remain full of water, it would become a valuable fishing and boating resort.

I have found no evidence that the large body of water which leaves so suddenly at times ever finds a final outlet through springs. This leads to the theory that there must be underground channels to the Ohio River which lies at a lower level than the lake bottom. There has been talk of trying to drain the area permanently by cutting a channel through the higher ridge which lies between the basin and the river. The cost might be prohitive. It would be interesting to learn what underground passages might be revealed if such were attempted. The Fredonia limestone, as before stated, has numerous sinks between the river and the lake basin.

The famous cavern at Cave in Rock is thought by some to be the remnant of an outlet from a small basin at the rear of it which now has a surface stream.

THE GLACIOLOGY OF THE DECATUR REGION

BY

M. M. Leighton and G. E. Ekblaw

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ABSTRACT

The drift deposits of the Decatur region have a maximum known thickness of 222 feet and are probably to be referred to three of the ages of the Pleistocene period—the Kansan, the Illinoian, and the Wisconsin. The bedrock surface beneath the drift probably represents a maturely eroded topography developed in "Coal Measures" strata in late Tertiary time. The maximum known relief of this surface, based on well records, is 117 feet. There are no rock outcrops in the Decatur region.

The Kansan drift is not exposed in the Decatur area, but its presence is inferred from numerous exposures south of the Wisconsin terminal moraine. An old coal shaft record from Decatur reports a black soil at a depth of 73 feet. This probably corresponds to the black soil (Yarmouth) exhibited at the top of the Kansan till in exposures further south.

Illinoian drift, covered by 2 or 3 feet of gumbotil and a black soil is exposed in a recent low, wave-cut cliff on the east side of Lake Decatur, at a point just south of State Highway No. 10. There may also be other outcrops further south along the east shore of Lake Decatur. That the Sangamon River valley below Decatur dates back to the Sangamon interglacial age is shown by its greater development west of the Shelbyville moraine and by the old slope of the valley wall with its Sangamon soil on the north side of the river at the site of the dam.

Iowan loess, about 2 feet thick and yellowish in color, is present above the old Sangamon soil in the exposure described above. Its occurrence here so far from the Illinois valley is somewhat surprising, but it may be related to the old Sangamon River valley.

The Wisconsin drift terminates about 7 or 8 miles west of Decatur which is situated on the inner edge of the Shelbyville moraine. In general, the moraine has a gently undulatory topography with a relief of 75 to 100 feet above the Illinois plain. Deposits of coarse, poorly sorted, poorly rounded gravel with foreset bedding suggesting torrential deposition, are exposed along the valley wall of Sangamon River. In sharp contrast to this is an exposure of a low valley-train terrace of finer, better rounded gravel. This valley train probably belongs either to the Cerro Gordo or to the Champaign moraine to the northeast.

Loess, generally 3 or 4 feet thick and locally fossiliferous where thicker, covers the drift in the Decatur area and is commonly leached down a few inches into the till.

The Wisconsin materials have been altered to a youthful profile of weathering, the Sangamon River has cleared away most of its terrace gravels, and short stubby tributaries of third or fourth order have begun their invasion of the adjacent uplands.

Situated as it is on the terminal moraine of the last ice sheet, and marked by good exposures of different types of glacial deposits and by deposits of older drift sheets and interglacial soils, Decatur affords a splendid opportunity to science teachers for the development of education along sound lines in natural science.

NEW AMERICAN PLANTS FROM THE PENNSYLVANIA PERIOD AS PRESERVED IN COAL BALLS

BY

A. C. NOÉ

University of Chicago and Illinois State Geological Survey

Of the various coal ball localities in Illinois, Indiana, and Texas from which I have made collections, two are almost completely worked up. The first one which has been examined is at Harrisburg, in Saline County in southern Illinois. There, in a now sealed-up mine located in the No. 5 coal seam of Illinois, excellent material was found which has been described by various of my students and friends as well as by myself. The second locality which is also located in an abandoned mine, but in a not yet fully determined, comparatively young coal seam is that of Calhoun in Richland County, Illinois. More than three hundred coal balls from Calhoun have been sectioned and given a preliminary examination. Quite a number of these have been selected for detailed research. During the academic year 1933-34 the following persons besides myself have been occupied with the Calhoun coal balls: Roy Graham, whose doctor's thesis, "Pennsylvanian flora of Illinois as revealed in coal balls, I", appeared in the Botanical Gazette of March, 1934, and Miss Mary Ellen Underwood, whose master's thesis, entitled "Morphology of some Illinois Coal Ball Plants", has been prepared under the supervision of Professor Paul J. Sedgwick in the department of Botany at the Graduate School of Syracuse University. A previous master's dissertation entitled "Morphological Studies of some Illinois Coal Ball Plants" was presented at Syracuse University in the spring of 1933, by Miss W. Louise Crocker.

Our investigations of Calhoun coal balls during the past year have added considerably to our knowledge of the coal ball flora of Illinois. Dr. Graham established in his above mentioned paper six new species and one new genus which had not been known previously, either in America or elsewhere. The new investigations brought to light additional facts about the Cycadofilicales and the Filicales in particular, while the existence of Amyelon radicans, the root of Cordaites, was established for America by Miss Underwood. She also found additional information on the well-known Cycadofilicalis *Heterangium grievii*, and its probable seed Sphaerostoma ovale. Entirely new Cycadofilicales seeds which were described by Roy Graham are *Conostoma platyspermum* and *Conostoma quadratum*. He found also a new microsporangium, *Telangium pygmaeum*, and he established the following new species of fern sporangia: *Notoschizaea robusta*, *Scolecopteris latifolia*, and *Scyathotrachus bulbaceus*. Miss Underwood photographed some excellent cross sections of the petioles of *Botryopteris forensis*. Additional material on Sphenophyllum, Psaronius, and Myeloxylon was found by all of us. One of the coal balls which I examined happened to be cut along the axis of a thick stem of Medullosa showing the branching. There are still quite a number of Calhoun coal balls which need detailed examination. As soon as this is done material from another locality will be studied and gradually our knowledge of the coal ball flora of the Illinois-Indiana-Kentucky basin will give us a fairly complete picture of the vegetation which formed the coal seams of this big basin. Dr. Graham took a number of Calhoun coal balls to Cambridge, England, and studied them in Professor A. C. Seward's laboratory. A paper containing these studies was recently received by the Botanical Gazette.

:FFECTS OF BAROMETRIC PRESSURE AND WINDS ON THE LEVEL OF LAKE MICHIGAN

BY

W. E. POWERS

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Although most persons know that Lake Michigan fluctuates 3 to 5 feet ı level over a period of several years, due to periodic variations in annual recipitation, few are aware of the sharp fluctuations that occur from day ɔ day or even from one hour to the next. Figures 1 and 2 show the hourly ɘvels of Lake Michigan as recorded during February, 1933, at Calumet Iarbor, Indiana, and referred to the low-water datum (579.6 ft. A. T.) Two f the larger fluctuations are particularly striking: a rise of 1.93 feet in 1 hours on February 5 to 7, and a rise of 1.22 feet in 4 hours on February 0 to 21, 0.79 feet of this rise occurring during the first hour. During this ıonth the extreme fluctuation was 2.56 feet which occurred within 5 days. 'he conditions of February, 1933, are quite typical.

The several factors which collectively control the level of Lake Michigan re precipitation, withdrawal of water through the Chicago Sanitary System rainage channel, evaporation, true tides, barometric pressure, winds, and ɘiches. These controls differ in their relative values.

Precipitation cannot account for the sudden changes in level indicated ı figures 1 and 2. No precipitation occurred during the rise of 1.22 feet on 'ebruary 20 and 21, and only 0.094 feet of precipitation during the rise of .93 feet on February 5 to 7.

Withdrawals through the Chicago Sanitary Canal are relatively contant, but differences from day to day should lead to slight changes in lake ɘvel. The maximum day-to-day difference during January, 1933, amounted ɔ 1,950 second feet; the depressing effect of this, if spread over the southern alf of the Lake Michigan basin would amount to 0.00055 feet, or over the ɔuthern quarter of the lake basin, to 0.0011 feet per day. The withdrawals re too small and too slow to account for the fluctuations in level.

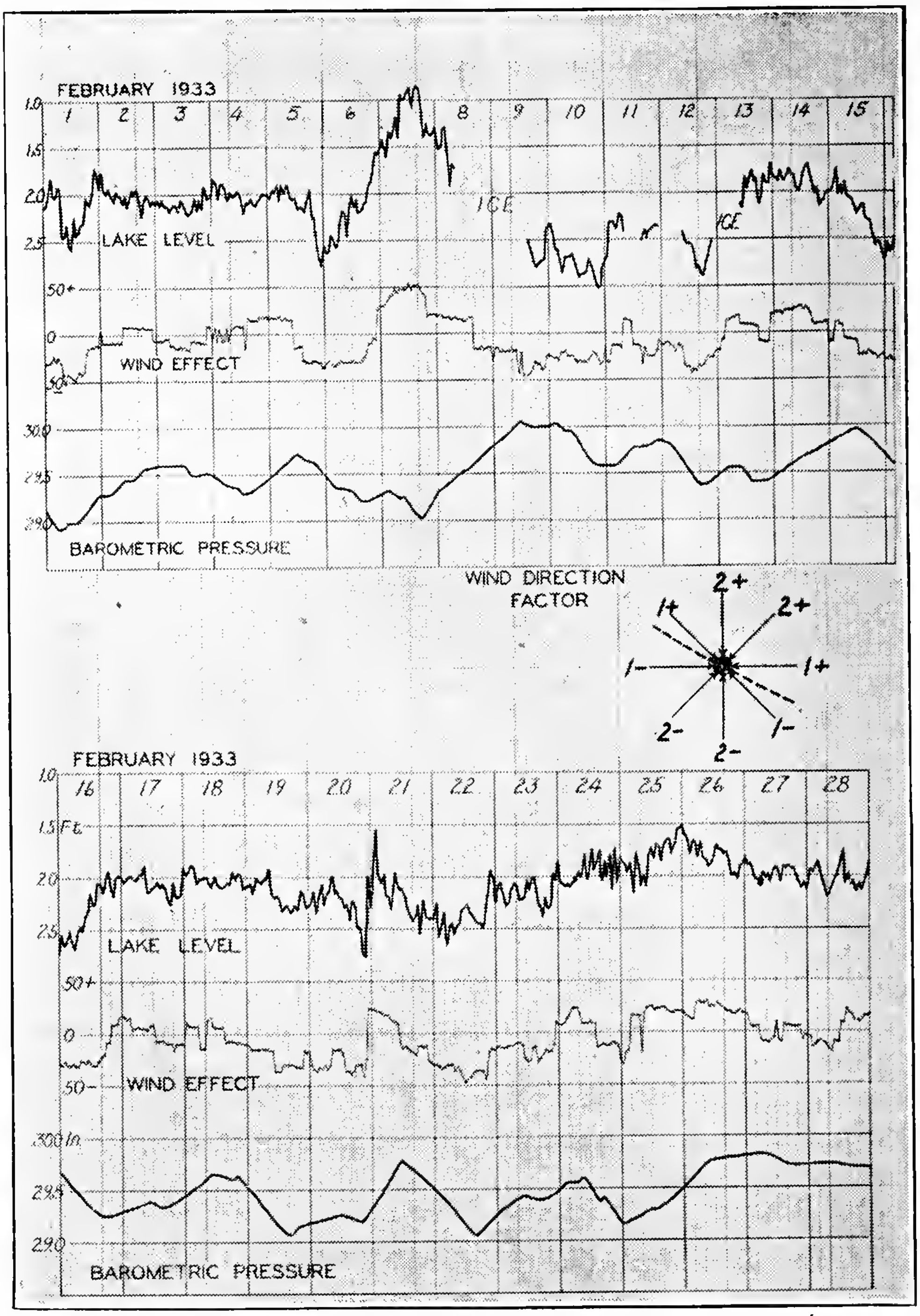
Evaporation from the surface never exceeds 0.021 feet per day, according ɔ Hayford, and therefore evaporation can account for no considerable part f the daily and hourly fluctuations in lake level.

The true tide at Chicago gives a maximum range of oscillation of 0.14 ɘet. The short period fluctuations (Figs. 1 and 2) are (1) too great to be aused by tides, and (2) do not show the periodicity characteristic of tides.

Barometric pressures should affect the lake level in an inverse relationhip. The curve of barometric pressure in figures 1 and 2 shows this inverse ɘlationship on some dates, notably February 7; but it shows a direct ɘlationship at many other times, as on February 1. The "improper" relationhips generally occur when the lows and highs pass to the north of Chicago, ıus inducing winds that oppose the effects of the barometric pressure.

Wind effects on the lake level during February, 1933, are very marked. earing in mind the west-northwesterly trend of the shore at Calumet Harbor nd the probable effect of winds in piling up water or repelling it, the writer rbitrarily assigned to the 8 major wind directions the values indicated in ıe wind rose in figure 2. By multiplying the wind velocities by these wind irection factors the wind effects from hour to hour were computed and lotted in the wind effect curve shown in figures 1 and 2. The close corresondence between this curve and that for the lake levels is marked and ıdicates that the winds are a major cause of short-period fluctuations.

Seiches are free oscillations of the lake water under the influence of inertia, initiated by changes in distribution of the lake water. The seiches and seiche areas of Lake Michigan have never been carefuly worked out but their importance is unquestioned. Unexplained residuals left after computing the effects of the other factors may represent the effects of the seiches.



—*Courtesy Northwestern University.*

Figs. 1 (above) and 2 (below). Hourly levels of Lake Michigan at Calumet Harbor, Indiana, during February, 1933, referred to low-water datum. Wind effect computed from records of U. S. Weather Bureau in Chicago. Barometric pressures recorded by microbarograph at Northwestern University.

The surprisingly large short-period fluctuations of the water surface of Lake Michigan correlate best with the wind direction and force, and more poorly with barometric pressure. Precipitation, withdrawals, evaporation and tides individually exert only a very slight control. Seiches are an important factor as yet never accurately evaluated for Lake Michigan.

CLAY-VEINS IN THE SPRINGFIELD (NO. 5) COAL

BY

W. B. ROE

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As found in the Canton area, the clay-veins in the Springfield (No. 5) al are made up of clay, shale, sand, or sandstone, in varying degrees of in- ıration, containing isolated masses of coal, roof slate, marine limestone prock, iron oxide concretions, calcite, pyrite, sphalerite, and galena. The aterial in the shale or clay type is usually of a light gray color, with a ry fine grained texture. Microscopical examination of the clay from the ins shows a predominance of very fine quartz grains and clay flakes, with inor amounts of muscovite.

Veins of the sandy variety closely resemble the typical Pennsylvanian, icaceous sandstones. The material in this type of vein is predominantly a ıe to medium grained, yellow to gray sandstone. This variety of vein is uch more resistant to weathering than the clay variety and is usually ırder in the original unweathered state.

In the clay type, considerable mineralization has occurred in the form of cementation or replacement of a part of the clay by pyrite. Sphalerite and ılena occur as well developed crystals, often an inch or so in diameter, but ɔt in disseminated masses. Calcite is more common in the sandy variety, ıt all unweathered veins are somewhat calcareous.

The veins may intersect the coal bed at any angle, but the more general titude is at high rather than low ones. They are very irregular in trend, ze, and shape. Their thicknesses vary from that of paper to a dozen feet. he walls in many cases show a distant matching, as though they had been rn apart. They are usually more regular in shape and trend in the roof ate or limestone than they are in the coal.

The clay and coal show distinct evidence of movement within the clay ass as well as between the clay and the coal.

The strikes of the clay-veins agree fairly well with the strikes of joints the roof slate and the limestone caprock, as well as with the strikes of eats in the No. 5 coal. All of these features, however, vary greatly in rike from place to place, with the varying strike of the rock. This evidence ems to indicate that the clay-veins are of tectonic origin.

The fact that the clay-veins are never observed penetrating through the ıderclay beneath the coal, and the distinct difference in type of material aking up the clay-vein and the underclay point to a place of origin for the aterial filling the veins either in or above the coal seam. The presence foreign material, derived from the strata above the coal, in the veins where ıey cut the coal, indicates that the clay originated above rather than within ıe coal seam.

THE PORT BYRON LIMESTONE AND ITS FAUNA

BY

T. E. SAVAGE

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It has long been recognized that a part of the Racine limestone, as developed at Racine, Wisconsin, and in the vicinity of Chicago, Illinois, contains some fossils that are characteristic of the Guelph limestone at Guelph, Ontario, and in New York. However, the coral-reef development of the typical Racine continued without apparent interruption to the end of Racine deposition, and there seems to be no place to divide Racine strata that would separate the part that contains the Guelph species from the part in which these species are absent.

In the northwest part of Illinois there is exposed in a quarry near the village of Port Byron, a Niagaran horizon belonging to a level higher than that of the Racine limestone in the vicinity of Racine or Chicago. During Port Byron time the coral reef conditions appear to have prevailed without a break. Pockets in the reef rock, and on the flanks of the reefs, contain a rich fauna of species other than corals, most of which are not found in the Racine limestone, nor are they known in any other formation except the Le Claire of Iowa.

Among this unique fauna from Port Byron there have been described several new genera and about seventy-five species of cephalopods, and the writer has a dozen or more species of brachiopods and mollusks, none of which occur in the Racine limestone, or in any other member of the Niagaran limestone at any known locality.

This large number of fossil species that seem to be restricted to the Port Byron limestone might be accounted for in two possible ways. It might be assumed that, as this limestone is younger than the Racine, it might originally have been deposited widely over this region, and that it has been removed by erosion over all Illinois except in the vicinity of Port Byron. An alternative explanation might assume that the Port Byron locality was situated in a different marine province from that in which the Racine limestone in the northeast part of the State was deposited.

During Edgewood time the Essex limestone on the east side of the LaSalle anticline, was represented by a similar limestone that occurs at the base of the bluff of Silurian limestone a short distance north of Savanna. The *Stricklandinia pyriformis* zone that, in the vicinity of Savanna, is found about forty feet above the base of the Silurian, occurs at a corresponding horizon on the east side of the anticline near Joliet and St. Charles. The limestone quarried extensively in the river bluff between Port Byron and Fulton, in western Illinois, appears to be the Waukesha limestone.

The above facts make it seem more probable to the writer that the Niagaran limestone in the northeast and the northwest parts of Illinois was deposited in the same marine basin, and that these areas have since been separated by the erosion of the Silurian strata from the top of the anticline in the north-central part of the State.

Neither of the foregoing assumptions explains the source or origin of the Port Byron fauna. It seems certain that it could not have developed from the earlier Racine fauna in this region, for the latter fauna does not contain species from which the Port Byron forms could be expected to have evolved.

Forms ancestral to these species are not known from any other region or provinces of the Niagaran, and the explanation of the source of this fauna must wait a more complete knowledge of the Silurian history.

STRUCTURAL CONTROL OF ORE DEPOSITION IN THE WISCONSIN-ILLINOIS LEAD-ZINC DISTRICT

BY

E. R. SCOTT AND C. H. BEHRE, JR.

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Recent studies conducted under a grant from Northwestern University ave developed certain facts, hitherto inadequately recognized, that bear pon the direction of movement of the ore-depositing solutions in the Wis-nsin-Illinois lead-zinc district.

Most earlier workers regarded the "oil rock" as a definite stratigraphic orizon, immediately above the phosphatic bed in the basal Galena dolomite. Galena" as here used includes the Guttenberg and higher members of Kay. his phosphate horizon and the bentonite five feet below it are apparently ependable key horizons. "Oil rock" resembling that of the Platteville ction occurs below both of these key horizons in mines at Dodgeville, Wis-nsin. Thus the "oil rock" is a recurrent sedimentary facies, rather than constant horizon. Its general association with ore is significant.

Superimposed on the southward regional dip are numerous small east-ending basins bearing much of the ore. Drill data, furnished by the Vine-r Hill Zinc Company, and recent detailed mapping shed more light on ese basins. Strata immediately beneath the "oil rock" show dips like those the "oil rock". Smaller basins seen underground exhibit no differential mpaction. These facts suggest that even the larger basins are not attribut-le to unequal compaction of "oil rock", but rather to its deposition on regular topography, with subsequent accentuation of primary irregularities tectonic movements.

"Crevices" (vertical ore veins) were restudied. Two pronounced fracture stems trend northeast and northwest respectively, as recognized by earlier ologists. Such a pattern also agrees with the tectonic interpretation of the sins mentioned above.

Faults, though not hitherto reported, were found in the mines. Two neral types occur. In the Trewartha mine (west drift), a steeply north-pping fault strikes northeast. It offsets the bedding and an earlier fault out one foot vertically, and is marked by a conspicuous breccia zone. A ore common type of fault, illustrated in the south drift of the Crawford ine, represents compressional fracturing of a bed, with relative shortening ong the bedding; the plane is zig-zag in vertical section, crossing the beds, en appearing to continue parallel to the bedding, and higher still crossing e beds again. Examination of faults of this type excludes assigning them (1) solution of underlying layers and collapse or (2) dominantly hori-ntal movements on steep fault planes.

The following conclusions may be listed:

1. Contrary to earlier statements the ore does not necessarily occur above shaly "oil rock".
2. Ore is commonest near (in, above, or below) "oil rock": this suggests deposition not through ponding but because of reducing action of bitumens or hydrogen sulphide in the "oil rock".
3. The basins are due to primary irregularities in deposition and subsequent tectonics, yielding the two fissure systems mentioned.
4. There are true faults definitely recognizable, offering channels for passage of ore solutions through shaly horizons. This weakens the argument which, because ores commonly occur above allegedly impervious "oil rock" and shales, assigned ore deposition to decending waters.

OVOVIVIPAROUS REPRODUCTION OF MIOCENE TURRITELLIDAE

BY

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ABSTRACT

The discovery of 48, apparently embryonic, shells closely packed in one whorl of a large specimen of *Turritella alumensis* Mansfield from the Choctawhatchee (Miocene) formation at Alum Bluff, Florida, increases our knowledge of reproduction in this genus. Thirty five years ago Frank Burns[1] reported the occurrence of embryonic shells in specimens of *Turritella cumberlandia* Conrad and *T. indenta* Conrad from the Miocene beds at Plum Point, Maryland. Not enough information on the reproductive habits of *Turritellidae* was available at that time to allow comparison of fossil with modern forms. Recently Dr. Marie V. Lebour[2] has reported on the eggs and larvae of *Turritella communis* Lamarck, a living oviparous species.

The 48 small shells are all essentially the same in size and stage of development. Each is approximately 2.5 mm. in length, from 1.6 to 1.75 mm. in maximum width and consists of the protoconch and three spiral whorls. There are no signs of abrasion on the shells, each preserving the spiral shell sculpture of the species.

There are four possible explanations of the occurrence of the small shells in the large individual: (1) they may have hatched from eggs deposited in the large shell after death of the large individual, (2) they may be the remains of young which of their own accord crawled into the large shell after death of the large individual and there perished, (3) they might have been washed into the large shell after death of all forms or, (4) they may represent unborn young.

The position of the small forms in the large shell, the similar size and stage of development of all the small shells, their unworn character, and the absence of this species or others of similar size in any other portion of the large shell or in the sediment surrounding, adhering to, or filling other shells of the collection seem to eliminate from consideration all of the hypotheses of origin except the last.

The conclusions reached as a result of the study are: (1) these shells are embryonic, the mother having died before birth of the young and, as the body decayed, fine sediment filled the large shell preventing any wear or destruction of the small forms, and (2) *Turritella* during its evolution from the Miocene to the present either has undergone important modification of the reproductive method, the development of an oviparous from an ovoviviparous habit, or the fossil Miocene forms, called *Turritella*, were not as closely related to living species of *Turritella* as formerly has been supposed.

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[1] Burns, Frank, Viviparous Miocene Turritellidae. The Nautilus Vol. XIII, No 6, pp. 68-69, October 1899.

[2] Lebour, Marie V., The Eggs and Larvae of *Turritella communis* Lamarck and *Aporrhais pes-pelicani* (L). Journal of the Marine Biological Association of the United Kingdom, Vol. XVIII, No. 2, pp. 499-506, Jan. 1933.

THE INTEGRATION OF SCIENCES REQUIRED FOR A LOGICAL STUDY OF COAL

BY

GILBERT THIESSEN

State Geological Survey, Urbana, Illinois

Because coal is a heterogeneous mixture of chemical compounds formed from botanical structures by biological means, the whole metamorphosed by physical forces exerted by geological processes, a study of coal requires the application of all of the natural sciences.

The fact that in spite of the vast literature on the subject, we know relatively little about the fundamental properties of coal is caused by the fact that the data contained in this literature represent mainly the viewpoint of only the particular science used by the investigator, or, indeed frequently the viewpoint of only a very specialized part of that science. Among others, the sciences of geology, petrology, paleontology, botany, chemistry, bacteriology, and physics are concerned in the study of coal. Findings of each science must be critically reviewed in the light of other sciences. Failure to do this has often led to erroneous conclusions. For example, certain chemical work has been put forth in Germany, purporting to show that cellulose rather than lignin is the substance from which coal originates. The argument is that coals artificially produced from lignin show cell structure, while those from cellulose do not; natural coals showing no cell structure in the woody tissue are therefore derived from cellulose. This argument entirely rejects the findings of biologists who have shown that the cellulose in wood is readily destroyed by decay while lignin is stable; of peat investigators, who have shown that cellulose is exceedingly rare in the lower parts of peat swamps, and that cellulose content decreases with age of the peat; and of microscopists, who have shown conclusively that coal derived from woody tissues always shows structure, though in some cases very refined technique is required to demonstrate it.

The geologist has, at times, tried to estimate the temperatures to which coal deposits were subjected during metamorphosis. Their estimates are frequently in the neighborhood of 200° to 300°C. as a maximum. If the conclusions of Lipman that bacteria have continued to live in coal since the peat stage are true, then this temperature must be revised downwards. The geologists in this phase of the work must cooperate thoroughly with the bacteriologist, but at the same time must be very critical of his work. The geologist, the bacteriologist, and the pedologist have related interests. Some chemists in studying coal have frequently been too prone to treat coal as a homogeneous material—as a pure compound whose identity is to be unraveled. A casual consideration of the compounds making up the plants whose decay products form coal, let alone a microscopic examination of coal, can leave no doubt as to the heterogeneous nature of coal. A study of the compounds in plants and the changes which these compounds undergo during decay and in the early stages of coalification, promises much greater progress in unravelling the chemical nature of coal than does the study of coal itself. To do this, however, the chemist must familiarize himself with the chemistry of living plants, with plant anatomy, with decay and the biology of decay organisms, and with the geology of coal formation. All of his conclusions must stand scrutiny in the light of the findings of other sciences as to the conditions under which the chemical changes took place.

If we study the minerals in coal, we bring mineralogy into the picture. It would seem that this should have been done long ago, yet a review of the literature shows that no mineralogical study of coal with any degree of completeness or accuracy has been made until the last two years. Other studies are found to be speculations based upon ash analyses and minerals found in nature. True, the minerals are found in nature, but only a certain few are found to make up over 95 per cent of the mineral matter in coal. A small amount of scientific study can settle volumes of philosophical speculation. Because of these accurately made mineralogical studies, we can take a new hold on the problem of ash-to-mineral matter calculations. By studying the fracture planes in coal, the physicist can tell to what forces the coal was subjected and perhaps their relative magnitude. Since the geologist believes that earth and tectonic pressures have much to do with coalification, the relationship is obvious. The behavior of coal components under high pressures is of great importance from the standpoint of possible flow of components from one part of the coal structure to another. For example, whether the resinous material to be found in fusain was always there, or whether it flowed in after fusainization is an important question in deciding the origin of fusain.

BOUNDARIES OF PENNSYLVANIAN CYCLOTHEMS[1]

BY

J. Marvin Weller

Illinois State Geological Survey, Urbana, Illinois

Many geologists believe that the top of the coal bed or the base of the marine members, if coal be absent, should constitute the boundary between cyclothems. Some favor the base of the coal. The writer contends that the base of the sandstone is the most logical boundary. Three other suggested horizons are believed to be unimportant and are not considered here.

It is generally agreed that diastrophism offers the best means for the major subdivision of geologic time and it is only logical that it be employed in minor subdivision if possible. Diastrophism is preeminently suggested at two horizons in the cyclothem: (1) at the top of the coal when the basin sank beneath the sea, and (2) at the base of the sandstone when the basin was elevated. The base of the coal does not clearly record a diastrophic movement and if the importance of diastrophism be admitted the unsuitability of this horizon as a boundary must be recognized.

According to the original conception, sedimentary cycles consist of beds deposited during a single incursion of the sea, separated by unconformities that represent periods of emergence. With the introduction of nonmarine beds in alternation with marine sediments the question arises, should these be included with the under or overlying marine cycle. By choosing the top of the coal as the boundary the nonmarine beds are included with the preceding marine cycle for which there appears to be no specific reason except local convenience.

In a basin of deposition, subsidence must be dominant. The particular subsidence that allowed submergence conforms to this general movement and is not necessarily unique. Uplift in the basin, however, would constitute a conspicuous irregularity, promptly recorded by change in sedimentation and perhaps by unconformity, and would furnish a more significant basis for cyclical differentiation.

Most important cycles of erosion have probably influenced sedimentation in adjoining basins so strongly that corresponding sedimentary cycles have been produced. Erosion and deposition are phases of a single physiographic process and the cycles of erosion and deposition should be defined with corresponding limits. Cycles of erosion are initiated by uplift and the early sediments produced are the coarsest. Therefore, the cycle of deposition should also be initiated by uplift, if uplift of the basin occurred, and the coarsest sediments should be considered the basal deposit.

The base of the sandstone is the logical boundary between cyclothems because (1) uplift of the basin is most strongly suggested, and unconformity most conspicuous at this horizon, and (2) the cycle of sedimentation is made to correspond with a possible related cycle of erosion. A boundary corresponding to the top of the coal can be recognized only where a coal horizon is present or marine beds overlie other types of nonmarine strata. The horizon corresponding to the base of the sandstone, however, can probably be recognized by change in sediment far beyond the limits of these members and is, therefore, probably of much wider application. Consequently this boundary is superior practically as well as theoretically.

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[1] Published by permission of the Chief, Illinois State Geological Survey.

THE SUBSURFACE STRATIGRAPHY OF THE DECATUR REGION

BY

L. E. WORKMAN

State Geological Survey, Urbana, Illinois

Decatur is situated above probably the deepest part of the syncline west of the LaSalle Anticline. Although no wells have reached the St. Peter sandstone in the immediate vicinity, it is estimated on good data that the top of that formation lies at a depth of about 3,100 feet. On less reliable data it is further estimated that at least an additional 3,100 feet of sedimentary rocks underlie this to a total depth of 6,200 feet to the pre-Cambrian granite. The sediments below the St. Peter consist in the lower half of coarse sandstone, and in the upper mostly of dolomites, but with some shale and sandstone formations. They represent all of the Upper Cambrian and the Prairie du Chien series of the lower Ordovician period.

The St. Peter sandstone is well known for its clean, white, medium grained sand. Above the St. Peter are the Platteville, Decorah, and Galena limestone formations in the order given, a total thickness of about 500 feet. The first is a mottled brown and gray, very fine grained limestone or dolomite, the second a shaly limestone, and the third a light brown coarsely crystalline limestone or dolomite. It is in this general region of Decatur that these formations change from being dominantly dolomite to the north and dominantly limestone to the south. The Maquoketa shale formation completes the Ordovician succession. It consists of a lower third of brown shale, a middle third of coarse grained limestone with interbedded brown and gray shale, and an upper third of green shale with limestone lenses.

The Silurian formations are similar to the St. Genevieve section of southeastern Missouri rather than to the Chicago section, having the brown cherty Edgewood limestone at the base, the pink, green and white speckled limestone of the Brassfield above, and red, gray and greenish, shaly dolomitic limestones similar to the Bainbridge above that. Studies of the Silurian in the region of Tuscola and southeastward into the oil fields show that at least 200 feet of Silurian is absent from the upper part of the section in the Decatur region where the total thickness is about 450 feet.

The Devonian system varies from 7 to 57 feet in thickness in sets of samples from the Decatur region. The brownish sandy and lithographic limestone with associated dolomite suggest the Wapsipinicon and Cedar Valley formations of the Rock Island region. There is much dense gray chert in the rocks which is distinctly different from the chert of the underlying Silurian beds.

The Sweetland Creek brown, Sporangites shale is 150 feet thick and has at its base a thin sandstone made up of reworked sand grains from the Devonian limestone. The upper layers of shale grade to black and dark gray. The question of the Devonian and Mississippian classification of the Sweetland Creek formation has been much discussed.

Of the Mississippian formations the Fern Glen red and green shales and cherty limestones are near the base, being about 100 feet thick. They are regarded as Osage and are followed in the same series by 140 feet of typical, very cherty, white to light gray Burlington and Keokuk limestones. East of the LaSalle anticline the Osage consists of sandy shales and sandstones quite unlike these formations. The Warsaw formation consists of a lower half of dark silty shale, and an upper half of shaly sandstones, sandy limestones, and sandy shales. The total thickness increases from 100 feet near St. Louis to 300 feet at Decatur. A limestone less than 30 feet thick and typical of the granular Endothyra-bearing Salem lies on top of the Warsaw sandstone. The St. Louis limestone is 100 to 200 feet thick at Decatur. It has suffered an erosion of 100 or more feet previous to the deposition of the Chester series.

The Chester series is represented by the Aux Vases, Renault, Yankeetown, Paint Creek, Cypress, and lowest beds of the Golconda formations, having a total thickness of 300 feet.

The Pennsylvanian sediments, 800 feet thick, consist mostly of shales and limestones. There are some sandstones and coals. The coal mined at Decatur is known as the No. 5 seam, reached at a depth of 560 feet in the shaft in the southern part of the city and 650 feet in the oil-test wells northwest of the city. A prominent red bed is encountered at about 350 feet and the Shoal Creek limestone at about 200 feet in these wells.

The bedrock in Macon County is everywhere covered by 100 to 200 feet of glacial drift.

THE SUBSURFACE STRATIGRAPHY OF THE DEVONIAN IN WESTERN ILLINOIS

BY

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AND

J. Huner, Jr.

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In the study of sample well cuttings and their residues from solution in acid, the Devonian strata in Adams, Hancock and McDonough counties is found to have the same divisions as in the Davenport and Rock Island regions. The Wapsipinicon limestone is at the base and the Cedar Valley above.

The Wapsipinicon is further sub-divided in the region studied into the Otis at the base—a very fine grained somewhat sandy, fossiliferous, slightly dolomitic limestone; the Independence shale above—a weak, plastic, massive, calcareous shale; and the Davenport at the top and occupying the greater part of the Wapsipinicon formation—a clean, hard, lithographic limestone which is slightly sandy near the top.

In the Cedar Valley limestone five distinct horizons were recognized: (1) a basal, fossiliferous, slightly dolomitic limestone, very sandy at the bottom and slightly cherty throughout. The lower sandy zone grades to a true sandstone with fine to medium rounded grains which is the Hoing sand; (2) A very cherty, fossiliferous, slightly dolomitic limestone differing from the basal horizon in containing only a trace of sand. Since this is recognizable only near Warsaw and in the northern part of Adams County, it may be of only local occurrence; (3) An argillaceous, dolomitic limestone containing dark gray, calcareous fossils such as Tentaculites, ostracods, and brachiopod fragments. This horizon is a typical development of the Cedar Valley as described from the Rock Island region; (4) A very cherty, slightly dolomitic, fossiliferous limestone containing some sand; (5) A somewhat variable limestone which is sandy at the base and grades upward to a slightly cherty, lithographic limestone near the top.

In most of Adams and Hancock counties the complete Devonian succession is found but over the Colmar-Plymouth dome in southwestern McDonough County only the basal Cedar Valley is present, the Wapsipinicon having been eroded away before Cedar Valley time. Southwestward from the Colmar-Plymouth dome the Devonian thins rapidly to and disappears entirely in a small area in the southeast corner of Hancock County. It reappears to the west and in the north-central part of Adams County the maximum thickness of 170 feet for the area studied is reached. Northwestward in Iowa a single set of cuttings from the Mt. Pleasant well shows a thickness of 247 feet and southwestward another set in Shelby County, Missouri, shows 182 feet. The increase of the Devonian thickness is mostly in the Cedar Valley for the Wapsipinicon is generally constant in thickness.

The Hoing sandstone at or in the base of the Cedar Valley limestone is similar in character to the Devonian Beauvais sandstone of southeastern Missouri. There it lies directly below the St. Laurent limestone which is correlated by Branson[1] with the Callaway in northeastern Missouri and the Cedar Valley of Iowa. It therefore appears that the Hoing sand is the northern extension of the Beauvais sandstone.

The Devonian system lies unconformably on the eroded edges of older strata. At the Colmar-Plymouth dome it is underlain by the basal Maquoketa shale. Westward it rests on the Kimmswick, except for a few remnants of the Maquoketa, and the two sets of cuttings from northeastern Missouri and southeastern Iowa indicate that the same is true west of the Mississippi River. In the Rock Island region[2] outcrop studies indicate a slight erosional unconformity between the Wapsipinicon and the Cedar Valley. This is emphasized on the Colmar-Plymouth dome. Sample well cuttings in certain places show a dark brown to brownish gray, finely laminated shale at this horizon. The Cedar Valley is overlain unconformably by the Sweetland Creek shale which everywhere contains a thin basal pyritic sandstone composed of reworked Devonian sand grains.

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[1] Branson, E. B., Devonian of Missouri, Missouri Bureau of Geology and Mines, Volume XVII, 2nd Series, 1923, page 2.

[2] Ekblaw, G. E., unpublished report, Illinois State Geological Survey, 1930.

PAPERS IN PHYSICS

EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN

Six of the seven papers that comprised the Physics program were given at the section meeting; all six were presented for publication.

Attendance at the meeting averaged seventy, maximum attendance was seventy-five.

Dr. Lester I. Bockstahler, Northwestern University, Evanston, Illinois, was elected chairman for 1934-35.

(Signed) JAKOB KUNZ, *Chairman*

A COMPACT VACUUM GAUGE FOR MEASURING PRESSURES RANGING FROM .2 MM DOWN TO .0001 MM OF MERCURY

BY

CHAS. T. KNIPP

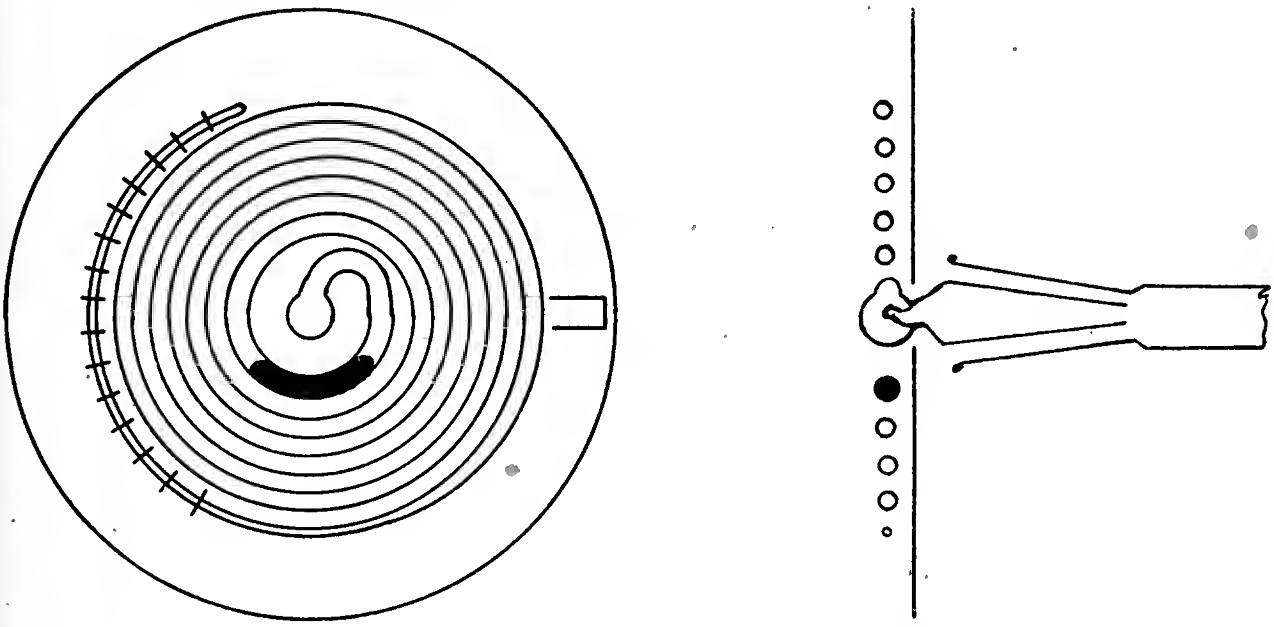
University of Illinois, Urbana, Illinois

Vacuum gauges are necessary equipment in a modern vacuum laboratory. This equipment is made necessary by the ever increasing use of vacuum devices, not only in research and in the industries, but also in the home. The perfection of the mercury vapor vacuum pump is also an important factor.

Vacuum gauges measure the pressure within an evacuated system in terms of mm of mercury. There are numerous types. Some are absolute in that their readings are deducible directly from a knowledge of Boyle's law, and others must be calibrated by reference to a known standard. The most commonly used of the former type is the well known McLeod gauge. This is the only one that will be referred to in this brief note.

The McLeod gauge (when constructed for the measurement of very high vacua) requires about 20 pounds of mercury for its operation. This in itself is quite an item of expense.

The principle of this gauge is that a known volume of air (say 1 liter) is compressed into an exceedingly small volume of a few cubic millimeters and the corresponding pressure required to do this is read. From the two volumes and the pressure the actual pressure of the gas in the evacuated system is deduced in mm of mercury as previously stated. This gauge not only requires much mercury but is ungainly in shape, heavy to handle, and easily broken.



—*Courtesy University of Illinois.*

FIG. 1 (Left).—Front elevation

FIG. 2 (Right).—Side elevation.

A suggestion for a modified form of McLeod gauge is as follows: This takes the form of a flat spiral of glass tubing of about 1 cm internal diameter. A front elevation is shown in Fig. 1 and a side elevation in Fig. 2. The outer end of the spiral for about one-half turn is drawn out in a decreasing diametered capillary as shown in Fig. 1. The spiral at the center terminates in a bulb which in turn is fused to an axial tube at right angles to the plane of the spiral.

This axis (and with it the spiral) turns in the ground joint shown in Fig. 2. This gauge requires but 8 to 10 cu. cm of mercury for its operation. The mercury, to begin with, is placed in the central bulb. This gauge must be calibrated. When in use the gauge is fused to the system with the ground joint horizontal. The spiral is then turned until the mercury all runs into the central bulb. In this position the vacuum connection between the spiral and the rest of the system is open. The system is now pumped out to any degree of exhaustion desired. To read the gauge it is only necessary to turn the spiral counter-clockwise (facing Fig. 1). The mercury as the turning proceeds will drop into the spiral as shown in the figure and travel along it forcing the trapped gas ahead of it ultimately compressing it in the capillary end of the spiral. The slug of mercury becomes longer as it reaches the narrower portion of the spiral and finally the reading is given when the right hand end is brought even with the stop (shown to right), and the left end to some point on the graduated scale. A calibration curve gives the pressure in mm of mercury.

Having taken the reading the spiral is now turned in the opposite direction (clockwise) depositing the mercury again in the center. Considerable care must be taken in the operation of the gauge since it too is made of glass. If the mercury is always returned to the central bulb *before* opening the stopcocks, or starting the pump, all will go well. Another manipulation difficulty may be with the ground joint. To prevent this from running dry it should be made long, very long (3 inches), and truly ground. This gauge is compact, requires but little mercury, and will give good service in the hands of a careful worker. Its range is from about .2 mm down to .0001 mm of mercury.

RENEWED ACTIVITY OF RADIUM BROMIDE AFTER HEATING, AS REVEALED IN A WILSON EXPANSION CHAMBER

BY

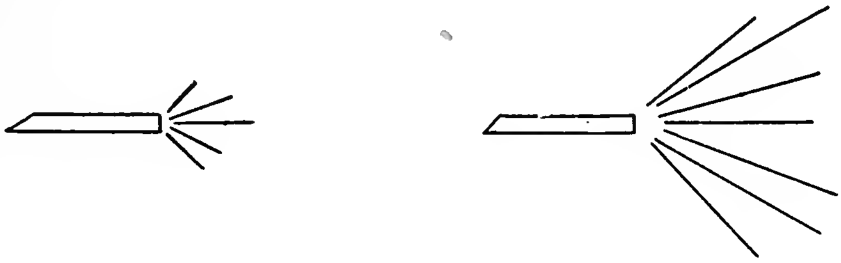
CHAS. T. KNIPP

University of Illinois, Urbana, Illinois

The recovery of the activity of a radioactive substance may be studied by proceeding as follows:

Place a minute quantity of the radioactive salt on the end of a solid rod (about 2 mm in diameter) of Pyrex glass by wetting the tip with alcohol containing a little shellac. Next blow a thin-walled bulb of Pyrex glass so thin that it *shows* Newton's rings in the form of *broad colored bands.* Now hold the tip in a soft blast, heating it slightly from the rear to insure against loss of radioactive material by the action of the blast, and when the tip begins to soften and assumes a spherical form, and with the thin walled bulb in line and in readiness, plunge the tip into it. This operation will cover the heated end of the tip with a thin film of glass, thus sealing in the radioactive salt. The tip may now be used in a Wilson expansion chamber without fear of losing any of the active material, and should last indefinitely as a source of alpha-particles free from emanation. This latter, obviously, is not able to pass through the thin glass film. Tips thus prepared were made over ten years ago by the writer and the protective film of glass seems to be intact.

If a *freshly* prepared tip is placed in a Wilson expansion chamber and the proper expansion is brought about, tracks will appear, but they will be few in number and only about one cm in length, as shown in Fig. 1. Re-



FIGS. 1 and 2.—Renewed activity of radium bromide. *(Courtesy University of Illinois.)*

peated expansions *immediately* following this one will not increase the number or length of the tracks. This apparently poor showing is disconcerting, for one naturally concludes that the tip is a poor one—that it contains but little active material under its film of glass, or that possibly the film is too thick. However if the apparatus be let stand for a day, the tracks will become more numerous and their lengths increase. This will come as a surprise. This increase in number and length has further support as time goes on. After ten days the alpha-ray tracks will seemingly have reached their full length—about 7 cm—and the number may vary from 20 to 40. The sketches shown in Figs. 1 and 2 are drawn to represent the first and last stages in this recovery of activity process. The explanation at first may seem a bit puzzling. It is quite evident that at the beginning when the salt is red hot, there is little or no activity trapped under the film of glass, but with time, this, also the emanation, builds up and reaches the steady state. This requires as stated above from six to ten days. The phenomenon is interesting and very pronounced.

MODEL OF AN ELECTRIC CELL, SIMULATING ION AND ELECTRON FLOW

BY

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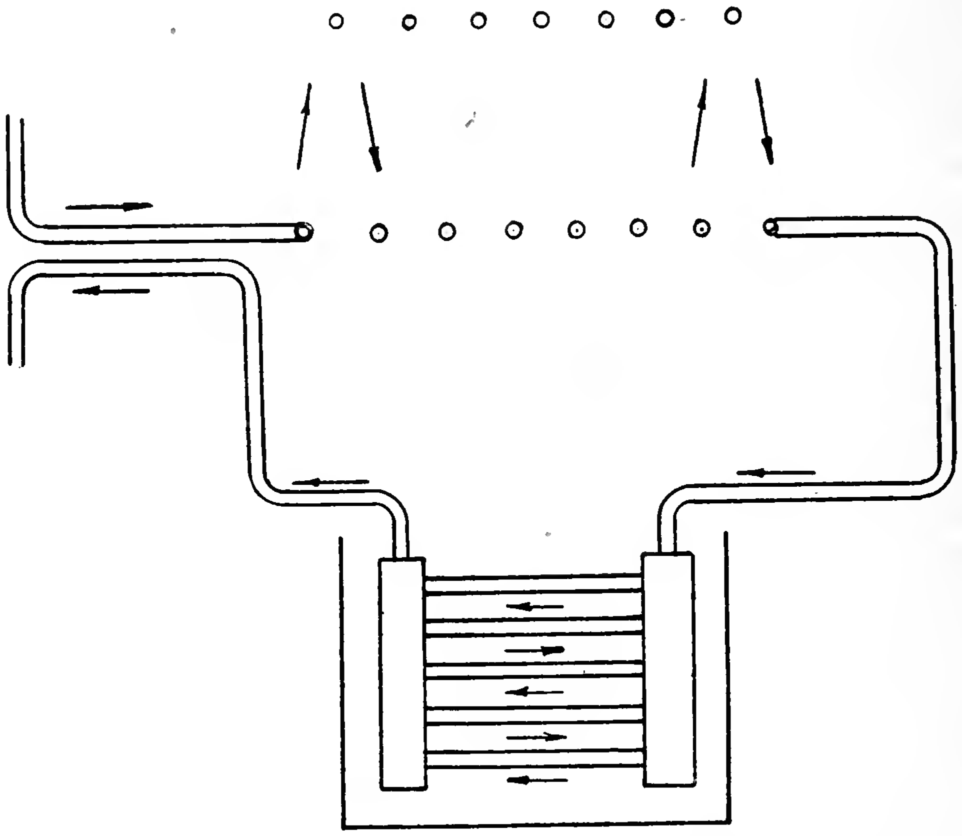
During the spring of 1934 a model of ion and electron flow in an electric cell was constructed in the physics laboratory. It was tried as an experiment at first and exhibited at the bi-annual Electric Engineering show held at the university in April and worked so well that it was planned to set it up at the "Century of Progress" fair, Chicago, for the summer.

The model in outline is shown in Fig. 1. All the parts are of Pyrex glass tubing of about 1 cm internal diameter. Beginning with the arrow at the upper left-hand corner of the figure and following round one comes first to the glass solenoid. This is 8 inches in diameter and about 12 inches long and has 10 turns. From this solenoid the tube leads to the battery cell and disappears in the positive electrode (a hollow copper box) and after traversing back and forth between this and the negative electrode (a similar box of zinc) it emerges and completes the circuit by passing up to near the starting point. To make the battery more realistic the improvised electrodes with their connecting tubes are placed in a large battery jar filled with water to the usual height. A few copper sulfate crystals placed in the jar adds color to the liquid in case one wishes to simulate a blue cell.



—*Courtesy University of Illinois.*

Fig. 1.—Model of an electric cell.

The operation of the model is quite simple, yet it requires considerable care in making the initial adjustments. It is only necessary to allow a stream of water from a suitable head (not shown in the figure) to flow down through the solenoid and on down through the cell (back and forth a number of times) and then on up to the starting point, as shown in Fig. 1 where it turns down and flows into the sink. The flow of electrons and ions is simulated by introducing air bubbles closely spaced at a point near the head. These are carried along by the flowing water, through the solenoid and down to the positive electrode of the battery. To this point the bubbles represent electrons (of course flowing against the conventional current). Their flow back and forth in the cell between the electrodes represents ions (plus ions and minus ions), while they again represent electrons as they leave the negative electrode (zinc) and complete the circuit.

To make the illusion more complete the incoming tube should be placed in front of the outgoing tube, thus making the flow appear to be continuous round the battery circuit.

The portion of the apparatus to the left at this point is screened from view.

In the Chicago set-up the same liquid was used over and over by the use of a small motor driven pump. The water should be slightly colored.

ELECTRON DIFFRACTION AND THE PHYSICS OF SOLIDS

BY

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During the last ten years our knowledge of the structure and properties of matter has greatly increased. One notes, however, that a large part of this information has to do with the gaseous or vapor state of matter. Studies of the solid state have lagged somewhat or at least have not been so amenable to interpretation in terms of forces and energy of the primary building units, whatever they may be. The introduction of X-ray analysis some twenty years ago resulted in a very complete knowledge of the arrangement of crystals and atoms in solids. The relation of many of the physical properties of a solid to its structure is not so well known.

The discovery that electrons are diffracted or selectively reflected by atoms in a crystal lattice has created a new tool for the study of the latter problem. Much of the theory developed for X-ray analysis can be carried over in electron diffraction studies. There are, however, certain advantages in each method. X-rays will penetrate a considerable thickness of a solid. Electron experiments must be confined to surface layers or thin films of the substance. The amplitude of the wavelets accompanying the electrons scattered by few atoms is so strong that diffraction effects can be obtained from exceedingly thin layers of material. In certain organic substances electron experiments yield patterns due to the carbon atoms in the molecule whereas the X-ray pattern is largely due to the molecular aggregate.

It is not my purpose to compare or contrast these two excellent aids in the study of solids. I wish to point out certain results which have been obtained and call attention to some problems yet to be tested by electron diffraction. In the recent theories of metals the question as to the number and energy of the free electrons arises. One is able, by means of diffraction experiments, to determine this energy commonly called the "inner potential".

The next field is in the investigation of orientations of crystal planes in thin films. This is of importance in photo electric work, in the transmission and reflection of light, in the resistance to oxidation or gas adsorption, polishing of surfaces, in short, any property which is specifically concerned with the surface of the solid.

It has been found that forming films by evaporation at certain temperatures will result in the selective orientation of crystal planes with respect to the backing surface. Silver on molybdenum deposited at 650° C prefers the 111 orientation while at 700° C there is little preference. Silvered optical mirrors when treated with aqua regia become better reflectors, and prefer to have the 110 plane of the oxide parallel to the surface.

The surface of a highly polished metal is revealed as a layer of molecular aggregates not unlike a super cooled liquid.

Questions having to do with curious and varying photo electric effects are no doubt related to the structure of the surface of the emitter. Different gases and varying pressures alter the structure of the surface of film deposited by sputtering or evaporation. The diffraction or reflection of electrons from such surfaces should throw some light on the processes involved. An examination of the rate of change of a collodial layer of a solid to a crystalline layer must in the end bear some relation to the forces existing in a solid. The catalytic action of such substances as platinum on asbestos is no doubt associated with the surface conditions.

In increasing our knowledge of the physics of solids it seems desirable to begin with the simple structures first. It is not likely that a structure more simple than the thin film and crystal is to be found in the solid state. For such studies electron diffraction methods are unusually adequate.

THE FLOW OF LIQUIDS THROUGH SUBMERGED ORIFICES

BY

JAKOB KUNZ

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The loss of head Δ h in a liquid, when flowing through a submerged orifice, has been measured by F. E. Giesecke. From his measurements two definite laws have been deduced: the loss of head or pressure difference is proportional to the square of the velocity; a fact which follows immediately from the principle of dimensional homogeneity; and in the second place the loss is an exponential function of the diameter D of the circular tube, Δ h being proportional to e^{-aD} where $a = 3.32$ and D is the diameter.

If the diaphragm is completely closed, the pressure will increase and a pressure wave will travel through the liquid column with the velocity of sound, but there is also another phenomenon recently observed by E. E. Ambrosius and J. C. Reed, namely the liquid returns at the diaphragm and moves along the wall of the tube in a direction opposite to the original motion in the center. If R is the radius of the tube and r the radius of the central veine, which flows in the original direction, then for laminar motion $r = R \cdot 0.71$, while for turbulent motion $r = R \cdot 0.766$. In the case of laminar motion it is shown that the velocity gradually dies down after the closing of the diaphragm according to the law: $\mu^2 = u_0^2 e^{-\frac{16\mu t}{\rho R^2}}$, where u is the average velocity within the veine of radius R, μ the viscosity, ρ the density and t the time, and u_0 a constant velocity. This expression and $r = R \cdot 0.71$ have already been verified by measurements of Ambrosius and Reed. When the diaphragm is suddenly closed, there is a pressure increase $p = um\sqrt{V_s}$, where m is the mass per unit volume, u the average velocity, V_s the velocity of sound in the liquid column; this pressure increase is the same when the liquid turns around and moves backward. This backward motion, obeying at first the exponential law, is unstable and soon breaks up in irregular turbulent motion.

From the submerged orifice there issues a jet, which seems to move in a sinus-oidal form, being accompanied by a system of vortices which finally in some distance from the orifice break up into turbulent motion. The system of vortices reminds me somewhat of the vortex ally of von Karman. But there may be vortex rings, whose axes are inclined toward the direction of the general motion. Or the issuing jet may describe a spiral motion. Indeed experiments have been made with a jet of smoke from a turpentine flame, which showed, from time to time, beautiful spiral motions of the form of a twisted elastic ribbon.

THE PRESENT CRISIS IN THEORETICAL PHYSICS

BY

JAKOB KUNZ

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We are living in a period of great physical discoveries, which follow each other in rapid succession. After the discovery of radioactivity, the electron, and Roentgen rays, toward the end of the last century, there followed the discovery of the diffraction of Roentgen rays, the Stern-Gerlach experiment, the Compton and Raman effects, the diffraction of electrons and hydrogen atoms, the discoveries of heavy hydrogen, of positrons, neutrons, induced radioactivity and the transmutation of the chemical elements.

This rapid progress in experimental physics is accompanied by a bold speculation in theoretical physics, aiming to coordinate all the wonderful phenomena discovered in experimental physics. The present mathematical researches in theoretical physics are dominated by two theories, the theory of relativity and the quantum theory. The special and the general theory of relativity rest on definite principles from which very definite conclusions can be drawn and which are in agreement with experiments. But unfortunately the logically perfect special theory of relativity, abandoning the ether as seat of the electromagnetic phenomena, becomes a purely mathematical-analytical theory rejecting all intuitive understanding of physical phenomena without mathematical formulae. It does not give a physical world picture, but only a formula. The mathematical apparatus of the general theory of relativity is much more complicated than that of the special relativity, and it coordinates besides the phenomena of Newtonian mechanics as a special case, three microscopic phenomena. The world appears as a four dimensional non-Euclidean, nonuniform finite continuum. While it is mathematically easy to construct such worlds, the space-time continuum of Minkowski and of general relativity are for me purely formal mathematical expressions or constructions. I do not live and make experiences in a non-Euclidean world of four dimensions. A four or two dimensional being is for me only a mathematical abstraction without contact with sense experience.

The quantum theory.—In the 18th century light was considered as made up of particles; in the 19th century as a wave in a medium called ether; and now since 1900 after Planck's ideas of radiation either as a wave or as particles called photons, or quanta of energy $E = h\nu$, which are emitted or absorbed in a discontinuous process, ruled by statistics. In 1905 Einstein materialized this idea concerning light to consist of particles of energy $h\nu$. In the photoelectric effect this energy is transformed into kinetic energy of moving electrons. The Compton effect also consists in a transformation of light energy of Roentgen rays into kinetic energy of electrons. But here an individual elementary collision between a photon and an electron is assumed with conservation of energy and of momentum. If the momentum is equal to $E/c = mc = h\nu /c = h/\lambda$, and if we assume for the momentum of an electron $g = mv = h/\lambda$, then $\lambda = h/mv$; i. e., the relation of deBroglie, i. e., with a moving particle is associated a wave of wavelength λ. But before the discovery of the Compton effect and the diffraction of electrons N, Bohr had made great progress in the theory of the structure of the atom, giving a rational explanation of the Balmer, Lyman and Paschen series of the hydrogen atom. This theory of Bohr was extended by Somerfeld, who introduced relativity into Bohr's theory. The theory was successful in many respects and gave rise to a classification of the line spectra by means of quantum numbers. But the theory was unable to explain the spectrum of helium, the next simple element after hydrogen. This theory was replaced by wave mechanics, quantum mechanics or probability mechanics, whose principles are difficult to enumerate separately, but which is largely based on Schrödinger's wave equation and the uncertainty principle. According to this principle it is impossible to measure in one experiment alone both the position and the momentum of one electron. If we determine the position, then we alter the momentum and vice-versa. Knowledge of position and velocity of a subatomic system is not obtainable, scientific causality breaks down, the future remains uncertain and open. We can determine only the probability of an atomic event, not the event itself. But if in the laboratory we look at the experiments on atomic structure, for instance the line spectra of the elements, they are just as well or better defined as other phenomena treated in classical physics. Hence either scientific causality has to be given up altogether, or it rules the atomic phenomena as well as the microscopic phenomena. The uncertainty may be only a subjective indeterminancy. Compton's experiments may be explained in different ways. That even in bulk experiments we disturb the quantities to be measured by means of our measuring instruments, is often a bitter experience of the experimental physicist. In the Schrödinger equation we have to know the kinetic and potential energy of the atomic or molecular system simultaneously, i.e., position and velocity, and here we introduce classical values. Herein I see a violation of the uncertainty principle itself. The question arises, if there are waves of electrons, what is the wave made of? It seems to me that the wave is taken in two different senses; a wave of an electron is considered either as a material wave (—for diffraction) or as probability wave (—in atomic structure.) The Schrödinger function for an atom with two electrons represents a wave in a six-dimensional space, for an atom with three electrons a wave in a nine-dimensions, in an atom with 92 electrons a wave in $92 \cdot 3 = 276$ dimensions! I doubt if any theoretical physicist believes in these dimensions in atomic systems, i. e., the Schrödinger equation again is a purely formal mathematical construction. Efforts to imagine such spaces, must forever fail. There are other difficulties connected with this function which I must omit here. Difficulties arise also with the mass and size of the photon. In the photoelectric and Compton effect, the photon is considered as of very small size, but in the formation of the image of a star, whose light is reflected from a 100-inch reflector, the photon must be of the size of the reflector. Moreover the energy E of a photon is equal to $h\nu$, its mass $m = h\nu/c^2$. But according to relativity the mass of a particle depends on the velocity v

$$m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}}$$

and if $v = c$, then the mass becomes infinite. To assume the rest mass m_0 equal to zero, destroys the conception of mass, as an empirical quantity altogether. Finally, if light from a source is emitted as particles, how can the velocity of light be independent of the velocity of the source, an assumption which is fundamental in special relativity. Both the wave theory and the corpuscular theory of light are true, but both together cannot be true.

NOTES ON THE FOUCAULT PENDULUM

BY

K. G. LARSON

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A pendulum weighing 33.1 kg., and 661 cm. long has been hung in the tower of the Old Main, on our campus. The suspension is of the double roller and steel plate type, described by A. C. Longden (Phys. Rev. 13:241, April 1919).

A steel roller 1.429 cm. diameter and 9 cm. long is mounted in a V-groove, on a steel rail fixed securely in an east-west line to the floor in an upper room. A steel plate 1.2 cm. thick[1] and 9 cm. square rests on it. A second roller in a north-south line on top of the plate supports a stirrup having a V-groove in its instep. The side members of this stirrup, 45 cm. long, extend down through the floor to the room below. A soft iron wire .072 cm. diameter forms a bifilar suspension for the ball from the stirrup.

The counterpoise, which is necessary to increase the moment of inertia of the shorter north-south component of the pendulum, consists of two 3.5 kg. weights, one at either end of a steel rod 1.59 cm. diameter and 98 cm. long, clamped to the plate in a north-south direction, horizontal. This construction and the length of the legs of the stirrup are intended to avoid the top-heavy rocking of the plate, which it was feared would occur due to the action of gravity on a counterpoise supported vertically above the plate.

The reflection of an index at the bottom of the ball in a mirror below, and very close to it, makes it possible to rotate the mirror on its pivot until a straight line across it coincides very exactly with the plane of motion of the pendulum. The position is then read to one-twelfth of a degree by a vernier at the edge of the mirror, and a graduated circle of 35 cm. radius on a circular table below. We can continue taking reading for 2½ to 3 hrs. after one start of the pendulum; rotation one degree each 6 minutes, approximately.

Since various writers have described pendulums suspended with piano wire, instead of soft iron wire, and since Professor Longden thought it impossible to get consistent rotation except with wire stretched beyond its elastic limit, or annealed, I wanted to try this effect also; this has not yet been done.

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[1] The thickness was later reduced to 5 mm. Two weights, 1125 grams each, placed 66 cm. apart, are thus sufficient counterpoise.

PAPERS IN PSYCHOLOGY AND EDUCATION

EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN

All but one of the eight papers on the Psychology and Education program were presented at the section meeting. The three which were given but which are not here represented are as follows:

"Contributions of psychology to education," by E. H. Cameron, University of Illinois, Urbana, Illinois.

"Education and the present reorganization of life," by Jordan Caven, Rockford College, Rockford.

"A study of certain rural teachers activities and the adequacy of training for performance," by Ted Ragdale, Southern Illinois State Normal University, Carbondale, Illinois.

Average attendance at the section meeting was about 30, maximum was 35.

Dr. Thomas E. Benner, University of Illinois, Urbana, was elected chairman for the year 1934-35.

(Signed) RALPH W. PRINGLE, *Chairman*

RELATION OF SCHOLARSHIP DURING COLLEGE CAREER TO SUCCESS IN TEACHING JUDGED BY SALARY

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Studies by Knight[1], Anderson[2], Wagenhorst[3], Ullman[4], and others have conclusively shown that there is little correlation between general scholarship in college and subsequent success in teaching judged by rating of supervisors. This has usually been interpreted as due to the submergence or outweighing of the effects of scholarship by other influences—appearance, a knowledge of people, ability to make friends, aggressiveness, peristence, and other personality traits.

Undoubtedly such factors exert an important influence on success in teaching. But we contend that this is a very inadequate explanation of the low correlation, and that as long as supervisors' rating shows the trend which they do, the matter has not been settled, Rugg[5] showed that supervisors' ratings show a pronounced over-estimation and a congestion of marks in the upper end of the rating scale, and our results confirm this conclusion. This factor alone accounts for a large part of the lowness of the correlation. Furthermore, many of the correlations were not corrected for attenuation.

Until more reliable ratings of supervisors than what we have been able to obtain so far are secured, teachers' salaries are a better, i. e., a more accurate, criterion of success in teaching. They are not influenced by any over-estimation or congestion factor, in fact show a normal distribution.

There have been two studies of the relation of scholarship in college to vocational success judged by salary. Gifford[6] showed a marked correspondence between scholarship and subsequent salary in the employes of the Bell Telephone Company. Gambrill[7] obtained a correlation of .28 between scholarship and salary in teaching in the case of men, and .04 in the case of women. Had her results been corrected for attenuation the correlations would have been larger. There is undoubtedly a sex difference in this matter,—a disinclination to recognize sufficiently differences in merit among women teachers, and also a generally lower salary scale for women, that operates to keep the correlation between scholarship and salary down, in groups composed of both sexes, as in the fifth correlation below.

Our principal contribution to the question is a series of correlations between general scholarship averages during college career and maximum salary during the first five years after graduation. We used returns from the graduates of the two-year classes in the case of elementary teachers, and from the four-year classes in the case of high school teachers and principals—all alumni of the Illinois State Normal University. The classes used were 1924-27 inclusive.

Results

57	principals and secondary teachers, men	.71	P.E. ± .04
95	elementary and secondary teachers, women	.64	P.E. ± .06
47	secondary teachers, women	.22	P.E. ± .10
48	elementary teachers, women	.30	P.E. ± .09
104	secondary teachers, men and women	.43	P.E. ± .05

These correlations have been corrected for attenuation. The correlations for men high school teachers and principals, and for women elementary and secondary teachers are new and significant contributions to the question, and reveal a much higher correlation than has heretofore been thought to exist. The third and fourth correlations, when compared with the others, also suggest strongly that the lowness of the correlations in some previous investigations is due partly to the small size of the groups, since correlations increase as the square root of the number of cases.

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PSYCHOLOGY AND JUVENILE CRIME

BY

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The psychological approach to criminal problems, first advocated by Franz von Liszt, has now taken hold in most countries. In Denmark, the State Attorney General asks the psychiatrist to determine amount and kind of punishment the criminal should have, type of institutional confinement, and other questions.

In juvenile and other crime, the psychologist and psychiatrist are interested in *why* the crime is committed. Thus, we are led to a study of the entire personality pattern of the individual. In every conduct situation there are three variables:

a) the individual with his native and acquired equipment,
b) the social milieu in which he finds himself,
c) a/b-(momentary relationship between the individual and the milieu at the time of executing the act).

The full relationship and bearing of these compound factors can hardly be written at the present time into any definite equation. It all involves greater knowledge than we now possess of human nature. The field of human mentality and motivation is as yet rather obscure. The age-old question of heredity and environment is still perfectly open as regards such large entities as "criminal tendencies". I am unwilling to say that we know much about the nature of intelligence and neither have we reached any ideal means of measurement. Experience has proved to me how little we know in the field of feelings and emotions. Along biological and medical lines, endocrinology seems to give promise for the future but its claims have been over-estimated. I think we can sum up our experience by now in the line of prognosis for the growing individual by saying that the early period of childhood is of great importance. Other periods of importance are around the 4th, 5th, and 6th grades in school, and the adolescent period. Adolescence is the plastic stage of secondary childhood in which new habit, new thought and emotional patterns might be successfully implanted.

When applying their science to juvenile crime, the main thing which the psychologist and the psychiatrist should contribute in the future is the genetic study of the growing individual with special references to factors and patterns of factors which might lead to anti-social conduct.

The specific task of the psychologist should be to explore the relation a/b in the light of what he knows also of *a* and *b* as entities. All psychology is to some degree social psychology.

Instead of using psychological clinics for the study of the juvenile criminal after he is caught, the sensible thing for prevention of crime should be to have clinics in all schools studying the individual from the first grade throughout the system.

I think we shall have to go the whole way and acknowledge the multitude of conditions which might determine the conduct of the bio-social structure of man inside the milieu in which he finds himself. The following are a few of such conditions which we *know* would be helpful:

1) A psychological clinic in each community.
2) Reforms in our schools with the main emphasis on more individualization of instruction and training. The teacher must remember that the child is a *living, growing structure.*

3) Further extension of adult education; reorganization of the training of lawyers and judges to include definite and good courses in branches of psychology and psychiatry which will suit their needs. Similar training for social leaders such as ministers and priests.
4) Continued public and private efforts for betterment of physical and mental health.
5) Non-political State Departments of Public Welfare, where experts can give good service.
6) Government should make available to the individual those things which his very nature rightfully demands (food, housing, education and so forth).

PSYCHIATRY AND THE MODERN CHILD

BY

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The introduction of psychiatry in the study of children grew out of two movements, mental hygiene on the one hand and the Juvenile Court on the other.

With the contribution of Mr. Clifford Beers in his book, *The Mind that Found Itself*, the organization of a mental hygiene society came first in Connecticut about forty years ago, and subsequently in many other states in this country, and found its culmination in the organization of the National Committee for Mental Hygiene. This movement carried with it a greater understanding of the problems of the mentally ill and more particularly a realization that most mental diseases have their onset in childhood.

Following the beginning of this movement the Juvenile Court came, established first in Chicago. This was the outgrowth of the thinking of men and women concerned with the problems of children. This group believed that delinquent children were not inherently pathological but that their delinquency was in response to unfavorable influences about them combined with physical or mental difficulties. Ten years after the establishment of the Juvenile Court, in 1909, psychiatry entered the picture through the organization of the first Juvenile Psychopathic Institute in connection with the court in Chicago. Dr. William Healy, the first director, together with a staff of psychologists and social workers, pioneered the field, working with children brought to the Juvenile Court. The results of these studies appear in *The Individual Delinquent* and *Mental Conflict and Misconduct* by Dr. William Healy. This was followed by the establishment of similar clinics, notably the Judge Baker Foundation in Boston. In 1917 this service was extended in Chicago to include children with minor behavior difficulties such as truancy, school retardation and, in the younger group, with temper tantrums and minor incorrigibilities. At a later date there were included behavior difficulties such as stammering, bed wetting, feeding problems and shyness. In 1921 the National Committee for Mental Hygiene began to establish local community clinics in large cities throughout the United States and Europe, operated on the same basis as the clinics in Chicago and Boston, connected not only with the juvenile courts but more commonly with children's agencies, public schools, and as separate organizations, totalling approximately 225 clinics in as many cities.

In Illinois, as in several other states, this movement has been extended as the Institute for Juvenile Research and has local community clinics in those cities prepared for and desiring it. Ten Illinois cities are now carrying on a local community clinic in which the professional staff of the Institute serves as examiners and consultants. These clinics operate in the following manner.

The local organizations—including public schools, social agencies and medical societies—co-operate in sponsoring the clinic and inviting the Institute to serve as consultant. They are required to select cases, to provide facilities for the examinations, to provide stenographic service, and to defray the extra expenses of travel of the Institute staff. The functions of the clinic are education and demonstration. Selection is therefore made with a view to including cases which not only are remedial but which will be useful as an educational medium for the public school teachers, the social workers, physicians, parents and other persons properly concerned with the control and direction of the child.

One of the sponsoring organizations in the community must agree to assume responsibility for the organization, supervision and follow-up of the clinic. Of the ten clinics in Illinois, four are carried by the public schools, four by social agencies, one by the Juvenile Court and one by a health agency.

The clinic functions through investigation of the social factors involved, measurement of intelligence, physical examination and psychiatric study. Each of these examinations is conducted by a person especially trained in these fields.

The type of service offered to the child and the community is illustrated in the following case:

A child of twelve was referred for incorrigibility and truancy from home and school. The social investigation revealed a home situation with marked instability and disorganization and an evident lack of academic development in other members of the family, a neighborhood which was run down and in which other delinquent children live. The school reported that the child was failing in the fourth grade.

The physical examination showed a well-nourished, well-developed boy with minor disabilities such as local focal infections limited largely to the tonsils, adenoids and nasal passages.

Intelligence tests revealed this twelve-year-old child to have a mental age of eleven years eight months with an intelligence quotient of .97, and therefore, classifiable in the group of average children, with an educational ability of sixth grade. Because of the discrepancy between the actual grade work and the educational age, educational achievement tests were given which showed that he had a marked reading disability of second grade level with arithmetic of the fifth grade level. Other subjects placed him in the fourth grade.

In response to personal interview with the psychiatrist the child indicated a marked antagonism toward school and a self-evaluation as a stupid child. He rebelled at the academic demands made upon him, and stated that he was biding only the time until he could go to work. His association with delinquent companies was already advanced and admiration for the daring of the older boys was clearly evident.

In this child we found we were dealing not only with the limitations in his social situation which contributed to his disinterest in school, but more particularly with a significant reading disability. His obvious good intelligence was a hindrance rather than an aid in the school room. Because he evidently could do better work his teacher demanded more of him without realizing that until his reading disability was overcome he could not be expected to respond at a level in keeping with his abilities. Thus antagonism had already been established in his relationship with his teacher and had grown with each successive change in teachers. It had reached a point at which he was reacting to the intolerable situation at school by escaping in truancy. This in turn threw him into the company of associates who were experienced in truancy, challenging him and stimulating him far beyond the point which he found in the school room.

Recommendations included social work with the family, treatment of the minor physical disturbances, special instruction directed to overcoming the reading disability and stimulation of his interest in school through a larger participation in the school activities which did not demand academic qualification. It was recommended further that special interest on the part of the teacher or some other person be directed towards giving him the confidence indirectly aimed at changing his point of view towards school.

This represents one of the great variety of behavior problems in children for each of which different causative factors may be found. Individual study becomes necessary and treatment directed towards underlying causative factors.

THE CULTURAL VALUE OF COURSES IN PSYCHOLOGY AND EDUCATION

BY

GEORGE D. WHAM

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Right thinking will justify the study of education *as such* by disclosing two sets of values: First, the *vocational*,—the contribution made to teaching and administration; second, the *cultural*,—the contribution made to a liberal education. This paper contends that the study of education *as such*, over and above its vocational worth, possesses cultural possibilities so distinctive as to make it indispensable in the acquisition of modern culture.

It is necessary to start with a working conception of culture. As the term is here used, a cultural or liberal education is one that *frees* a person —that frees him from ignorance, from awkwardness, from low and destructive attitudes and tastes, from the stultifying effects of superstition and prejudice. To put the matter differently, a liberal or cultural education is one that affords all of the necessary insights into contemporary civilization, as a result of which a person may walk through an intelligible world, understanding and controlling the forces that play upon him, and responding emotionally to that which is good and beautiful and true.

With this conception of culture in mind, I am prepared to affirm that courses in education are liberalizing to precisely the same degree that other courses are liberalizing, that is, to the degree that they furnish insights, understandings, appreciations, and tastes relative to some great department of human life. I shall thus proceed to indicate some of the ways in which the subject of education can create the insights, understandings, appreciations, and tastes necessary to the life of the present day.

In the first place, the study of education affords a set of sympathetic insights into our largest public enterprise, that of public education. No person in the United States, whether he engages in education professionally or not, can afford to be ignorant of this gigantic enterprise. The nature of education, the objectives of education, the curricula of education, the qualifications of teachers, the housing of school-children, and the means of financing the system—all these are matters about which every citizen should be adequately informed and profoundly interested.

In the second place, wholly aside from an understanding of the educational system of the United States, the study of education contributes a range of penetrative insights and emotionalized attitudes as broad and deep as life itself. To illustrate, a study of *educational objectives* brings the student to a consideration of what is worth while in human living, because what is worth striving for in life determines what is worth striving for in education. Again, the study of *educational curricula* brings the student to a consideration of what is most worth while in subject-matter, thus revealing the essential nature of the great body of human culture, its value to the race, and the uses to which it may be put in the cultivation of the individual. Also, a study of education brings a person to a consideration of the *learning process itself* whereby subject-matter may be appropriated, with resulting insights as to how a human being learns, how a human being can be motivated, and how both matter and method can be adjusted to suit the varying needs of individuals. The study of education also trains a person to take into account all of the *imponderable influences* that impinge upon the human mind—the unmeasured but vast influence of music, art, literature, and human personality, and the multitude of other environmental stimuli that help or hinder the processes of liberalization. And finally, it may be affirmed that the study of education *culminates* in a chastened view of life, a reverential regard for youth, a richer conception of the meaning of education, and a firmer conviction of the necessity of education as a means of preserving and promoting civilization.

We may close with the conclusion that if the conception of culture as a set of sympathetic insights into contemporary civilization is accepted, and if the study of education is so revelatory of profound insights as my analysis has indicated, then we may confidently affirm that the study of education as such makes *an indispensable contribution* to the type of socialized and humanized culture demanded by the present day.

PAPERS IN ZOOLOGY

EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN

Nineteen papers were listed on the program of the Zoology Section, of which only ten were presented at the meeting. The following paper was given but is not here represented:

"Swimming of the Muskrat," by J. D. Mizelle, University of Illinois, Urbana.

The following paper was read by title only:

"Observations on the stream life of the Charleston, Illinois, region with notes on the food ecology of fishes," by T. L. Hankinson, Michigan State Normal College.

Dr. C. L. Furrow, Knox College, Galesburg, Illinois, was elected chairman of the Zoology section for 1934-35.

(Signed) W. C. SPOONER, *Chairman*

ENTOMOPHAGOUS PARASITISM AMONG THE BEETLES

BY

W. V. BALDUF

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A small number of beetles may be properly described as entomophagous parasites. Regardless of the fact that they belong to widely diverse taxonomic groups, all, so far as known, have assumed the same type of relation to their hosts. They do not deposit their eggs directly upon the future host, as is done by the parasitic true flies and the ichneumon wasps. The first or primary larval instar resembles a silverfish. It retains its facilities for running about rapidly, and has the responsibility of finding its host or food supply. If successful, the larva begins feeding on the host and subsequently has two or more instars, in each of which its body becomes increasingly bulky and the legs grow correspondingly smaller and weaker. Both these changes obviously result from the availability of an ample supply of food. The fullgrown larva then transforms to an adult in or near the habitat of the host. A few examples of this relationship are given herewith, the development of all, so far as known, possessing the features just described.

1. *Carabidae.* The larva of the bombardier beetle, *Brachinus janthinipennis* has been reared from the pupae of *Dineutes assimilis*, a whirligig beetle, and at least two species of *Lebia* are known to parasitize the larvae or pupae of certain leaf beetles. *Pelecium sulcatum*, related to the Carabidae, is reported from South America as attacking parasitically, soft millipedes, a beetle pupa, and a leaf beetle larva.

2. *Cucujidae.* *Catogenus rufus* lives upon the pupae of long-horned beetles or the pupae of their braconid parasite, *Bracon dorsatus*. *Scalidia* spp. are said to be parasitic upon bark-boring beetles.

3. *Bothrideridae.* It is believed that *Bothrideres geminatus* passes its larval stage as an internal parasite of various long-horned beetles, including *Saperda candida.*

4. *Staphylinidae.* The species of the Aleocharinae, as far as known, enter the puparia of the muscoid flies and devour the pupae.

5. *Rhipiphoridae.* The larvae of wasps and bees are the hosts of these beetles in all known cases.

6. *Meloidae.* The adult blister beetles eat the foliage of plants and lay their eggs on or in the soil. The hosts of their larvae are either the egg masses of the common grasshoppers or the eggs and the food stored by parent bees for their young. The primary larva of the first type runs over the ground to find the eggs of the locusts, whereas the second kind climb upon a bee and are thus transported to the bee's cell. No less than 45 species of this family have been recorded as living at the expense of locust egg masses, and at least 21 first eat the bee's egg, then consume the store of nectar and pollen intended for the larvae of the bee.

THE AUTOMOBILE AND WILD LIFE
(ANIMALS KILLED ON A 25-MILE STRETCH OF ILLINOIS HIGHWA FROM 1930 TO 1933)

BY

W. P. FLINT

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The automobile has had a tremendous effect on many phases of ou modern life. It has also had a very marked effect on the wild life in th districts which are traversed by main automobile highways. The followin records give some interesting data on the effect of the automobile on the wil life of a prairie area in central Illinois.

The highway on which these records were taken can be considered typica of many of the paved state roads in central Illinois. The records were take in a twenty-five mile stretch between Urbana, Illinois and Oakwood, Illinois, o state highway No. 10. The road passes through four towns of from 10 to approximately 800 population and also goes close by two other towns c about the same size. Most of the road runs over the level prairie country c central Illinois and passes through a fertile farming area. It crosses tw small streams, the Salt Fork near St. Joseph and Stoney Creek near Oak wood. There are several pieces of woodland near the road but it does nc actually pass through any forested land. The pavement is nearly all cemen in good condition throughout. The Illinois Traction System and the Peori Branch of the Big Four Railroad closely parallel the road for most of it distance.

TABLE I—*Dead Animals on a 25-Mile Stretch of Illinois Highway.*
May 1, 1930 to December 31, 1930.

Number of observations.	4	4	4	4	2	1	0	1	20
Month.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Tota
ANIMALS OR BIRDS.									
1. Blackbirds	1	------	------	------	------	------	------	------	
2. Cats	2	------	1	6	------	1	------	------	[illegible]
3. Chickens	6	4	5	11	3	1	------	1	[illegible]
4. Flickers	2	------	1	2	------	------	------	------	
5. Gophers	10	7	3	10	5	2	------	------	[illegible]
6. Meadow Larks	1	1	1	------	------	------	------	------	
7. Mice	------	1	------	------	------	------	------	------	
8. Muskrats	------	1	------	------	------	------	------	------	
9. Owls	------	------	------	------	------	1	------	------	
10. Rabbits	4	4	7	4	1	------	------	2	[illegible]
11. Rats	------	1	------	1	1	------	------	------	
12. Redheaded Woodpeckers	2	1	2	2	------	------	------	------	
13. Robins	1	------	------	------	------	------	------	------	
14. Skunks	1	------	------	------	1	------	------	------	
15. Snakes	1	------	------	------	4	------	------	------	
16. Sparrows (English)	9	23	45	59	6	2	------	2	1[illegible]
17. Squirrels	------	------	------	------	1	------	------	1	
18. Threshers	------	2	1	1	------	------	------	------	
19. Toads	------	------	1	------	------	------	------	------	
20. Turkeys	1	------	------	------	------	------	------	------	
21. Turtles	1	2	------	------	------	------	------	------	
Total	41	47	67	96	22	7	------	7	2[illegible]
Animals unknown	1	1	4	4	2	------	------	------	
Birds unknown	2	7	3	6	------	------	------	------	
Total	44	55	74	106	24	7	------	7	3[illegible]
Number of miles	100	100	100	100	50	25	------	25	5[illegible]
Average number of animals per mile	.44	.55	.74	1.06	.48	.28	------	.28	.6[illegible]

The speed of cars going along the road will average from 35 to 50 miles per hour. Traffic is moderately heavy. In the summer months one will meet from 80 to 100 cars in driving this stretch of 25 miles. In the winter there will be only about 40 to 80. From counts of cars made on many different days it is certain that from early morning until late in the evening an average of about two cars per minute will pass over a section of the surface of this highway.

The records were made for the most part on Sunday mornings between seven and nine o'clock. They were sometimes made in the afternoon and on other days. The data were taken while driving at 20 to 25 miles per hour with two people in the car, both keeping careful watch on the highway. If a dead animal or bird was seen which could not be readily identified, the car was slowed down or stopped. There was at least a five day interval, in most cases a seven day interval between the records. Previous experience in placing dead animals on this type of highway has shown that it is a very rare for the body of the animal to remain on the road more than three days. In most cases the animal does not remain more than a day. In a few cases the body of the animal may become stuck to the highway and remain in the same place for a week or more.

TABLE II—*Dead Animals on a 25-Mile Stretch of Illinois Highway.*

January 1, 1931 to December 31, 1931.

Number of observations.	2	1	0	3	5	3	4	2	4	1	1	3	29
Month.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
ANIMALS OR BIRDS.													
1. Blackbirds					2	1	3	1	1				8
2. Bluejays						1							1
3. Cats				2	5	1		1	3	1		1	14
4. Chickens	2			1	4		7	9	3		2	2	30
5. Dogs	1											1	2
6. Doves							1						1
7. Flickers				1		2	3						6
8. Gophers					15	7	7	1	8	1			39
9. Hawks	1			1									2
10. Juncos				1									1
11. Meadow Larks							1						1
12. Moles							1						1
13. Opossum								1					1
14. Owls (Screech)												1	1
15. Pigeons	1												1
16. Rabbits	2			5	2		1			2	1	5	18
17. Rats	1						2						3
18. Redheaded Woodpeckers						4	1						5
19. Robins					1		3		1	1			6
20. Skunks									1				1
21. Snakes				2	1	2	2	3	4				14
22. Sparrows (English)	1			6	8	8	60	31	12		1		127
23. Squirrels	1												1
24. Toads					3	1		1					5
25. Turtles						1	1		2				4
Total	10	0	0	19	41	28	93	48	35	5	4	10	293
Animals unknown					1		1		1				3
Birds unknown					5	3	4	1	3				16
Total	10	0	0	19	47	31	98	49	39	5	4	10	312
Number of miles	50	25	0	75	125	75	100	50	100	25	25	75	725
Average number animals per mile	.2	0	0	.25	.38	.41	.98	.98	.39	.2	.16	.13	.43

Crows have apparently found that a considerable amount of food can be secured along such highways and will very frequently be seen feeding on the carcasses of animals that have been killed by passing automobiles. They will often drag the carcass of a rabbit or other animal or bird off the highway where it can be fed upon with less disturbance. As most of their feeding is done in the early morning, they had in most cases removed only a few animals before the counts were made.

There are several matters of interest in connection with the figures presented. It is quite evident from these figures as well as from previous observations that most of the animals are killed on highways during the months of April to October inclusive. One of the surprising things to those who have occassionally observed the dead animals along highways is the number of English sparrows. These small birds are seen only when driving slowly but are usually completely overlooked if a car is traveling at 35 to 50 miles per hour.

It was quite surprising to note the uniformity of numbers of animals killed each year, particularly in the case of cats and gophers, which varied very little during any of the three years when the observations were made. It seems quite evident from these observations that the only game animal which is killed in any number is the rabbit. The killing of cats can be considered beneficial as they are notorious destroyers of birds and small game. The same may be said of the killing of English sparrows.

TABLE III—*Dead Animals on a 25-Mile Stretch of Illinois Highway.*

January 1, 1932 to December 31, 1932.

Number of observations.	0	3	3	3	6	2	5	4	4	3	2	0	35
Month.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total
ANIMALS OR BIRDS.													
1. Blackbirds	----	----	----	----	1	1	----	----	----	1	----	----	3
2. Cat Birds	----	----	----	----	----	----	----	1	----	----	----	----	1
3. Cats	----	1	1	1	2	1	4	1	2	1	----	----	14
4. Chickens	----	----	1	1	3	4	5	3	4	2	----	----	23
5. Dogs	----	----	----	1	----	----	----	----	----	----	1	----	2
6. Flickers	----	----	----	----	----	----	1	----	----	----	----	----	1
7. Frogs	----	----	----	----	----	----	----	1	----	----	----	----	1
8. Gophers	----	----	----	1	15	2	10	4	6	4	----	----	42
9. Guinea-fowl	----	----	----	1	----	----	----	----	----	----	----	----	1
10. Junco	----	----	----	1	----	----	----	----	----	----	----	----	1
11. Meadow Lark	----	----	----	----	----	----	----	2	----	----	----	----	2
12. Mice	----	1	----	----	----	----	----	----	1	----	----	----	2
13. Owls (Screech)	----	----	----	----	----	1	----	----	----	----	----	----	1
14. Rabbits	----	2	----	3	6	----	5	2	3	3	9	----	33
15. Rats	----	----	----	1	1	----	----	----	----	1	----	----	3
16. Redheaded Woodpeckers	----	----	----	----	1	----	2	1	----	----	----	----	4
17. Robins	----	----	----	----	3	1	3	----	----	----	----	----	7
18. Skunks	----	----	----	----	----	----	----	----	2	----	----	----	2
19. Snakes	----	----	----	----	6	4	----	1	4	----	----	----	15
20. Sparrows (English)	----	1	1	4	27	13	68	37	17	5	2	----	175
21. Threshers	----	----	----	----	----	1	----	----	----	----	----	----	1
22. Turtles	----	----	----	----	----	2	1	1	----	----	----	----	4
Total	0	5	3	14	65	30	99	54	39	17	12	0	338
Animals unknown	----	----	----	1	1	----	2	2	----	1	----	0	7
Birds unknown	----	----	1	3	3	5	10	5	1	2	2	0	32
Total	0	5	4	18	69	35	111	61	40	20	14	0	377
Number of miles	0	75	75	75	150	50	125	100	100	75	50	0	875
Average number of animals per mile	0	.07	.05	.24	.46	.7	.88	.61	.4	.26	.28	0	.43

Judging from these data the automobile is not appreciably reducing the numbers of any of our song or insectivorous birds. Of the total number of known animals found dead on this stretch of highway (918), 628 or 68.4 per cent were blackbirds, cats, gophers, mice, rats, and English sparrows. All of these from the human standpoint are more or less undesirable. Reasoning along this line there is grounds for our saying that the automobile is of benefit in reducing the undesirable animals of this region.

Thanks are due for assistance in making these observations to Mrs. W. P. Flint and Dr. M. D. Farrar, both of whom assisted in making a number of these records.

TABLE IV—*Counts of Dead Animals Found on Highways During a Three-Year Period.*

May 1, 1930 to December 31, 1932.

Number of observations.	20		29		35		84
Year.	1930		1931		1932		
	No.	Average number per mile.	No.	Average number per mile.	No.	Average number per mile.	Total.
ANIMALS OR BIRDS.							
1. Blackbirds	1	-----	8	-----	3	-----	12
2. Bluejays	-----	-----	1	-----	-----	-----	1
3. Catbirds	-----	-----	-----	-----	1	-----	1
4. Cats	10	.02	14	.019	14	.016	38
5. Chickens	31	.062	30	.041	23	.026	84
6. Dogs	-----	-----	2	-----	2	-----	4
7. Doves	-----	-----	1	-----	-----	-----	1
8. Flickers	5	-----	6	-----	1	-----	12
9. Frogs	-----	-----	-----	-----	1	-----	1
10. Gophers	37	.074	39	.053	42	.048	118
11. Guinea-fowl	-----	-----	-----	-----	1	-----	1
12. Hawks	-----	-----	2	-----	-----	-----	2
13. Junco	-----	-----	1	-----	1	-----	2
14. Meadow Lark	3	-----	1	-----	2	-----	6
15. Mice	1	-----	-----	-----	2	-----	3
16. Moles	-----	-----	1	-----	-----	-----	1
17. Muskrats	1	-----	-----	-----	-----	-----	1
18. Opossum	-----	-----	1	-----	-----	-----	1
19. Owls (Screech)	1	-----	1	-----	1	-----	3
20. Pigeons	-----	-----	1	-----	-----	-----	1
21. Rabbits	22	.044	18	.025	33	.038	73
22. Rats	3	-----	3	-----	3	-----	9
23. Redheaded Woodpeckers	7	-----	5	-----	4	-----	16
24. Robins	1	-----	6	-----	7	-----	14
25. Skunks	2	-----	1	-----	2	-----	5
26. Snakes	5	-----	14	-----	15	-----	34
27. Sparrows (English)	146	.292	127	.175	175	.200	448
28. Squirrels	2	-----	1	-----	-----	-----	3
29. Threshers	4	-----	-----	-----	1	-----	5
30. Toads	1	-----	5	-----	-----	-----	6
31. Turkeys	1	-----	-----	-----	-----	-----	1
32. Turtles	3	-----	4	-----	4	-----	11
Total	287	-----	293	-----	338	-----	918
Animals unknown	12	-----	3	-----	7	-----	22
Birds unknown	18	-----	16	-----	32	-----	66
Total	317	-----	312	-----	377	-----	1,006
Number of miles	500	-----	725	-----	875	-----	2,100
Average number animals per mile	.634	-----	.43	-----	.43	-----	.48

SEXUALITY AMONG PROSOBRANCH MOLLUSCS

BY

Clarence Lee Furrow

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Until recently studies on the sexuality of the Prosobranch Molluscs have been confined almost exclusively to marine genera. In 1914 Von Kemnitz studied a freshwater Bavarian Prosobranchiate, *Valvata piscinalis*, and concluded that this species offered no unusual deviations with respect to hermaphroditism, which was not already present among the pulmonate gastropods. The literature on the marine Prosobranchiates records many unusual conditions connected with reproductive activity, such as protandry, atypical spermatogenesis, vegetative cannibalism, etc. It was thought that the fresh water Prosobranchiates might offer some clews as to the evolution of the reproductive functions among the few remaining hermaphrodite members of this group.

With this in mind attention was directed to the American species, *Valvata tricarinata.* In 1930-31 the author observed atypical spermatogenesis in this species. The atypical spermatogenesis terminates in the formation of two types of abnormal spermatozoa which deviate in size and form with respect to the normal. Further study on this form revealed that the condition of primitive hermaphoroditism exists, and that the female germ cells and male germ cells are clearly stratified in the ovotestes. The female germ cells are restricted to the marginal layer and the male germ cells are confined to the central medullary zone.

In 1931-32 Artom and Cavallini re-investigated the European species, *Valvata piscinalis*, and were able to confirm the observations of Von Kemnitz. In addition they studied *Valvata cristata* which is an Italian species. They found *V. cristata* to differ markedly from *Valvata piscinalis* in that *V. cristata* presented a case of spermatozoon dimorphism. They also found that in this case the general histological and morphological conditions of the gonad resemble those of *Valvata tricarinata.* In the observations on *Valvata tricarinata* the segregation of the male and female germ cells is followed during the sexual phases by a period of reduced protandry during which the animal alternates between a male sexual phase and a female sexual phase. The intervals between the two phases are marked by a restoration and a transition, the transition occurring between the male and female phase and the restoration period occurring between the female and the male phase. The atypical spermatogenesis which occurs in *Valvata tricarinata* and the abortive transformation of the spermatozoa are interpreted as arising from the hermaphrodite condition of the animal, especially in view of the segregation of the male and female zones.

SKELETAL MODIFICATIONS IN RIVER CATFISHES OF ILLINOIS

BY

WILLIAM F. HOHEISEL

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Preliminary observations on the skeletons of the species of *Ameiurus*, *Ictalurus* and *Leptops* seems to indicate that these fishes can be separated out either on the basis of their skulls or their vertebral columns. The nature of these differences can be listed briefly as follows:

1) General shape of skulls: The genera *Ameiurus* and *Leptops* have broad skulls which are flattened dorso-ventrally, whereas the *Ictaluri* skulls are compressed laterally.

2) Brain case: Dorso-lateral margin broadly concave in *Ictalurus;* irregular in *Leptops* and *Ameiurus*. *Leptops* has a wedge-shaped lateral extension of the sphenotic.

3) Subcutaneous dorsal region of the skull: This median portion of the skull which is not covered with muscle is made up of the supraoccipitals, frontals, prefrontals and mesethmoids. The line of attachment of the temporal muscles gives this region a characteristic appearance and limits it laterally.

4) Vertebrae: It seems reasonably certain that they are distinctive for genera. These differences involve the pattern of the sides of the centra and also the character of the zygapophyses. The outstanding marking on the side of the vertebrae is an hour-glass pattern which varies in its shape and proportion relative to the entire centrum. The last few caudals and the more anterior vertebrae are not characteristic, so about one third of the column is needed to insure a diagnosis.

5) The "complex vertebrae" which is made up of the fused 2, 3, and 4th vertebrae, is definitely distinctive for genera and has been found to be useful in the identification of species. The median dorsal keel of the complex is progressively reduced in the genera *Leptops*, *Ictalurus* and *Ameiurus* in the order named.

The skulls of the species of the three genera separate out easily enough. The presence of one-third of the vertebral column would be sufficient for recognition of the genus of the fish and it seems likely that this is adequate for species identification especially if the complex vertebra is also present.

ABNORMALITIES IN THE UTERINE YOUNG OF THE FRESH-WATER SNAIL *CAMPELOMA RUFUM*

BY

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ABSTRACT

An observational study of the uterine young of the fresh-water snail *Campeloma rufum* has been made, using materials collected in the Salt Fork branch of the Vermilion River between September, 1933, and May, 1934. Various abnormalities were found in considerable numbers and variations among the normal uterine young. Sinistral forms were noted. Of the total number studied 2.7 per cent were in a twinned or polyvitelline condition. Polyvitelly in the veliger stage was found. One instance of three individuals enclosed within the same membrane was noted. Double monsters with various degrees of fusion of the soft parts with a conjoining of the oral surfaces, bicephalic individuals and a fusion of the foot tissues were the different types found, representing 0.67 per cent of the total number of embryonic young examined. Abnormal shells, such as elongate and asymmetrically coiled shells, flattened, discoidal forms and shells compressed without coiling constitute 2.3 per cent of those studied.

THOMAS SAY, EARLY AMERICAN ZOOLOGIST OF THE MIDDLE WEST

BY

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There was born in Kingsessing, Pennsylvania, near Philadelphia in 1787 a pioneer in the field of natural science. As was the case the environment was ideal for the future scientist. Philadelphia at this time was the center of culture and education in the United States. In 1812 Thomas Say became a member of the Philadelphia Academy of Natural Science and for the next fourteen years spent his time studying, classifying, traveling and collecting scientific material for the Academy.*

Many papers were prepared and read by Thomas Say while associated with the Philadelphia Academy of Natural Science. A number of these papers were on fossil zoology (shells and crinoids) dealing with the descriptions and classifications made from various collections. It was here that Thomas Say lay the foundations of American Zoology which identify him as the father of American Zoology.

G. D. Harris in his introduction to some of the writings of Thomas Say mentions the fact that he is one of America's greatest naturalists. Too many times European co-workers have overlooked Say's original descriptions of *Exogyra* and credited the genus to Sowerby and too often has Say's work on "Crinoids" been forgotten.[1]

Thomas Say did not confine himseif to the study of fossil zoology, but made many discoveries in entomology[0] and became much interested in Herpetology—their descriptions, habits, and the composition of poisons of the poisonous varieties, and cures for snake bite.[2]

In 1826 Thomas Say became interested in the New Harmony movement and went to live in New Harmony, Indiana. In and around the New Harmony community there was an inexhaustable fund of zoological material new to the student of natural science. Therefore, it was the pleasure and honor to Thomas Say to name and describe many scientific specimens new to the scientific world. Thomas Say and other scientists of New Harmony spent much time tramping over the hills and searching the valleys, examining the geological strata of the land and studying the fish and shell life in the Wabash River and its small tributaries.[3]

The descriptions of zoological life by Say were published in the newspaper of New Harmony, called the Disseminator, or in pamphlet form. He also published a book on "Conchology" and listed and named in this book most of the shells found in the Wabash River. This book was printed on the school press by the boys of the School of Industry. The pictures of shells in this book were drawn from nature by his wife who formerly was an artist. It is very interesting to note that these drawings were engraved by the teacher of the Industrial School, Cornelius Tiebout, then the engravings were hand painted in water colors by Mrs. Say. These books were

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* Thomas Say made several expeditions to different parts of the United States; one to Florida in 1817; one to the Rocky Mountains (Pike Expedition 1819-1820) and one to the source of St. Peters River in Florida 1823.

[1] Bulletins of American Paleontology. No. V. A Reprint of the Paleontological Writings of Thomas Say. Field Museum Library, Chicago, Illinois.

[2] American Journal of Science, Say on Herpetology, Vol. I., pp. 257-258.

[3] Nora C. Fretageot, Librarian, Thomas Say, Workingmen's Institute Library, New Harmony, Indiana. 1929.

[0] Thomas Say discovered the Colorado beetle commonly called the Potato beetle or bug.

printed in New Harmony in 1830 and are considered of great value among book collectors and of great beauty by art lovers.[4]

The works of Thomas Say are numerous, for today in many of the larger institutions are to be found collections of scientific material.†

After eight years crowded with scientific investigations and writings at New Harmony, Thomas Say fell victim to fever and dysentery which resulted in death October 10, 1834.

Today one may visit the town of New Harmony and look upon many of the works and collections of Thomas Say housed in the Workingmen's Institute and there live again the interesting days of discovery. As the American Journal of Science and Arts states, "It is no exaggeration to assert that Thomas Say has done more to make known the zoology of his country than any other man."

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[4] Nora C. Fretageot, Librarian, Thomas Say, Workingmen's Institute Library, New Harmony, Indiana. 1929.

† National Museum, Washington, D. C., Academy Natural Sciences, Philadelphia, Metropolitan Museum, New York, N. Y.

BIOLOGICAL PRINCIPLES UNDERLYING THE FIELD OF EDUCATION

BY

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The average teacher of biology has come to look upon the field of education as one distant from his own with few or no connections of any worth. In some instances this feeling has grown into an attitude which holds that educational material is of no value to the general student. On the other hand, education outside the field of biology has come to look upon the processes of life as casual without ever realizing that they are the only activities of the human machine.

Psychologists speak of the types of energy in the various mental processes but with little or no understanding of its real meaning. The work of the physiologists has shown without doubt that the work of the nerve cells is the result of the expenditure of energy just as in muscles and other organs. This energy releasal process is initiated by some energy disturbance in the environment, directly or indirectly, such as light, sound, pressure, etc., all of which are called stimuli. It has its effect in some muscle, gland or nerve reaction. The nature of this final reaction is determined by the intensity of the stimulus and chemical set up in the responsive machinery. Space does not permit any discussion of the factors in the chemical set up but it may be sufficient to say that so far as education of the individual goes it is about the most important feature involved. The problem of the weak student is not a lack of proper environmental influences so much as it is a non-receptive chemical machine on the inside. The bright student is just the reverse. He not only is able to release an abundance of energy when provoked by stimuli, but can direct it into useful channels. The subnormal child is more a medical than a psychological problem. Initiative and genius are expressions of mental machines that are aroused by stimuli which do not reach the common person.

Volumes have been written covering the various phases of the mental activities, but to the average beginning student and teacher there is nothing but a misty haze of technical terms to confuse them. Much stress is placed upon training of leaders and thinkers without any question as to the possibility of doing either. Urges, emotions, reflexes and all other psychological acts have a chemical basis. Learning, therefore, is not a mere matter of being exposed to certain environmental relations but an actual releasal and usage of mental energy. The individual who may have a good mental machine and does not use it, is little or no better off than the person who may have a poor one. The successful teacher is the person who can arouse and inspire individuals to a definite and positive mental action.

Modern educational research has done a great deal to improve the work in the field of instruction but at the present stage it has not reached the bottom of the problem. Researchers in education will have to meet the biologist and, together they may be able to move forward in their work. Education is a biological adaptation. If the average thinking person can be brought to this level of understanding, the study of problems in all phases of human adjustment will be placed on a much saner foundation. Every teacher should have a clear knowledge of the importance of heredity and its early environmental relations. It is probable that more damage is done to the pre-school child than to the child in school. Many teachers in zoology and biology do not recognize the importance of this phase of their work.

LIVING VS. DEAD

BY

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Since Biology is the study of living things, it seems fitting that the living as well as the dead should find a place in a scientific workshop. Every laboratory worthy of the name has at least one aquarium but seldom is any other life found there.

Plenty of preserved specimens are found in the supply rooms and from them students may learn much regarding both the external and internal structure.

Where General Biology is taught the frog or the pig is frequently used. The latter is more valuable, though the frog is more frequently used. The reason is because of the heart of the pig. Should we dissect simply for dissection sake or should we do so the better to appreciate ourselves and our place in creation?

Why, may I ask, do most teachers rest satisfied with only lifeless material? The answer is obvious; they abhor the extra work necessitated by the presence of living animals who need care. The lifeless material needs only a place. Such living specimens as white rats, frogs, and birds need abodes where they can and will contentedly live. These need to be kept clean and that work falls to the teacher.

The teachers, therefore, protest against the housing of them in a laboratory; the students, on the contrary, enjoy them and can learn much concerning them. This first hand knowledge seems practical. Such a display enables students to compare animals with humans, teaching them to be grateful to their Creator for all they have which raises them to a higher level than the dumb animals before them. Man has been gifted with five senses, each of which, unless diseased, is keen. In the animal every sense is not equally keen. For instance, the white rats have been endowed with a keen sense of hearing and of smell but their sight is quite deficient. Watching such animals scent around for food ought to inspire any thinking student with gratitude that he is blessed with five senses equally keen and hence is superior to lower animals of the mammalian phylum.

Many, blinded by prejudice, are of the unchangeable opinion that animals are disease spreaders. Especially is the albino rat so condemned. Yes, rats are, but can not circumstances alter cases even in the brute creation? The common pest, the alley rat, lives among filth, eats filth, and seems contented only in filth. Usually, too, it is infested with fleas, the bite of which may prove disastrous to the human whom it may attack.

Is our tamed albino to be so catalogued? The white rat of the laboratory has or should have an abode that can be easily and daily cleaned. He favors cleanliness. He should be fed with proper food, including milk and lettuce. Rats that are given care will not wander far from their cage but will hover near to return to it when it is ready. Well-cared for rats are as playful as kittens when they are allowed to romp around the laboratory.

As teachers, it is our duty not only to present material but also to arouse interest in every possible way. Most educators will agree that the average student dreads the study of science. The secret of the teacher's success is in the manner of presentation.

What is there more interesting than life? Nothing, therefore, I hold that a well-equipped laboratory should have not only the essential preserved material that will tend to effective teaching but also live specimens. Proud should a teacher be who can proclaim that she has living in her laboratory one or more of each type of vertebrate.

A STUDY OF CHARACTERS FOR THE DIFFERENTIATION OF TWO SPECIES OF MINNOWS OF THE GENUS *NOTROPIS*

BY

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ABSTRACT

Notropis whipplii and *N. lutrensis* are two species of Illinois minnows which are frequently confused and are often said to intergrade. These two species have been studied to determine to what extent internal characters are available for differentiation. It has been found that while the number of gill rakers tends to be distinctive for each species, there is some intergradation. In similar manner while each species has a characteristic pharyngeal tooth formula, some individuals show variations from the normal that tend to run the two sets of observations together.

Anatomical details to some extent confirm the statements of Forbes and Richardson concerning the intergradation of these two species. However, a statistical analysis of variability in number of pharyngeal teeth and in number of gill rakers for each species reveals the fact that each has a characteristic range of variability. This variation has no observable correlation with length of body. In *N. whipplii* the formula for pharyngeal teeth varies from 4-3 to 1, 4-4, 1, and in *N. lutrensis* from 3-3 to 1, 4-4, 1. The mean for the former is 1, 4-4, 1; for the latter 4-4. *N. whipplii* has 9 to 12 gill rakers in the lower limb, while *N. lutrensis* has 12 to 14 in the material studied.

SEASONAL LIFE HISTORY OF A SNAIL OF THE GENUS *FOSSARIA*

BY

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ABSTRACT

A snail, *Fossaria modicella*, previously reported from a peculiar habitat at Turkey Run, Indiana, where it lives on vertical sandstone cliffe, has been under observation for a number of years. Collections have been made periodically, analyzed and correlated with field observations to determine facts in the life history. Periods of egg production have been observed and their subsequent influence on size range of individuals noted. An analysis of distribution curves based on size of shells furnishes the basis for predicting the time of appearance of new generations in cyclic repetition of similar population samples.

Full details of this investigation are to appear in *Ecology.*

A BIBLIOGRAPHY OF THE ECOLOGY OF ILLINOIS, PART 1

A PROJECT OF THE ACADEMY'S COMMITTEE ON ECOLOGICAL SURVEY

COMPILED BY

ARTHUR G. VESTAL

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About five years ago the chairman of the Committee on Ecological Survey, Dr. E. L. Stover, submitted to the Academy a Bibliography of Ecological Literature on Illinois Flora and Fauna. This was given to the writer as his successor, for its enlargement and publication, with the help of the other members. A plan for completing the work was approved at a meeting of the committee in May, 1930. Somewhat radical departures from this plan gradually developed. During the more active later phase of preparing the bibliography, the conviction grew that annotations of many of the titles were essential, to show wherein their ecological content or bearing lies, or to make known the occurrence of hidden gems of ecological significance, especially in older descriptions of vegetation or animal life now extinct in that locality, or to serve as very brief abstracts of their ecological import. These annotations are the more valuable if the publications themselves are not readily accessible.

Another direction of enlargement has been considered indispensable. That is the inclusion of materials outside the boundaries of our state which bear directly upon Illinois environments, organisms, or communities. A knowledge of publications dealing with adjoining states as a whole, or with the counties or districts closest to Illinois is a necessary part of the equipment of every Illinois biologist, ecologist, geographer, agriculturist, forester, meteorologist, and soil scientist.

One difficulty has been to decide what non-ecological writings have sufficient ecological import to be included. The field ecologist finds value in those studies in physical geography which elucidate topography, substratum, soil character, climate, and environmental history, particularly that of glacial and post-glacial events. For this reason such articles are more likely to be included than not, as well as certain others which give locational details in particular areas in which Illinois ecologists are interested. Likewise, floral and faunal lists, and less comprehensive locality records, especially in the older publications, are necessary equipment. Pertinent accounts in early travels, and certain passages in works on the history of Illinois and its settlement, are also referred to.

For about one-third as many citations as here appear, references not yet completed are on hand. It is expected that in about two years, the second sizable part of the bibliography will be ready, with a grouping-together of the more important citations for certain subjects in a partial index. This will cover both parts.

Among the titles and annotations herein are more than a few of interest in many other regions than Illinois and the middle west. Some of the discussions of the "causes" of the treeless condition of prairie country are a contribution to the nearly world-wide problem of tree or bush vegetation as waging a never-ending struggle with grassland. Other problems of more than local interest are similarly approached.

In the citations, the date appearing at the left is the year in which the volume or the particular article was *issued*. If the volume containing the article was issued at a later time, that may be given in parentheses at the end. But most citations with two dates are for annual proceedings or reports in which the time of issue is one year or in a few cases two years later than the date prominently shown on cover or title-page which is the date in parentheses in the citation. Thus Vol. 10 of Trans. Ill. Acad. Sci. is the volume *for* 1917, but was published in 1918.

The compiler will be most grateful for additional citations that may be sent in by users of the bibliography. Some of them may duplicate titles now on hand, but in more cases may complete them or be new references. Titles of papers which are not to be included in either Part 1 or Part 2 because of limited scope or interest, will be kept filed on cards at the University of Illinois, Department of Botany, and may be consulted there as a supplement to the printed bibliography.

The compiler's obligation must be expressed, first to Dr. Stover, who assembled the nucleus of titles, and to other members of the committee who have contributed citations from time to time. The other members of the committtee are:

W. G. Waterman, Northwestern University, Evanston.
V. O. Graham, 4028 Grace Street, Chicago.
V. E. Shelford, University of Illinois, Champaign.
W. C. Allee, University of Chicago, Chicago.
L. E. Sawyer, State Natural History Survey, Urbana.
C. E. Montgomery, State Teachers College, DeKalb.
John Voss, Manual Training High School, Peoria.
Mary M. Steagall, Southern Illinois Normal University, Carbondale.

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1884 Lake county, Indiana, 1884 . . . with historical papers and other interesting records . . . Crown Point, Ind. 486 pp. Contains biological descriptions by E. W. DINWIDDIE (pp. 150-157) and BALL (158-175).

[BALL, T. H., AND HENRIETTA BALL]

1884 The flora of Lake county. Pp. 158-174 of BALL, 1884, q. v. [Brief descriptions of: sand ridges and marshes near L. Mich., forests and groves s. of Little Calumet river; prairie; Calumet marshes; bottom forests of the Kankakee. 239 plant spp. det. by HENRIETTA BALL are listed, pp. 166-171. No annotations. Groves descr. separately, pp. 171-174.]

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BARNES, W. D., REPPERT, FRED, AND MILLER, A. A.

1900 The flora of Scott and Muscatine counties [Iowa]. Proc. Davenport Acad. Sci. 8:199-287. [Abundance and habitat notes; occas. locality records. 1068 spp. listed. Flora of Wild Cat Den specially mentioned: this is now a state park. At the end are reprinted articles on Cnicus Hillii and Quercus ellipsoidalis by E. J. HILL.]

BARNEY, R. L., AND ANSON, B. J.

1920 Life history and ecology of the pigmy sunfish, Elassoma zonatum. Ecology 1:241-256.

1923 Life history and ecology of the orange-spotted sunfish Lepomis humilis. U. S. Bur. Fish, Doc. no. 938. 16 pp. [Work done at Fairport, Iowa.]

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1917 The beautiful Shades. Ind. Dept. Geol. and Nat. Resources, Ann. Rept. 41:80-89. (1916). [S. w. Montgomery co., on Sugar Creek.]

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1910 Geography of the middle Illinois valley. Ill. Geol. Surv. Bull. no. 15. 128 pp. Reprinted 1925.

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1919 The amount of standing timber in Kentucky. Dept. of Geol. and Forestry. Mineral and Forest Resources of Ky. (Ser. 5) 1:251-284.

BAUER, F. C.

1930 Response of Illinois soils to systems of soil treatment. Univ. Ill. Agr. Exp. Sta. Bull. 25:435-514c (no. 362). [Ill. soil-classification, p. 439; map, 440; Appendix, 514 a-c, gives type names, N, P, and pH data for 10 soil groups.]

BEAL, W. J.

1870 A stroll along the beach of Lake Michigan. Am. Nat. 4:356-358. [South of Chicago: strand and dune plants apparently as in Indiana dunes.]

BEBB, M. S.

1859 List of plants occurring in the northern counties of the state of Illinois, in addition to the catalogue given by Dr. I. A. Lapham. Trans. Ill. State Agr. Soc. 3:586-587. (1857-8).

1860 The flora of Ogle and Winnebago Cos., Ill. Prairie Farmer 22: (new ser. 6:)182-183. [The numbers appearing on these pages are 172-173, since pp. 176-192 were misprinted as 166-182. This article is on the *second* pair of pages numbered 172 and 173.—Plants characteristic of the following habitats: stream margins, level valley (presumably of Rock River) with prairie grasses and herbs; forested bluffs; rolling prairie of thinner soil near bluffs; higher prairies. Also describes: the groves, mostly in valleys, tree species few, incl. scrubby bur oak; hazel border or "ruff"; plants of Black Hawk's Pulpit (Castle Rock).]

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1826 to 1828 Contributions towards the botany of the states of Illinois and Missouri. Am. Jour. Sci. and Arts 10:257-264. 1826.—11:167-182. 1826.—14:112-121. 1828. [From Beck's records I have made a list of 65 plants that he found in prairies near St. Louis, and 14 spp. in barrens. Other habitats were noted. Abundance and seasonal data also given. Many of the records are from the Illinois River bluffs and valley.]

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BEHRENS, OTTO, JR.

1928 The ferns of Turkey Run. Proc. Ind. Acad. Sci. 37:377-379. (1927). See TEST, F. H., 1930.

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1893 A partial list of the flora of Wabash and Cass counties [Ind.] with notes. Ind. Dept. Geol. and Nat. Resources, Ann. Rept. 17:260-272. (1891).

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1929 Notes on the fall-flowering plants of the central Mississippi river valley. Rhodora 31:145-151.

1932 Floristics of a young lake. Am. Bot. 38:74-79.

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1915 A list of the Lepidoptera of Linn county, Iowa. Proc. Iowa Acad. Sci. 21:279-316 (1914). [Degree of abundance given. 6608 spp. listed.]

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1928 Preliminary list of Iowa mosses. Proc. Iowa Acad. Sci. 34:125-132. (1927).

1929 to 1931 Additional notes on Iowa mosses. Proc. Iowa Acad. Sci. 35:113-116. (1928); 36:137-139. (1929); 37:96-98. (1930).

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1925 A collection of amphibians and reptiles from southeastern Missouri and southern Illinois. Papers Mich. Acad. Sci. 4:533-541. (1924).

BLANCHARD, W. O.

1924 The geography of southwestern Wisconsin. Wis. Geol. and Nat. Hist. Surv. Bull. no. 65 (Educ. Ser. no. 8). 117 pp. [Map of prairie and forest, after Martin, p. 67.]

BLATCHLEY, W. S.

1891 Notes on the Batrachians and reptiles of Vigo county, Indiana. Jour. Cincinnati Soc. Nat. Hist. 14:22-35.—Supplement with same title, Ind. Dept. Geol. and Nat. Resources, Ann. Rept. 24:537-552. (1899). 1900.

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1892 II. 24:28-34.
1894 III. 26:217-223, 241-245.
1898 IV. 30:54-64.

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1865 On buried stems and branches in Illinois. Am. Jour. Sci. 2d. ser., 39:95-96.

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BODE, IRWIN T.

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1931 Grasses of Champaign county, Illinois. Ill. State Acad. Sci. 23: 104-116. (1930).

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1859 The oaks of Illinois. Trans. Ill. State Agr. Soc. 3:605-631, incl. 10 pls. (1857-8). [Botanical characters, life-history, buds, bark, wood, etc. No distributional or habitat data.]

1859 Forests and trees. Trans. Ill. State Agr. Soc. 3:651-661. (1857-8). [Discusses succession, quoting Vaupell and Dureau de la Malle. Includes some facts of Ill. plant geography.—Presented at first meeting of the Ill. Nat. Hist. Soc., at Bloomington, June 30, 1858. (Organization described pp. 637-643.)]

1859 On meteorology in connection with botanical investigations. Trans. Ill. State Agr. Soc. 3:671-675. (1857-8). [Read at 1859 mtg., Ill. Nat. Hist. Soc., Bloomington.—Correlates growth of corn in 1857 with temp. Mentions need for records of soil temp., intensity of insolation, and other data.]

1860 Notices and additions to Illinois flora. Prairie Farmer 22: (new ser. 6:) 294-295. [Lists of plants, mostly from s. Ill.]

1870 Occurrence of rare plants in Illinois. Am. Nat. 4:374.

1887 Flora Peoriana. The vegetation in the climate of middle Illinois. Peoria, J. W. Franks and Sons. 89 pp. [Classic vegetation study and flora.]

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BRETZ, J. HARLAN

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1872 The Diatomaceae of Lake Michigan. The Lens 1:41-44.

BROADHEAD, G. C.

1875 [Topography, soil, timber, and prairie in south-central Illinois.] In WORTHEN, rept. on Geol. Surv. Ill., 6:129-130 (Bond co.); 135-137 (Fayette co.—"we ascend by white oak slopes to post oak flats, thence to flat prairies, around which there is generally a margin of pin oak and sometimes black jack and post oak"); 149-150 (Montgomery); 156-158 (Christian, with note on Silphium terebinthinaceum); 163-165 (Shelby); 175-176 (Effingham); 184 (Moultrie, Macon and Piatt counties). [The descriptions of re-

BROADHEAD, G. C.—*Continued*

lation of topography to forest and prairie types are specific and accurate. On the whole they are the same as may be discerned in 1934. He names grasses rarely, but more conspicuous prairie plants frequently. He names many tree species, and uses them as indicators of soil quality. On p. 184 he describes "scalds"—today known as "slick spots" of poor soil, and mentions Ambrosia bidentata as characteristic of them.]

BROWN, AGNES, RUTH MARSHALL, AND PAUL B. RIIS.

1914 The trees of Rockford and vicinity, 11 pp.

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BROWN, PERCY EDGAR

1914 The fertility in Iowa soils. Iowa Agr. Exp. Sta. Bull. 1914-15:85-152. (Bull. no. 150). [1905 map of principal soil areas on p. 98.]

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1817 Western gazetteer; or, Emigrant's directory, containing a description of the western states and territories . . . Kentucky, Indiana, Ohio, and the territories of Illinois and Missouri. Auburn, N. Y. 336 pp.

BRUMFIEL, D. M.

1919 The animal ecology of Johnson county [Iowa]. Univ. Iowa Lab. Nat. Hist. Bull. 8 (1):1-37.

BRUNCKEN, ERNEST

1900 Bibliographical notes on Wisconsin forests. Bull. Wis. Nat. Hist. Soc. 1:127-128.

1910 Studies in plant distribution. 9. The shore of Lake Michigan. Bull. Wis. Nat. Hist. Soc. 8:145-157. [Nos. 1 to 8 of this series in vol. 2 of the same publication, deal with Wisconsin floras and vegetation, largely in the vicinity of Milwaukee and Waukesha county. Nos. 1 and 2 are in 2:17-24. 1902. Nos. 2 to 8, 2:137-169. Similar short articles are in vol. 1, 1900.]

BUCK, SOLON J.

1914 Travel and description, 1765-1865, together with a list of county histories, atlases, and biographical collections and a list of territorial and state laws. Springfield, Collections Ill. State Hist. Libr. vol. 9. 514 pp.

1917 Illinois in 1818. Ill. Centennial Publs. Introductory vol., preliminary to the Centenn. History of Ill. Decatur, Ill., Review Printing and Stationery Co. 26 + 362 pp. See ALVORD, C. W., 1920, and PEASE, T. C., 1919.

BUHL, CARL A.

1934 Supplement to an annotated flora of the Chicago area by H. S. PEPOON. Bull. Chicago Acad. Sci. 5:5-12. (See PEPOON, 1927). [Many spp. added, some deleted.]

BURKE, MYRLE

1929 Prairie vegetation and environmental factors. Proc. Iowa Acad. Sci. 35:143-145. (1928). [Black Hawk co.]

1932 Flowering plants of Black Hawk county, Iowa. Proc. Iowa Acad. Sci. 38:135-149. (1931).

BURRILL, A. C.

1910 How sanguinary ants change at will the direction of column in their forays. (F[ormica] sanguinea var.). Bull. Wis. Nat. Hist. Soc. 8:123-131.

1926 Missouri. Pp. 485-490 of Naturalist's guide to the Americas. See SHELFORD, 1926.

1934 Missouri's natural resources, including a source list of where to obtain information . . . Mo. State Museum, Bull. no. 2. 16 pp., mimeographed. Jefferson City. [Arranged under 5 geographic provinces.]

1934 Missouri cave remains . . . Mo. State Museum, Bull. no. 3. 20 pp., mimeographed. Jefferson City. [Gen. account of Mo. caves, with locations and descriptions.]

BURRILL, A. C., AND SMITH, M. R.

1919 A key to the species of Wisconsin ants, with notes on their habits. Ohio Jour. Sci. 19:279-292. See also SMITH, M. R., and BURRILL, A. C.

BURRILL, T. J.

For bibl. of scientific writings of T. J. B., see JANVRIN, 1917.

1879 Effects of frost on plants. Trans. Ill. State Hort. Soc., n. s. 12:155-163. (1878).

1880 Anthrax of fruit trees; or, The so-called fire blight of pear and twig blight of apple trees. Proc. Am. Assoc. Adv. Sci. 1880:583. [First announcement that bacteria cause plant disease.]

1881 Bacteria as a cause of disease in plants. Am. Nat. 15:527-531. [Peach yellows considered due to bacteria, as well as pear blight. Pear blight experiments described. Diseases of Lombardy poplar and aspen also ascribed to bacteria.]

1885 The Uredineae of Illinois—a list of the species. Proc. Am. Micros. Soc. 8:93-96.

1886 The forest-tree plantation [U. of I. campus]. Univ. of Ill. Bd. of Trustees Rept., 13:255-282.

1886 Climatical destruction of orchard trees. Rept. Ill. Industr. Univ. 13:283-293.

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1889 The biology of silage. Ill. Agr. Exp. Sta., Bull. no. 7: 177-194.

1895 The distribution of plants. Trans. Ill. State Hort. Soc., n. s. 29:105-111.

1897 The tulip tree. Trans. Ill. State Hort. Soc., n. s. 31:436-446.

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1904 Micro-organisms of soil and human welfare. Science 20:426-434. Also in Trans. Am. Micros. Soc. 26:5-18.

1907 Forestry for Illinois. Trans. Ill. State Hort. Soc., n. s. 41:62-75.

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1913 The drouth and its lessons. Trans. Ill. State Hort. Soc., n. s. 47:79-87.

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1924 The geography of the western Kentucky coal field. Ky. Geol. Surv., ser. 6, vol. 24. 211 pp. [veg., 48-50.]

BURUNJIK, MAY

1931 Studies on germination of seeds of native herbaceous plants of the Chicago region. Trans. Ill. State Acad. Sci. 23:126-127. (1930).

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1895 A list of the trees, shrubs and vines of Missouri. Jefferson City, Mo. Mo. State Hort. Rept. 1895:353-393.

BUSWELL, A. M.

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BUTLER, AMOS W.

1894 Bibliography of Indiana ornithology and notes on Indiana birds. Proc. Ind. Acad. Sci. 1893:108-120.

1896 Indiana—a century of changes in the aspects of Nature. Proc. Ind. Acad. Sci. 1895:31-42.

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BUTTS, CHARLES

1925 Geology and mineral resources of the Equality-Shawneetown area. Ill. State Geol. Surv. Bull. no. 47. 76 pp.

BUZZARD, R. G.

1931 The red-top production of southeastern Illinois. Trans. Ill. State Acad. Sci. 23:465-475. (1930). [Red-top and broom-corn are highly localized Ill. crops. The environmental basis for broom-corn is said to be the soil, of quite heavy texture. The center is Arcola, Douglas county.—A. G. V.]

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1917 Bibliography of the loess. Proc. Iowa Acad. Sci. 23:159-162.

CADY, G. H.

1919 Geology and mineral resources of LaSalle and Hennepin quadrangles. Ill. State Geol. Surv. Bull. no. 37. 136 pp.

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CAIN, S. A.

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1874 The land and fresh water shells of LaSalle county, Ill. Proc. Ottawa Acad. Nat. Sciences, 1874:1-48. (Chicago, H. McAllaster & Co., Printers.) [Academy of Ottawa, Illinois.]

1896 The lichen flora of Chicago and vicinity. Chicago Acad. Sci., Geol. and Nat. Hist. Surv., Bull. no. 1. 50 pp.

CALL, RICHARD E.

1900 A descriptive illustrated catalogue of the Mollusca of Indiana. Ind. Dept. Geol. and Nat. Resources, Ann. Rept. 24:335-535, and 78 plates. (1899). [Pl. 1, Hydrographic map of Ind.—See supplementary papers by BLATCHLEY and DANIELS, 1903, and DANIELS, 1903.]

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CALVIN, SAMUEL, AND BAIN, H. F.

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CAMERON, J. E.

1897 Forest trees of Delaware county. Repts. Iowa Geol. Surv. 8:193-199.

CAMPBELL, J. L.

1882 Report upon the improvement of the Kankakee River and the drainage of the marsh lands in Indiana. [Referred to, and in part summarized, in BLATCHLEY, 1898:60-65. (Geol. of Lake and Porter counties, q. v.)]

CAMPBELL, JOHN T.

1885 Why certain kinds of timber prevail in certain localities. Am. Nat. 19:337-341. [Infl. of time of shedding seeds of trees in Wabash bottoms, w. Ind.]

1885 Age of forest trees. Am. Nat. 19:838-844. [Growth-ring studies; infl. of tornadoes; resistance of sycamore to burial by flood sediment.]

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1886 Track of a cyclone which passed over western Indiana more than three hundred years ago. Am. Nat. 20:348-353.

1886 Causes of forest rotation. Am. Nat. 20:521-527, 851-856. [Crows as carriers of heavy seeds and fruits.]

CAMPBELL, R. A., AND WALLING, H. F.

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1917 The homes of blindfishes. Geogr. Rev. 4:170-182. [Incl. discussion of Ind. and Ky. blindfishes, and (p. 176) mentions an eyed relative, in a cave spring in s. Ill.]

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1880 Vegetation along the lakes. Trans. St. Louis Acad. Sci. 4; 190-192. [Read in 1878.] on p. 408 of coll. works. [Apparently recognized Hill's oak (before it was described) as different from red oak and black oak.]

1883 The mean and extreme daily temperatures in St. Louis during forty-seven years, as calculated from daily observations. With diagram summarizing results, by G. HAMBACH. Trans. Acad. Sci. St. Louis 4:496-508. (1878-1886).

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ENGELMANN, HENRY A.

1863 Remarks upon the causes producing the different characters of vegetation known as Prairies, Flats, and Barrens in southern Illinois, with special reference to observations made in Perry and Jackson counties. Am. Jour. Sci. and Arts (ser. 2) 36:384-396. [Emphasizes poor drainage and fine-textured soil of prairie uplands. The flats or post-oak flats, are admirably described: scattered tree growth, with prairie plants between.]

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1865 On the fruit soils of Illinois. Trans. Ill. State Agr. Soc. 5:938-947. (1861-'64). Also publ. in Trans. Ill. State Hort. Soc. for 1864:-58-67. 1865. [Of high value for its descriptions of physical geography, soil, and vegetation. 6 divisions distinguished for southwestern Ill.: 1. Prairie soils (poor drainage emphasized). 2. Post-oak flats and barrens (latter mostly on slopes). "Before long the last of the grass-barrens will be naturally changed into forests . . . of black-oak and post-oak." 3. White and black-oak ridges [Ozark hills]. 4. Tertiary formation in the extreme south. 5. Mississippi bluffs. 6. Bottom-lands of the Mississippi.]

1866 [Surface configuration and timber of Pulaski and Massac counties.] Geol. Surv. Ill. (WORTHEN) 1:410-412, 429-434. [These are the more specific notes on timber in 2 of the 5 county descriptions by ENGELMANN in this vol. Good correlations with substratum and topogr.] See also WORTHEN (and ENGELMANN), 1868.

1868 [Surface configuration, prairie, and timber of Washington, Clinton, Marion, and Jefferson counties.] Geol. Surv. Ill. (WORTHEN) 3:146-147, 173-174, 192-193, 219.

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EVERMANN, BARTON W.

1902 List of species of fishes known to occur in the Great Lakes or their connecting waters. Bull. U. S. Bur. Fish. 21:95-96. (Doc. 486). (1901).

1917 A century of Zoology in Indiana. 1816-1916. Proc. Ind. Acad. Sci. 1916:189-224.

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1909 The Oribatoidea of Illinois. Bull. Ill. State Lab. Nat. Hist. 7:337-389.

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1913 The future of the North American fauna. Pop. Sci. Mo. 82:169-177.

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1870 The genus Quercus in Menard county, Ill. Am. Ent. and Bot. 2:191. [10 spp., with estimated relative abundance in virgin forests.]

See WOLF and HALL, 1878.

HALL, JAMES (1793-1868)

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1838 Notes on the western states, containing descriptive sketches of their soil, climate, resources, and scenery. Philadelphia. 304 pp.

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1911 Forest conditions in Illinois. Bull. Ill. State Lab. Nat. Hist. 9:175-253.

HAMMAR, C. H., AND KRUSEKOPF, H. H. (Editors)

1933 Proceedings of the first Missouri conference on land utilization. Mo. Agr. Exp. Sta., Bull. no. 323. 62 pp.

HANCOCK, J. L.

1894 Unusual flights of the grouse locust (Tettigidea lateralis Say), in northeastern Illinois. Am. Nat. 28:483-487, and pl. 13, opp. p. 496. [Swarms appeared in Chicago, Sept. 1893, following drought. Movement partly due to winds from south.]

1911 Nature sketches in temperate America. A series of sketches and a popular account of insects, birds, and plants, treated from some aspects of their evolution and ecological relations. Chicago, A. C. McClurg & Co., 18 + 451 pp., 215 figs., 12 col. pls. [n. Ind. dunes, pp. 295-300; ecology of Orthoptera, especially in Ill., Ind., and s. Mich., pp. 324-429. Index, pp. 435-451.]

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1911 An ecological study of the fish of a small stream. Trans. Ill. State Acad. Sci. 3:23-31 (1910).

1914 Distribution of fish in the streams about Charleston, Illinois. Trans. Ill. State Acad. Sci. 6:102-113. (1913).

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HARMAN, J. A.

1913 Report and plans for reclamation of land subject to overflow in the Embarrass River valley. Ill. State Geol. Surv. Bull. no. 25. 61 pp., maps, profiles.

1916 Report and plans for reclamation of land subject to overflow in the Spoon River valley. Ill. State Geol. Surv. Bull. no. 32. 57 pp., maps, profiles.

HARPER, R. M.

1918 Review of Hall and Ingall on Illinois forests. Torreya 18:166-171. [p. 171: "Or it may be that the beech avoids the richest soils, with abundant soil fauna, such as characterize most of Ill."]

HARRIS, HUBERT A.

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HARSHBERGER, JOHN W.

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1895 On the entomology of the Illinois River and adjacent waters. Bull. Ill. State Lab. Nat. Hist. 4:149-273.

1903 Synopsis of insect collections for distribution to Illinois high
1906 schools. I. Lepidoptera (pp. 1-64, 1903). II. Orthoptera (pp. 65-92, 1906). Ill. State Lab. Nat. Hist., Urbana.

1909 Biotic zones and districts in Illinois. Abstract. Trans. Ill. State Acad. Sci. 1:57-58. (1908). [Transition zone in n. e. Ill.; n. e. sand area, adjoining L. Mich. and in Kankakee Valley; w. and n. w. sand areas in Ill. and Miss. River Valleys; n. prairie, to lat. of Shelbyville; s. prairie; Ozark ridge and river valley area; Lower Austral zone s. of Ozarks.]

1919 The Pentatomoidea of Illinois. Bull. Ill. State Lab. Nat. Hist. 13:157-223.

HART, C. A., AND GLEASON, H. A.

1907 On the biology of the sand areas of Illinois. Bull. Ill. State Lab. Nat. Hist. 7:137-272.

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1909 Contents and index of the reports of the State Entomologist of Illinois, 13-24, 1884-1908. Appendix to 24th rept., 157 pp. See ANGE V. MILLER, 1885, and FRISON and SNYDER, 1925.

HARVEY, EDWARD M.

1914 Evaporation and soil moisture on the prairies of Illinois. Trans. Ill. State Acad. Sci. 6:92-99. (1913).

HAY, OLIVER PERRY

See LULL, 1931. [Bibl. of Hay's writings.]

1878 An examination of Prof. Leo Lesquereux's theory of the origin and formation of prairies. Am. Nat. 12:299-305. [Hay shows that prairies do not in most areas form upon lacustrine deposits.]

1887 The red-headed woodpecker a hoarder. The Auk 4:193-196. [It stores beechnuts, acorns, and other hard-coated fruits.]

1887 The massasauga and its habits. Am. Nat. 21:211-218.

1892 On the breeding habits, eggs, and young of certain snakes. Proc. U. S. Nat. Mus. 15:385-397. Paper of same title in Proc. Ind. Acad. Sci. 1891:106-120. [Observations in Ill. and Ind. included.]

1892 The batrachians and reptiles of the state of Indiana. Ind. Dept. Geol. and Nat. Resources, Ann. Rept. 17:409-609. (1891). [30 batrachian and 51 reptile spp.]

1895 The lampreys and fishes of Indiana. Ind. Dept. Geol. and Nat. Resources, Ann. Rept. 19:146-296. (1894).

1896 On some collections of fishes made in the Kankakee and Illinois rivers. Publs. Field Columbian Mus. Zool. 1:85-97.

1909 The geological and geographical distribution of some Pleistocene mammals. Science 30:890-893.

1910 On the changes of climate following the disappearance of the Wisconsin ice sheet. Die Veränderungen des Klimas seit dem letzten Eiszeit: 11th Internat. Geol. Congr., Stockholm 1910:371-374.

1912 The Pleistocene period [in Indiana] and its Vertebrata. Ind. Dept. Geol. and Nat. Resources, Ann. Rept. 36:539-784. (1911).

1914 The Pleistocene mammals of Iowa. Iowa Geol. Surv., Ann. Rept. 23:1-662. 75 pls., 142 figs.

1923 The Pleistocene of North America and its vertebrated animals from the states east of the Mississippi River and from the Canadian provinces east of longitude 95°. Carnegie Inst. Wash., Publ. no. 322. 499 pp.

1927 The prong-horn antelope in Illinois. Jour. Mamm. 8:61-62. [Pleistocene or early Recent remains, n. w. Ill.]

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1913 Scattering of weeds. Iowa Geol. Surv. Bull. no. 4:627-640.

1919 Notes on the floristic features of a prairie province. Proc. Iowa Acad. Sci. 25:369-389. (1918).

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1926 The story of weed seed dissemination. Iowa Geol. Surv. Bull. no. 4 (revised ed.), pp. 561-574.

HAYES, WILLIAM P.

1927 Prairie insects. Ecology 8:238-250.

1931 Morphology, taxonomy, and biology of larval Scarabaeoidea. Ill. Biol. Mon. 12(2):85-119. (1929). [Biol. and ecol. literature, p. 13; devel. and biol. 47-71.]

HEBARD, MORGAN

1934 The Dermaptera and Orthoptera of Illinois. Ill. State Nat. Hist. Surv. Bull. 20 (Art. 3):125-279. Chapters by H. H. Ross: Biology and habits of the orders, and Ecological factors affecting Orthoptera, pp. 125-135.

HEIMLICH, LOUIS F.

1918 The trees of White county, Indiana, with some reference to those of the state. Proc. Ind. Acad. Sci. 1917:387-471. [Detailed account with colored maps, annotated list of spp.]

1921 to 1923 Native plants of White county. A series in Proc. Ind. Acad. Sci.: I deals with the primrose-leaved violet (1914:213-217). II is the preceding item on trees of the county. III to V constitute a local flora of herbs, shrubs, and woody vines.—III. 1920:219-224.—IV. 1921:117-119.—V. 1922:281-289.

HEMPEL, ADOLPH

1899 A list of the Protozoa and Rotifera found in the Illinois River and adjacent lakes at Havana, Illinois. Bull. Ill. State Lab. Nat. Hist. 5:301-388.

HENDERSON, JOHN G.

1872 The former range of the buffalo. Am. Nat. 6:79-98. Many quotations from early French travelers, relating to bison in Illinois and elsewhere.

HENDERSON, LENA B.

1929 The plants of Castle Rock. A preliminary report. Trans. Ill. State Acad. Sci. 21:144-151. (1928).

HENDRICKSON, G. O.

1928 Some notes on the insect fauna of an Iowa prairie. Ann. Ent. Soc. Am. 21:132-138.

1930 Studies on the insect fauna of Iowa prairies. Iowa State Coll. Jour. of Sci. 4:49-180.

1931 Notes on vertebrates of Iowa prairies. Proc. Iowa Acad. Sci. 37:398-399. (1930).

HESS, ISAAC E.

1910 One hundred breeding birds of an Illinois ten-mile radius. The Auk 27:19-32. Center at Philo, Champaign co.

HIGLEY, WILLIAM KERR

1902 Historical sketch of the Academy. Chicago Acad. Sci. Special Publ. no. 1. 52 pp., pls. (publ. also in vol. 2 of BLANCHARD'S History of the Northwest.)

HIGLEY, WILLIAM KERR, AND RADDIN, CHARLES S.

1891 The flora of Cook county, Illinois, and a part of Lake county, Indiana. Bull. Chicago Acad. Sci. vol. 2, no. 1, 23 + 168 pp. [1042 native plant species with notes on habitat, localities, season, and abundance. List preceded by descriptive sections, including sketch of H. H. BABCOCK, author of Chicago flora and director of the Chicago Botanical Garden in South Park (1874-77). Other sections describe physical geography of Cook co., forest trees, plants and localities of special interest, etc.]

HILL, E. J.

1881 Plants and plant-stations. Bull. Torr. Bot. Club 8:45-47. [A few plants in various habitats at Englewood, L. Mich. dunes, banks of Kankakee River, etc.]

1881 Botanical notes. [Plant localities, Ill., Ind., Mich.] Bot. Gaz. 6:259-263.

1883 Notes on Indiana plants. Bot. Gaz. 8:187-188. Cont. 1884, 9:45-48.

1885 Some Indiana plants. Bot. Gaz. 10:262-263. Cont. 1888, 13:323.

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1890 The revised manual and some western plants. Bull. Torr. Bot. Club 17:169-174. [Distr. in Ill. and near L. Mich.]

1892 Notes on the flora of Chicago and vicinity. I. Bot. Gaz. 17:246-252.

1896 II. Bot. Gaz. 21:118-122.

1896 The sand dunes of northern Indiana and their flora. Garden and Forest 9:353-354, 373-374, 382-383, 393-394.

1897 Ecological notes on the white pine. Garden and Forest 10:331-332. [Ind. dunes and elsewhere, not Ill. Wide range of adaptability to soils and to moisture conditions.]

1899 A new biennial-fruited oak [Quercus ellipsoidalis.] Bot. Gaz. 27:204-208. [First recognized near southern limits of Chicago.]

1899 Notes on plants of the Chicago district. Bull. Torr. Bot. Club 26:303-311.

1899 The habitats of the Pellaeas. Bull. Torr. Bot. Club 26:596-598. [Limestone ledges, lower DesPlaines valley.]

1900 The southern limit of Juniperus sabina. Plant World 3:140.

1902 Notes on migratory plants. Bull. Torr. Bot. Club 29:564-570. [Incursions of weeds and certain native plants into Ill. and L. Mich. dunes.]

1906 Distribution and habits of some common oaks. Bot. Gaz. 41:445-447. [A brief confirmatory note in] 42:59. 1907.

1912 The fern flora of Illinois. Fern Bull. 20:33-43.

1915 Notes on plants of the Chicago region. Torreya 15:21-28.

1927 The southern and southwestern moraine and the adjacent low-lying regions, portions of Cook, Will, and DuPage counties, Illinois. Pp. 63-100 of PEPOON, 1927, Flora of the Chicago region (q.v.). [Mr. Hill died in 1917.]

HINRICHS, G. D.

1880 Rainfall and timber in Iowa. Trans. Iowa Hort. Soc. 14:198-201.

HOLDER, R. H.

1861 Birds of Illinois. Catalogue. Trans. Ill. State Agr. Soc. 4:605-613. (1859-60). [152 spp. Names only.]

HOLLISTER, NED

1910 A check list of Wisconsin mammals. Bull. Wis. Nat. Hist. Soc. 8:21-31.

HOLMES, C. L.

1929 Types of farming in Iowa. Iowa Agr. Exp. Sta. Bull. 1928-29:113-166. (Bull. no. 256). [Numerous maps, showing precipitation, length of growing season, prevailing soil types (with which the 6 type-of-farming areas are closely correlated) and data on particular farm products.]

HOLMES, J. S., AND BRADFORD, WESLEY

1908 First report on a study of the forest conditions of Kentucky made by the Forest Service, U. S. Dept. Agr. Bienn. Rept. Ky. Commr. Agr., Labor, and Statistics, 1907:67-94.

HOLMQUIST, A. M.

1926 Studies in arthropod hibernation.
I. Ecological survey of hibernating species from forest environments of the Chicago region. Ann. Ent. Soc. Am. 19:395-429.

1928 II. Hibernation of the ant, Formica ulkei Emery. Physiol. Zool. 1:325-357.

1931 III. Temperatures in forest hibernacula. Ecology 12:387-400.

1928 Notes on the life-history and habits of the mound-building ant, Formica ulkei Emery, Ecology 9:70-87. [Colonies at Palatine and Palos Park, Ill.]

HOOKOM, DON W.

1931 A study of the Membracidae known to occur in Iowa. Proc. Iowa Acad. Sci. 37:385-386. (1930). [Earlier list by H. OSBORN, vol. 1, part 2:128. 1892 (1890-1891).]

HOPKINS, CYRIL G.

1907 Illinois soils in relation to systems of permanent agriculture. Rept. Ill. Farmers' Inst. 12:247-263.
See also Illinois Soil Survey. [Hopkins was one of the leading authors of the early county reports of the Survey.]

HOPKINS, C. G., MOSIER, J. G., AND BAUER, F. C.

1916 Summary of Illinois soil investigations. Bull. Univ. Ill. Agr. Exp. Sta. 13:449-484. (No. 193). [With colored soil map, as in Bull. 123.]

HOPKINS, C. G., AND PETTIT, J. H.

1908 The fertility of Illinois soils. Bull. Ill. Agr. Exp. Sta. 8:187-294. (No. 123). [With colored soil map of Ill., largely based on Leverett's glacial map. Moraines and till-plains of different ages are shown.]

HOPKINS, C. G., READHIMER, J. E., AND FISHER, O. S.

1912 Peaty swamp lands; sand and "alkali" soils. Bull. Univ. Ill. Agr. Exp. Sta. 11:95-131. (No. 157. 137 pp.)

HOPKINS, C. G., AND WHITING, A. L.

1916 Soil bacteria and phosphates. Bull. Univ. Ill. Agr. Exp. Sta. 13:391-406. (No. 190).

HORTON, A. H.

1914 Water resources of Illinois. Ill. Rivers and Lakes Commission. Springfield. 400 pp.

HOTTES, F. C., AND FRISON, T. H.

1931 The plant lice, or Aphiidae, of Illinois. Ill. Nat. Hist. Surv. Bull. 19:119-447. Host index (389-403), bibl. (404-417), 10 pls.

HOUDEK, PAUL K.

1924 An ecological survey and flora of Lake Knox. Trans. Ill. State Acad. Sci. 16:163-170. (1923). See ADCOCK, 1923.

1933 Pollen statistics for two Indiana bogs. Proc. Ind. Acad. Sci. 42:73-77. [One bog at Mineral Springs, in L. Mich. dune area.]

HOWARD, ARTHUR DAY

1914 Experiments in the propagation of fresh-water mussels of the Quadrula group. U. S. Bur. Fish. Doc. 801. 50 pp.

HUBBARD, F. T.

1917 Andropogon scoparius in the United States and Canada. Rhodora 19:102-103.

HUBBELL, THEODORE H.

1929 The distribution of the beach grasshoppers Trimerotropis huroniana and Trimerotropis maritima interior in the Great Lakes region (Orthoptera, Acrididae). Jour. N. Y. Ent. Soc. 37:31-39.

HUBBS, CARL L.

1919 The nesting habits of certain sunfishes as observed in a park lagoon in Chicago. Aquatic Life 4:143-144.

HUELS, F. W.

1915 The peat resources of Wisconsin. Wis. Geol. Surv. Bull. 45: (Econ. Ser. no. 20.) Map shows bog and swamp areas.

HUESING, MARGARET

1932 Hexagonal spacing in native vegetation. M. A. thesis, Univ. of Ill. 32 pp., veg. maps of small areas. [Incl. space-arrangement of spice-bush in Brownfield Woods.]

HUETT, J. W.

1897 Essay toward a natural history of LaSalle county, Ill. Part I—Botany, Flora LaSallensis. 4 + 137 pp. Part II—Geology and Zoology. 9 + 174 pp. Ottawa, Ill., Fair Dealer Print.

HULL, H.

1922 [Article on Starved Rock.] See COWLES, SMITH, et al., 1922.

HURTER, JULIUS

1884 List of birds collected in the neighborhood of St. Louis, Mo. Ornithologist and Oologist 9:85-87, 95-97, 128. 265 spp., brief notes.

1893 Catalogue of reptiles and amphibians found in the vicinity of St. Louis, Mo. Trans. Acad. Sci. St. Louis 6:251-261. (1892-1894). [St. Louis co., Mo., and "American Bottoms" in St. Clair and Madison counties, Ill.]

1911 Herpetology of Missouri. Trans. Acad. Sci. St. Louis 20:59-271. Two earlier papers on same subject, 7:499-503, and 13:77-86.

HUS, HENRI

1908 An ecological cross-section of the Mississippi River in the region of St. Louis, Missouri. Ann. Rept. Mo. Bot. Gard. 19:127-258.

HYATT, JAMES

1875 Western plants. Bull. Torr. Bot. Club 6:66-68. [Trip N. Y. to Peoria.]

ILLICK, JOSEPH S.

1927 Common trees of Indiana. Publ. and distributed by Am. Tree Assoc., Washington, D. C. 111 pp. A popular handbook.

ILLINOIS BOARD OF PARK ADVISORS

1933 Report on the system of state parks in Illinois. Springfield, Schnepp & Barnes, printers. 71 pp., maps. (1932). See SERVICE, 1920, 1925.

ILLINOIS COUNTY ATLASES. See PHILLIPS, P. L., 1909.

ILLINOIS FISH COMMISSON

1880 to 1912 First report 1880, 2d 1882. Biennial reports begin with vol. publ. 1886. Continued by Illinois Game and Fish Commission, Annual Report 1913-1914 et seq.

ILLINOIS, GAME AND FISH COMMISSION

1913 Annual reports beginning 1913.

ILLINOIS SOIL SURVEY, AGRICULTURAL EXPERIMENT STATION, UNIVERSITY OF ILLINOIS, R. S. SMITH, Chief of Soil Physics and Mapping.

Soil reports are published for 56 of the 102 counties as follows:

1911	1. Clay	1921	20. Bureau	1927	38. Ogle
	2. Moultrie		21. McHenry		39. Logan
1912	3. Hardin	1922	22. Iroquois	1928	40. Whiteside
	4. Sangamon		23. DeKalb		41. Henry
1913	5. LaSalle		24. Adams		42. Morgan
	6. Knox	1923	25. Livingston	1929	43. Douglas
	7. McDonough	1924	26. Grundy		44. Coles
	8. Bond		27. Hancock		45. Macon
1915	9. Lake		28. Mason	1930	46. Edwards
	10. McLean	1925	29. Mercer		47. Piatt
	11. Pike		30. Johnson	1931	48. Effingham
1916	12. Winnebago		31. Rock Island		49. Wayne
	13. Kankakee		32. Randolph		50. Macoupin
	14. Tazewell	1926	33. Saline		51. Fulton
1917	15. Edgar		34. Marion	1932	52. Fayette
	16. DuPage		35. Will		53. Calhoun
	17. Kane	1927	36. Woodford	1933	54. Ford
1918	18. Champaign		37. Lee		55. Jackson
1921	19. Peoria			1934	56. Schuyler

Soil maps are available for the following counties (reports not yet published):

Clinton	Jasper	Vermilion
Crawford	Monroe	Wabash
Cumberland	Pulaski	Washington
Franklin	St. Clair	White

County soil maps in process of engraving and printing:

Alexander	Shelby
Cumberland (revised)	Stark
	Warren

Each soil report is the work of several joint authors. The following list includes the names of authors of reports thus far published: F. C. Bauer, R. W. Dickenson, O. I. Ellis, E. E. DeTurk, F. A. Fisher, O. S. Fisher, F. W. Garrett, S. V. Holt, C. G. Hopkins, W. R. Leighty, J. G. Mosier, E. A. Norton, J. H. Pettit, J. E. Readhimer, L. H. Smith, R. S. Smith, H. J. Snider, H. W. Stewart, E. Van Alstine, and F. W. Wascher. On the next reports to be published will appear other names, including those of Eric Winters, Jr., and Herman Wascher.

See also AGRONOMY DEPARTMENT, UNIVERSITY OF ILLINOIS.

ILLINOIS STATE GEOLOGICAL SURVEY

1917 Geologic map of Illinois, 4th ed. 35 x 51 inches. 1st ed. in Bull. 1 of Ill. Geol. Surv. 1906.

1925 Base map of Illinois, 5th ed. Replaces earlier eds. 31 x 51 inches, approx. 8 miles to the inch.

- Other maps, incl. numerous special topographic maps. See list of publs., Ill. Geol. Surv.

1933 List of publications on the geology, mineral resources, and mineral industries of Illinois, with appended index. Urbana, Sept. 1, 1933. 83 pp. Incl. series of misc. publs., 1906 to 1933, based on data of the Ill. Surv., but published elsewhere.

IMLAY, GILBERT

1797 Topographical description of the western country of North America; containing a succinct account of its climate, natural history, population, agriculture, manners and customs, with an ample description of the several divisions into which that country is divided. . . . Ed. 3. London. 598 pp., maps.

IOWA STATE PARKS BULLETIN

1923 to 1927 Publ. bimonthly by Iowa State Board of Conservation. Vol. 1, 1923-24; Vol. 2, 1924-25; Vol. 3, 1925-26, 192 pp.; Vol. 4, 1926-27, 168 pp. [Map of Iowa locating parks and other areas of interest, 3:112-113. Notice of discontinuance at end of Vol. 4.—Many very short non-technical articles. See PAMMEL et al, 1920.]

ISENBARGER, J.

1934 A contrast of plant habitats, with reference to hydrogen ion concentration and plant distribution. Trans. Ill. State Acad. Sci. 25:126-128. (1932). [Thornton woods, 22 mi. s. of Chicago; sphagnum bog near Lake Villa, Lake co.]

JACKSON, HARTLEY H. T.

1910 The distribution of certain Wisconsin mammals. Bull. Wis. Nat. Hist. Soc. 8:86-90.

JANVRIN, CHARLES E.

1917 The scientific writings of Thomas J. Burrill. Trans. Ill. State Hort. Soc. 51:195-201.

JAQUES, H. E.

1927 A preliminary survey of May beetles (Phyllophaga spp.) in Iowa. Proc. Iowa Acad. Sci. 33:337-339. (1926).

1928 A further report on the May beetles (Phyllophaga spp.) in Iowa. 34:314-315. (1927).

Other Phyllophaga papers by H. E. Jaques—29:163-164; 32:423-424; 35:303-304; 36:371; 37:387-388.

JENNY, HANS

1928 Relation of climatic factors to the amount of nitrogen in soils. Jour. Am. Soc. Agron. 20:900-912.

1929 Relation of temperature to the amount of nitrogen in soils. Soil Sci. 27:169-188.

1930 The nitrogen content of the soil as related to the precipitation-evaporation ratio. Soil Sci. 29:193-206.

JENSEN, JENS

1929 The native beeches in the Chicago region. Trans. Ill. State Acad. Sci. 21:69-71. (1928).

JEWELL, MINNA E.

1920 The quality of water in the Sangamon River. Ill. State Water Surv. Bull. No. 16:230-246.

1922 The fauna of an acid stream. Ecology 3:22-28. [Suggestions that certain laboratory studies of pH relations of fishes may require reinterpretation in the light of field data.]

JILLSON, W. R.

1926 Kentucky State Parks. Ky. Geol. Surv., Ser. 6, Pamphlet 6. 14 pp.

1927 The topography of Kentucky. Ky. Geol. Surv., Ser. 6, vol. 30:1-60.

1929 Kentucky state maps. Packet containing 3 large folded maps: Geol. map, 1927. Base map, 1928. Relief map, 1924. Ky. Geol. Surv., Ser. 6.

JOHNS, M. RAE

1930 Heliantheae of Iowa. I. Proc. Iowa Acad. Sci. 36:147-184. (1929).

1931 II. Proc. Iowa Acad. Sci. 37:161-208. (1930). [Photographs of composites in native prairie veg., etc.—other field data.]

JOHNSON, BENJAMIN F.

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1838 Illinois and the west; with a township map containing the latest surveys and improvements. Boston. 255 pp.

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1921 Effect of soil temperature upon the development of nodules on the roots of certain legumes. Jour. Agr. Res. 22:17-31.

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1838 Some observations made in Holland, connected with our prairie region. Am. Jour. Sci. and Arts, Ser. 2, 33:226-230. [Descr. of "barrens" in Ind.—in this case sand-hills covered with white oak, alternating with wet prairies in depressions.]

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1930 A method of determining the degree of coincidence in distribution of agricultural uses of land with slope-soil-drainage complexes. Trans. Ill. State Acad. Sci. 22:549-554. (1929). [Adaptations of such methods for ecological and other survey will suggest themselves.]

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1903 The self-purification of streams. Univ. Chicago, The Decennial Publs. 10:81-89. [Data from streams of the state, particularly Ill. River.]

JUDAY, C.
1914 The inland lakes of Wisconsin. The hydrography and morphometry of the lakes. Wis. Geol. and Nat. Hist. Surv. Bull. no. 27. 15 + 137 pp.

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1926 Opportunities for field study in the Chicago area. Trans. Ill. State Acad. Sci. 18:184-192. (1925). [Maps of Cook and DuPage counties, with forest preserves; detailed map of Morton Arboretum.]

KARPINSKI, LOUIS C.
1931 Bibliography of the printed maps of Michigan, 1804-1880, . . . an historical atlas of the Great Lakes and Michigan. Mich. Historical Commission, Lansing. 539 pp. Many reproductions of old maps.

KAUFMANN, REBECCA
1922 (Article on White Pines Park.) See COWLES, SMITH, et al., 1922.

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1931 The relative ages of the Iowa and Wisconsin drift sheets. Am. Jour. Sci. 21:158-172. [Interval between Iowan and Wisconsin glacial ages was relatively short. These two, with the Peorian interglacial age, make up the Eldoran epoch. Map p. 159.]

1931 Classification and duration of the Pleistocene period. Bull. Geol. Soc. Am. 42:425-466. [Glacial chronology in Iowa. Pleistocene deposits represent work of 700,000 to a possible 2,000,000 years. Postglacial time 25,000. Times of glaciation a small fraction of interglacial time (30,000:675,000, or 1:22.5). Information graphically summarized in maps and diagrams.]

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1930 Preliminary study of the profiles of the principal soil types of Wisconsin. Wis. Geol. and Nat. Hist. Surv., Bull. no. 77A, Soil Ser. no. 54. 112 pp.

KELLOGG, HARRIETTE S., AND PAMMEL, L. H.

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KELLOGG, R. S.

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1907 Forest planting in Illinois. Rept. Ill. Farmers' Inst. 12:232-244. [Mentions certain plantations, notably that of 1871-74 in Christian co. Ecol. results of plantations in indicating requirements of certain trees. Plan of mixed plantation at DeKalb, with triangular spacing.]

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1855 Catalogue of animals observed in Cook county, Illinois. Trans. Ill. State Agr. Soc. 1:577-595. (1853-4). [Degree of abundance given, with occasional brief habitat or other notes, as that Cooper's hawks follow the pigeons in their migrations.]

1857 The quadrupeds of Illinois, injurious and beneficial to the farmer. Trans. Ill. State Agr. Soc. 2:615-684. (1856-57). "From the Patent Office Report." Plates with 20 woodcuts at end of vol. [Full accounts on habits, life-histories, habitats, relation to other animals and to vegetation. Incidental information on other topics, as increase of oaks in n. Ill., p. 622, prairie sloughs, in acct. of muskrat, p. 681.]

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1916 Environmental influences on nectar secretion. Iowa Agr. Exp. Sta., Res. Bull. 1916:217-232. (Res. Bull. no. 37).

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1896 Bibliography of Missouri geology. Repts. Mo. Geol. Surv. 10:219-523.

KING, CHARLOTTE M. See PAMMEL AND KING.

KING, INEZ N.

1915 The Coleoptera of Henry county, Iowa. Proc. Iowa Acad. Sci. 21:317-340. (1914).

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1930 Geographical distribution of variability in the yields of field crops in the states of the Mississippi valley. Ecology 11:293-306. [Ill. and other states e. of Miss. river less subject to fluctuations than states farther west.]

KNAPPEN, R. S.

1926 Geology and mineral resources of the Dixon quadrangle. Ill. State Geol. Surv. Bull. no. 49. 141 pp.

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1897 I. Methods and apparatus . . . 5:1-25.

1898 II. On Pleodorina illinoisensis, a new species from the plankton of the Illinois River. 5:273-293.

1899 III. On Platydorina, a new genus of the family Volvocidae . . . 5:419-440.

1903 IV. The plankton of the Illinois River, 1894-1899, with introductory notes on the hydrography of the Illinois River and its basin. Part I. Quantitative investigations and general results. 6:95-629.

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1921 Mallophaga of our native birds. Proc. Ind. Acad. Sci. 1920:119-133.

KOMAREK, E. V., AND SPENCER, DON A.

1931 A new pocket gopher from Illinois and Indiana. Jour. Mammal. 12:404-498.

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1931 Skyshine and sunshine at Ames. Proc. Iowa Acad. Sci. 37:303-305. (1930). [Determinations with Macbeth illuminometer.]

KURZ, HERMAN

1922 Hydrogen ion concentration in relation to topography, types and depths of soil, seasonal phenomena, and plant distribution. Ph.D. thesis, Univ. of Chicago.

1923 Hydrogen ion concentration in relation to ecological factors. Bot. Gaz. 76:1-29. Studies at Thornton, Palos Park, Apple River Canyon, Benton Mound, Starved Rock, Ill.; Chesterton bog and L. Mich. dunes, n. Ind.; Sawyer dunes and Baroda bog, s. w. Mich.

1928 Influence of sphagnum and other mosses on bog reactions. Ecology 9:56-69. [Lake co., Ill. (Sayer, Duck Lake, Wauconda, and Cedar Lake bogs; County Line tamarack forest). Indiana dunes (Cowles, Chesterton, and Merrillville bogs). Others in Mich. Classification of bogs, etc.]

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1857 The native, naturalized, and cultivated grasses of the State of Illinois. Trans. Ill. State Agr. Soc. 2:551-613. (1856-7). [Synonyms, descriptions, notes on mode of growth, time of flowering, distribution, habitat, etc. 4 pls. with many figs., index.]

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1925 The glacial history of the Elgin region. Trans. Ill. State Acad. Sci. 17:65-71. (1924).

1930 Topographic and other maps of Illinois. The Ill. Engineer 6 (2):4-6.

1931 The Peorian loess and the classification of the glacial drift sheets of the Mississippi valley. Jour. Geol. 39:45-53. [Peorian time too brief for interglacial stage. Iowan regarded as earliest Wisconsin. Map, p. 52. Correlation of American and European classifications, p. 53.]

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1866 On the origin and formation of the prairies. Geol. Surv. Ill. 1:238-254.

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1888 Raised beaches of Lake Michigan. Trans. Wis. Acad. Sci. 7:177-192.

1895 Soils of Illinois. Pp. 73-92 of Final Rept. of Ill. Board of World's Fair Commissioners. Springfield.

1896 The Pleistocene features and deposits of the Chicago area. Chicago Acad. Sci., Bull. No. 2. 87 pp.

1896 Water resources of Illinois. U. S. Geol. Surv., Ann. Rept. 17, Part II: h, 695-849.

1899 The Illinois glacial lobe. U. S. Geol. Surv., Monograph 38. 817 pp.

1908 Glacial deposits of Indiana. Pp. 29-41 of DRYER, 1908, q.v.

1910 Outline of the history of the Great Lakes. Rept. Mich. Acad. Sci. 12:19-42.

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1929 Ecologic foliar anatomy of some plants common to Illinois and North Carolina. Trans. Ill. State Acad. Sci. 21:77-83. (1928).

LINDLY, J. M.

1905 Flowering plants of Henry county, Iowa. [I] Proc. Iowa Acad. Sci. 12:157. (1904).

1928 II. 34:133-137. (1927).

LINDSEY, ALVA J.

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LOBECK, A. K.

1929 [Physiographic diagram of Kentucky.] P. 332 of the geology and physiography of the Mammoth Cave National Park. Ky. Geol. Surv. ser. 6, 31:327-399. (Separate issued as Pamphlet 21, 1928.)

1930 The Midland Trail in Kentucky; a physiographic and geologic guide book to U. S. Highway no. 60. Ky. Geol. Surv., Ser. 6, 33;163-252. 39 photographs, maps, and diagrams.

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1929 A study of the Coccinellidae of Iowa. Proc. Iowa Acad. Sci. 35:307-311. (1928).

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1894 The life history and distribution of the prothonotary warbler in Illinois. Bull. Ill. State Lab. Nat. Hist. 4:10-35. See ADAMS 1902.

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1888 Report on geological and economic features of the Jackson Purchase region [w. end Ky.] Geol. Surv. Ky. (J. R. Procter, Director), [ser. 2], vol. F. 357 pp. [Soils, topogr. and veg. of different types of areas, pp. 139-172. Cane hills, see index. Conversion of grass barrens to scrub oak, 163-172. Notes on timber, etc., in county descriptions, 201-320.]

LUCE, W. M.

1933 A survey of the fishery of the Kaskaskia River. Ill. Nat. Hist. Surv. Bull. 20:71-123.

LULL, R. S.

1931 Memorial of Oliver Perry Hay. Bull. Geol. Soc. Am. 42:30-48. [Bibl. of Hay's writings, 1878-1930, on pp. 34-48. Early papers incl. ecol. notes on species and faunas; those of Ill. and Ind. well represented.]

LUNT, H. A.

1929 The vertical distribution of soil bases and acidity in some Illinois soils. Soil Sci. 28:137-176.

1931 The carbon-organic matter factor in forest soil humus. Soil Sci. 32:27-33.

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1923 Notes on the mammals of the dune region of Porter county, Indiana. Proc. Ind. Acad. Sci. 1922:209-221.

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1930 Suppl. to the above. Ibid 12:33-43.

MACBRIDE, J. FRANCIS

1924 [Wild flower leaflets] published by Field Museum of Natural History, Chicago. Photographs mostly by L. W. BROWNELL. Botany Leaflet No. 7 Spring wild flowers. 32 pp.
No. 8 Spring and early summer wild flowers. 30 pp.
No. 9 Summer wild flowers. 30 pp.
No. 10 Autumn flowers and fruits. 29 pp.

MACBRIDE, THOMAS H.

1888 to 1896 The saprophytic fungi of eastern Iowa. Bull. Lab. Nat. Hist. State Univ. Iowa 1:30-44; 181-195. (2d part, 1890).—[3d part.] The Polyporeae, Part II of Vol. 3:1-30. 1895.—[4th part.] The Puff-balls, 4:33-66 (with NORRA ALLIN). 1896.

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1895 Forest distribution in Iowa. Proc. Iowa Acad. Sci. 3:96-101.

MACCLINTOCK, PAUL

1929 Physiographic divisions of the area covered by the Illinoian drift-sheet in southern Illinois. Ill. Geol. Surv., Rept. of Investigations No. 19:6-25.

1929 Recent discoveries of pre-Illinoian drift in southern Illinois. Ill. Geol. Surv., Rept. of Investigations 19:27-57.

1933 Correlation of the pre-Illinoian drifts of Illinois, Jour. Geol. 41:710-722. [Nebraskan ice-sheet advanced from w., Kansan from n.e. Map of these two drifts in Ill.]

See also LEIGHTON and MACCLINTOCK.

MACDONALD, ROSE M. E.

1921 An analytic subject bibliography of the publications of the Bureau of Fisheries, 1871-1920. U. S. Bur. Fish., Doc. 899. 306 pp. [Includes many additional titles on aquatic life and conditions of Great Lakes and inland waters of Ill. and adjoining states.]

MALLOCH, JOHN R.

1915 The Chironomidae, or midges, of Illinois, with particular reference to the species occurring in the Illinois River. Bull. Ill. State Lab. Nat. Hist. 10:275-543 (additional records in 11:305-363. 1915.)

MALOTT, C. A.

1922 The physiography of Indiana. Part 2, Handbook of Indiana Geology. Ind. Dept. Conserv., Publ. 21:59-256. [Topographic map, pl. I; physiographic divisions, pl. II; glacial map, moraines, etc., pl. III.]

1926 The glacial boundary in Indiana. Proc. Ind. Acad. Sci. 35; 93-107. (1925).

MARBUT, CURTIS F.

1896 Physical features of Missouri. Repts. Mo. Geol. Surv. 10:11-109.

1923 Soils of the Great Plains. [Includes broader area eastward than the short-grass plains.] Ann. Assoc. Am. Geographers 13:41-66.

MARTIN, G. W.

1926 Some Amanitas from eastern Iowa. Proc. Iowa Acad. Sci. 32:205-213. (1925).

MARTIN, LAWRENCE

1914 The physical geography of Wisconsin. Jour. of Geogr. 12:226-232.

1932 The physical geography of Wisconsin, 2d ed. Wis. Geol. and Nat. Hist. Surv. Bull. No. 36 (Educ. Ser. No. 4). 608 pp. (Rev. of above and other articles on Wis. geography in Geogr. Rev. 23: 135-136. Map of Wis. showing 22 geographic districts on p. 135.) [1st ed. of MARTIN in 1916. On p. 16 of 2d ed., forest map of 1882 showing 4 groups of forest types. Prairies in Driftless Area, pp. 137-139; map, p. 138. Prairies in s. e. Wis., p. 291; map, p. 292. Map of swamps, p. 290. Glacial maps, p. 83, 87, etc. Bibl. of maps, pp. 494-513. Index map of soil survey, p. 512. Full bibl. at end of each chapter. Relief map in pocket.]

MASON, EDWARD GAY

1901 Chapters from Illinois history. Chicago, H. S. Stone and Co. 322 pp. [Incl.: The land of the Illinois, and Illinois in the eighteenth century.]

MATHER, IRVIN F.

1900 The making of Illinois. Chicago. A. Flanagan. 244 pp.

MATHER, STEPHEN T.

1917 Report on the proposed Sand Dunes National Park, Indiana. Dept. of the Interior, Nat. Park Serv., Washington. Govt. Printing Office. 113 pp.

MATSON, NEHEMIAH

1874 French and Indians of Illinois River. 2d ed. Princeton, Ill. 270 pp.

MATTOON, W. R., AND MILLER, R. B.

1927 Forest trees of Illinois: how to know them. Ill. Dept. of Conserv., and U. S. For. Serv. Springfield, Ill. 93 pp. 6 reprintings.

MAURY, SARAH WEBB

1910 Native trees of Kentucky. Ky. Fed. of Women's Clubs, Louisville. 140 pp.

McADAMS, WILLIAM

1882 [Description of Madison co.] Pp. 58-64 of History of Madison County, Ill. Edwardsville. W. R. Brink and Co., publishers. 603 pp.

McATEE, W. L.

1926 Notes on Homoptera from Illinois. Ill. State Nat. Hist. Surv. Bull. 16:127-136.

McBETH, WM. A.

1916 Loess and sand dune deposits in Vigo county, Indiana. Proc. Ind. Acad. Sci. 1915:185-188.

McDONALD, FRANK E.

1890 to 1918 [Unpublished book of notes on flora of Peoria district. Embodies his own field data and later observations of FREDERICK BRENDEL. In private library of V. H. Chase, Peoria. The period covered is an approximation only.]

1899 Geographical range of Asclepias meadii and Hypericum kalmianum. Plant World 2:126-127.

1900 A sand dune flora of central Illinois. Plant World 3:101-103. [Illinois river valley, Cass county.]

McDOUGALL, W. B.

1916 The growth of forest tree roots. Am. Jour. Bot. 3:384-392.

1920 Plant succession on an artificial bare area in Illinois. Trans. Ill. State Acad. Sci. 11:129-131. (1918).

1920 The forests of Vermilion county. Trans. Ill. State Acad. Sci. 12: 282-289. (1919).

1921 A comparison of soil temperatures in upland and bottomland forests. Trans. Ill. State Acad. Sci. 13:249-254. (1920).

1922 A preliminary key to some forest tree roots. Trans. Ill. State Acad. Sci. 14:87-91. (1921).

1922 Mycorhizas of coniferous trees. Jour. Forestry 20:255-260.

1922 Symbiosis in a deciduous forest. I. Bot. Gaz. 73:200-212.

1925 II. Bot. Gaz. 79:95-102.

1925 Forests and soils of Vermilion county, Illinois, with special reference to the "striplands". Ecology 6:372-379.

McDOUGALL, W. B., AND LIEBTAG, CHARLOTTE

1928 Symbiosis in a deciduous forest. III. Mycorhizal relations. Bot. Gaz. 86:226-234.

McDOUGALL, W. B., AND PENFOUND, W. T.

1928 Ecological anatomy of some deciduous forest plants. Ecology 9: 349-353.

McEATHRON, W. J., AND HIDINGER, L. L.

1911 Report upon the prevention of overflow of the Little Wabash and Skillet Fork Rivers. Rivers and Lakes Commission, State of Ill. Springfield. 39 pp., with separate atlas (5 profiles and 18 maps, folded, in case).

McGEE, W. J.

1891 The Pleistocene history of northeastern Iowa. U. S. Geol. Surv., Ann. Rept. 11, part 1:199-577. [22 pls., incl. map of forest and prairie districts.]

McLAUGHLIN, W. T.

1932 Atlantic coastal plain plants in the sand barrens of northwestern Wisconsin. Ecol. Monographs 2:335-383. [Important relation to flora of Lake Michigan strand, and Ill. and Ind. dunes and swales near south end of lake.]

McNEILL, JEROME

1891 A list of the Orthoptera of Illinois. Psyche 6:3-9, 21-27, 62-66, 73-78.

McNUTT, W., AND FULLER, G. D.

1913 The range of evaporation and soil moisture in the oak-hickory forest association of Illinois. Trans. Ill. (State) Acad. Sci. 5:127-137. (1912).

MEAD, S. B. See LAPHAM, 1857, and VASEY, 1861.

MEEHAN, THOMAS

1881 Treeless prairies. Bot. Gaz. 6:253-255. [Emphasizes fire in preventing encroachment of forest upon prairie.]

MEEK, S. E.

1889 The native fishes of Iowa. Bull. Lab. Nat. Hist. Univ. Iowa 1:161-171.

MEEK, S. E., AND HILDEBRAND, S. F.

1910 A synoptic list of the fishes known to occur within fifty miles of Chicago. Field Mus. Nat. Hist., Zool. Ser. 7:223-338.

MICHAUX, ANDRÉ

See C. S. SARGENT, 1889, Portions of the journal of André Michaux. [The Flora Boreali-Americana, and the Sylva of N. Am. by the younger MICHAUX, are apparently of little value for distributional and habitat studies in Ill. The colored plates in the Sylva are of high quality and usefulness even as judged by present standards.]

MIDDLETON, A. R., JILLSON, W. R., McFARLAND, F. T., AND ANDERSON, W. A., JR.

1926 Kentucky. Pp. 349-354 of Naturalist's guide to the Americas. See SHELFORD 1926.

MILLER, ANGE V.

1885 General indexes to the first twelve reports [of the Illinois State Entomologist]. Appendix to 14th rept., 19 + 107 pp. Includes an index to food plants. [See HART and SNYDER, 1909; and FRISON and SNYDER, 1925.]

MILLER, ARTHUR M.

1919 The geology of Kentucky: a classified compend of State Reports and other publications, etc. Dept. of Geol. and Forestry Ky., Ser. 5, Bull No. 2. 392 pp. [Incl. "Physical regions of Ky.," "Natural features and phenomena of geologic and scenic interest," and extensive bibl.]

1927 Origin of the prairie. Science 66:655-656.

MILLER, ERIC R.

1917 The meteorological influences of lakes. Proc. 2d. Pan-Am. Sci. Congr. 2:189-198.

MILLER, JOHN T.

1931 Parent materials of Pike county, Indiana, soils. Proc. Ind. Acad. Sci. 40:235-236. (1930).

MILLER, M. F., AND KRUSEKOPF, H. H.

1929 The soils of Missouri. Univ. Mo. Agr. Exp. Sta. Bull. 264. 120 pp., with large folded soil map of entire state, in colors. [Topogr., p. 7; forests, 14; climate, 16; soils, soil profiles, and soil types by districts, 19-113. Maps: timber areas and forest types, p. 15; rainfall and temp., 16, 17; maps showing agricultural geography, pp. 115-120.]

MILLER, ROBERT B.

1923 First report on a forest survey of Illinois. Ill. State Nat. Hist. Surv. Bull. 14:291-377.

1926 Past and present interest in Illinois trees. Trans. Ill. State Acad. Sci. 18:193-202. (1925). [Quotations from MICHAUX, 1803, Flora Boreali-Americana; work of Ill. botanists.]

MILLER, R. B., AND FULLER, G. D.

1920 Strip survey and growth studies in LaSalle county, Illinois. Trans. Ill. State Acad. Sci. 12:273-281. (1919).

1922 Forest conditions in Alexander county, Illinois. Trans. Ill. State Acad. Sci. 14:92-108. (1921). [Geol. and geogr. papers on the Ozark Hills of Ill. in same vol.]

MILLER, R. B., AND TEHON, L. R.

1929 The native and naturalized trees of Illinois. Ill. State Nat. Hist. Surv. Bull. 18:1-339. [122 of the many figs. are full-page. For most spp. a small map is given showing which Ill. counties are represented by herbarium specimens or other authentic record. 94 tree spp. are given individual treatment. Other spp. and varieties mentioned (excl. oak hybrids) bring the list to 128.—Figs. 122 to 146 are photomicrographs of various woods in transverse section.]

See also CHAPMAN AND MILLER, FRISON AND MILLER, and MATTOON AND MILLER.

MILLS, HARLOW B.

1934 A monograph of the Collembola of Iowa. Collegiate Press, Ames. 11 + 143 pp.

MISSOURI SOIL SURVEY

[Index map on p. 11 of MILLER and KRUSEKOPF, 1929, q. v., showing counties of Missouri covered by detailed soil surveys to 1929. Those for Mississippi River counties opposite Illinois are, north to south: Marion, Ralls, Pike, Lincoln, St. Louis, Perry, Cape Girardeau, and Mississippi.]

MITCHELL, S. AUGUSTUS

1837 Illinois in 1837; a sketch descriptive of the . . . prominent districts, prairies, rivers, minerals, animals, . . . Philadelphia. 143 pp.

1838 Another edition: Illinois in 1837 and 1838 . . . "The publisher is probably the author. It was got up mainly to promote the sale of Illinois lands then owned by John Grigg of Philadelphia." —Sabin, Bibl. Amer. v. 9, no. 34260.

MOFFATT, WILL SAYER

1909 The higher fungi of the Chicago region. Part I.—The Hymenomycetes. Chicago Acad. Sci., Nat. Hist. Surv. Bull., no. 7, part 1. 156 pp.

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MOHR, CARL

1932 Correlation of host plant and color pattern of *Rhodobaenus tredecimpunctatus* (Ill.) (Coleoptera, Rhyncophoridae). Trans. Ill. State Acad. Sci. 24:226-227. (1931).

MONTGOMERY, B. ELWOOD AND ROBERT W.

1931 Records of Indiana Coleoptera. I. Cicindelidae. Proc. Ind. Acad. Sci. 40:357-359. (1930).

MONTGOMERY, C. E.

1931 Ecology of the mosses of the Grand de Tour region of Illinois, with special reference to pH relations. Bot. Gaz. 91:225-251.

MONTGOMERY, ROBERT W.

1931 Preliminary list of the butterflies of Indiana. Proc. Ind. Acad. Sci. 40:351-355. (1930).

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1901 The Hirudinea of Illinois. Bull. Ill. State Lab. Nat. Hist. 5:479-547.

MOSHER, EDNA

1916 The grass flora of Illinois. Trans. Ill. (State) Acad. Sci. 8:137-139. (1915).

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MOSIER, J. G.

1918 Climate of Illinois. Univ. Ill. Agr. Exp. Sta. Bull., 15:1-125 (no. 208). Also, Bull. No. 208—Abstract. 8 pp. 1918.

See also Illinois Soil Survey.

MUMFORD, H. W.

1934 The significance of the conservation of land resources. Trans. Ill. State Acad. Sci. 27:19-22. [Based upon and applicable to Ill. conditions.]

MURCHISON, A. C.

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MUSSELMAN, T. E.

1921 A history of the birds of Illinois. Jour. Ill. State Historical Soc. 14:1-75.

NAGEL, J. J., AND HAUPT, J. B.

1876 List of phaenogamous plants (in the vicinity of Davenport, Iowa, 1870-1875). Proc. Davenport Acad. Sci. 1:153-164.

NEEDHAM, J. G.

1900 Insect drift on the shore of Lake Michigan. Occas. Mem. Chicago Ent. Soc. 1 (1):19-26. [Infl. of storms in blowing insects into the lake, later drifting them ashore in windrows. Lake Bluff and Lake Forest, Ill. Analysis of insect drift.]

1904 Beetle drift on Lake Michigan. Can. Ent. 36:294-296. [Lake Forest, Ill. Lachnosterna (Phyllophaga) fusca in enormous numbers; other beetles, incl. many Calosoma frigidum.]

NEEDHAM, JAMES G. AND HART, CHARLES A.

1901 The dragon-flies (Odonata) of Illinois, with descriptions of the immature stages. Part I. Petaluridae, Aeschnidae, and Gomphidae. Bull. Ill. State Lab. Nat. Hist. 6:1-94.

NELSON, E. W.

1876 Birds of northeastern Illinois. Bull. Essex Inst. 8:90-155.

1876 Additions to the avifauna of Illinois with notes on other species of Illinois birds. Bull. Nutt. Orn. Club. 1:39-44.

1877 Notes upon birds observed in southern Illinois between July 17 and September 4, 1875. Bull. Essex Inst. 9:32-65.

NELSON, EDWARD W.

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NOLAND, LOWELL E.

1925 Factors influencing the distribution of fresh water ciliates. Ecology 6:437-452. [Extensive collections and factor-determinations from a diversity of habitats in s. Wis. Data on 60 + spp. Full bibl.]

NORTON, ETHAN ARLO

1928 Profiles of soils in southern Illinois. Proc. and Papers 1st Internat. Congr. Soil Sci., Washington (1927), 4:283-290.

1934 Soil erosion map of Illinois. In SAWYER, L. E., 1934, Illinois' need for public ownership of forest lands. Centr. States Forestry Congr., Proc. 4th Ann. Conf. 1933:100-105. Springfield, Ill.

NORTON, E. A., AND BRAY, R. H.

1929 The soil reaction profile. Jour. Am. Soc. Agron. 21:834-844. [pH of A_1 horizon in Ill. soils approaches 5.7.]

NORTON, E. A., AND SMITH, R. S.

1927 Certain soil profiles in southern Illinois. Am. Soil Surv. Assoc. Bull. 8:21-27a.

1930 The influence of topography on soil profile character. Jour. Am. Soc. Agron. 22:251-262.

1932 The relationship between soil and native vegetation in Illinois. Trans. Ill. State Acad. Sci. 24:86-93. (1931). [Emphasizes poor drainage of flat prairie uplands as the controlling factor excluding forest.]

NORTON, E. A., AND WINTERS, ERIC

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NORTON, J. B. S.

1897 The effects of wind on trees. Gard. and For. 10:292-293. [Tornado of 1896 at St. Louis. See VON SCHRENCK, 1898.]

OESTERLING, H. C. (EDITOR)

1931 Serial lists of publications of the Illinois State Natural History Survey, and its predecessors, the State Laboratory of Natural History, and the State Entomologist's Office. Urbana. 30 pp.

OSBORN, HERBERT

1892 On the orthopterous fauna of Iowa. Proc. Iowa Acad. Sci. 1 (part 2):116-120. (1890-1891).

OWEN, DAVID DALE

1840 [Descriptions of prairies.] In: Geological exploration of part of Iowa, Wisconsin, and Illinois. House Exec. Doc. 239, 26th Congr., 1st session. Washington. See township descriptions, pp. 70-115.

1856 [Remarks on the barrens of Kentucky.] Pp. 83-84 of Rept. Geol. Surv. Ky. for 1854 and 1855 [Ser. 1, vol. 1]. 416 pp., maps, etc. [Barrens considered not altogether attributable to fires, since these equally prevalent in well-timbered districts. Likely that some peculiarity of calcareous soil favored prior occupation by grasses.]

PACKARD, A. S., JR.

1873 On the cave fauna of Indiana. Peabody Acad. Sci., Ann. Rept. 5:93-97.

PAINTIN, RUTH D.

1929 The morphology and nature of a prairie in Cook county, Illinois. Trans. Ill. State Acad. Sci. 21:152-175. (1928).

PALMER, E. J.

1921 Botanical reconnaissance of southern Illinois. Jour. Arnold Arboret. 2:129-153. [Excellent concise account, with well annotated list of ligneous plants collected, pp. 138-153. 205 species, varieties and hybrids included.—"The topography of southern Illinois is remarkably varied."]

1921 The forest flora of the Ozark region. Jour. Arn. Arb. 2:216-232. [Mo., Ark., Okla. Includes good descriptions of naturally treeless openings: barrens, rock barrens, prairies, and rounded hill-tops or "bald knobs," pp. 223-226.]

1932 Notes on Ophioglossum engelmanni. Am. Fern Jour. 22:43-47.

PALMER, E. L.

1917 A seed key to some common weeds and plants. Proc. Iowa Acad. Sci. 23:335-394. (1916). [Descriptions, figures, bibl., index.]

PALMER, E. LAURENCE

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PAMMEL, L. H.

1892 Windstorms and trees. Monthly Rev. Iowa Weather and Crop Service. 34:7.

1899 Some ecological notes on Iowa grasses. Proc. Soc. Promotion Agr. Sci. 1898:204-211. Reprint, Contr. Bot. Dept. Iowa State Coll. no. 12:204-211. Home Journal Print, LaFayette, Indiana.

1899 Some ecological notes on the Muscatine flora. Plant World 2:182-186. [Sand prairie, loess prairie, boreal survivals.]

1901 Some changed conditions of our flora incident to the settlement of the state [Iowa]. Proc. Soc. Promotion Agr. Sci. 1901:107-112.

1902 Ecological relations of plants. Iowa State Hort. Soc. Rept. 37:236-240.

1903 Ecology. Hungerford Press, Carroll, Iowa. 364 pp. ["A limited edition of this work was published in 1893 under the caption of 'Flower Ecology.'" Chapters 1 to 12 deal with pollination, its mechanisms and interrelations, etc. (to p. 230). Dispersal, adaptation, acclimatization and phenology, myrmecophytes, symbionts, are other subjects. Examples from Iowa and adjoining states are included. Figures largely by CHARLOTTE M. KING.]

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1905 Notes on some plants of northeastern Iowa. Plant World 8:31-35.

1905 A comparative study of the vegetation of swamp, clay and sandstone areas in western Wisconsin, southeastern Minnesota, northeastern, central and southeastern Iowa. Proc. Dav. Acad. Sci. 10:32-126.

1909 Flora of northern Iowa peat bogs. Iowa Geol. Surv., Ann. Rept. 19:737-777. (1908).

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1913 Weed migration. Iowa Geol. Surv. Bull., 4:685-769. (Revised ed., 4:576-614. 1926).

1917 The oaks. Trans. Iowa State Hort. Soc. 51:96-105, and 18 figs. (1916).

1920 The relation of native grasses to Puccinia graminis in the region of Iowa, western Illinois, Wisconsin, southern Minnesota and eastern South Dakota. Proc. Iowa Acad. Sci. 26:163-192. (1919).

1922 Trees of the proposed Mississippi Valley National Park; [and] Shrubs of the McGregor district. Proc. Iowa Acad. Sci. 28:264-267, 268-271. (1921). [These companion papers deal with n.e. Iowa and s.w. Wis.]

1924 The flora of Pine Hollow, Dubuque county, Iowa. Proc. Iowa Acad. Sci. 30:263-277. (1923). [See CONARD 1933.]

PAMMEL, L. H.—*Continued*

1925 A century of botany in Iowa. Proc. Iowa Acad. Sci. 31:45-68. (1924). [Mentions many articles, grouped by subjects, but does not attempt complete citations.]

1926 Notes on spear grass. Annals of Iowa, Ser. 3, 15:249-250.

1926 Iowa. Pp. 480-485 of Naturalist's guide to the Americas. See SHELFORD 1926.

See SHIMEK and KING, 1933 (Proc. Iowa Acad. Sci. 38:55-68) for account of life and writings of Dr. Pammel.

PAMMEL, L. H., AND DIEHL, W.

1918 The flora of Devil's Backbone. Iowa Conservationist 2:66-67.

PAMMEL, L. H., FORD, J. F., KELSO, J. AND HARLAN, E. R.

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PAMMEL, L. H., AND KING, CHARLOTTE M.

1903 The vascular cryptogams of Iowa and the adjoining parts of southeastern Minnesota and western Wisconsin. Proc. Iowa Acad. Sci. 9:133-150, with 41 maps. (1902).

1904 The distribution of some Iowa plants; formations on which they occur. Science, n.s. 19:170.

1913 The general character of seeds. Iowa Geol. Surv., Bull., 4:405-502. (Rev. ed. 4:430-511, 1926.)

1918 The germination and juvenile forms of some oaks. Proc. Iowa Acad. Sci. 24:367-391. (1917). [One of a series of papers on germination and juvenile forms of mostly native plants. See bibl., Proc. Iowa Acad. Sci. 38:55-68.]

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1926 Agencies of weed seed dissemination. Iowa Geol. Surv. Bull., Revised ed. 4:574-575.

PAMMEL, L. H., SEAL, J. L., AND DURRELL, L. W.

1916 Vegetation of Iowa lakes. State Highway Comm., Rept. on the Iowa lakes and lake beds, pp. 161-189.

PAMMEL, L. H., WEEMS, J. B., AND LAMSON-SCRIBNER, F.

1901 The grasses of Iowa. Iowa Geol. Surv., Bull. no. 1. 525 pp.

1901 Grasses of Iowa. Part I. Iowa Agr. Exp. Sta. Bull., 1901:61-342. (Bull. no. 54).

PAMMEL, L. H., BALL, CARLETON R., AND LAMSON-SCRIBNER, F.

1905 The grasses of Iowa. Part II. Supplementary Report, Iowa Geol. Surv., 1903:1-405.

PARK, ORLANDO

1929 Taxonomic studies in Coleoptera, with notes upon certain species of beetles in the Chicago area. I. Jour. N. Y. Ent. Soc. 37:429-436.

1929 Ecological observations upon the Myrmecocoles of Formica ulkei Emery, especially Leptinus testacus Mueller. Psyche 36:195-215.

PARK, ORLANDO—*Continued*

1929 Reticulitermes tibialis Banks in the Chicago area. Proc. Ent. Soc. Wash. 31:121-126. [A western sp. (one of many western organisms in dune areas of Ill. and Ind.) Here recorded from upper beach, Indiana dunes. Behavior, life-hist., etc.]

1930 Studies in the ecology of forest Coleoptera. [I.] Ann. Ent. Soc. Am. 23:57-80.

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PARK, THOMAS

1929 Notes on the relationship between Formica ulkei Emery and Solenopsis molesta Say. Ent. News 60:325-326.

PARKMAN, FRANCIS

1905 LaSalle and the discovery of the Great West. 11th ed. Boston. Little, Brown, and Co. 25 + 483 pp. 2 maps.—1st ed. 1869: "The discovery of the Great West." 425 pp.

PARRISH, RANDALL

1906 Historic Illinois, the romance of the earlier days. Chicago. A. C. McClurg & Co. 3d ed. 479 pp.

PARVIN, J. B.

1855 On the habits of the gopher of Illinois (Geomys bursarius). Ann. Rept. Smithsonian Inst. 1854:293-294.

PATTERSON, HARRY N.

1876 Catalogue of the phaenogamous and vascular cryptogamous plants of Illinois, native and introduced. Oquawka, Ill.: Spectator Print. 54 pp.

PEARSE, A. S.

1921 The distribution and food of the fishes of three Wisconsin lakes in summer. Univ. Wis. Stud. Sci. 3:1-61.

1924 Amount of food eaten by four species of fresh-water fishes. Ecology 5:254-258.

1926 Wisconsin. Pp. 284-287 of Naturalist's guide to the Americas. See SHELFORD 1926.

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PEARSE, A. S., AND ACHTENBERG, H.

1920 Habits of yellow perch in Wisconsin lakes. Bull. U. S. Bur. Fish. 36:293-366.

PEARSON, JAY F. W.

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PEASE, THEODORE CALVIN

1919 The frontier state, 1818-1848. Centennial History of Ill., vol. 2. Springfield. 475 pp. See BUCK, S. J., 1917, and ALVORD, C. W., 1920.

PEATTIE, DONALD CULROSS

1922 The Atlantic coastal plain element in the flora of the Great Lakes. Rhodora 24:57-70, 80-88.

1925 Plants of Wolf Lake, Indiana-Illinois. Am. Bot. 31:99.

1930 Flora of the Indiana dunes. Handbook of the flowering plants and ferns of the Lake Michigan coast of Indiana and of the Calumet district. Field Mus. Nat. Hist., Chicago. 432 pp., folding map.

PECK, JOHN MASON

1834 A gazetteer of Illinois; in three parts: containing a general view of the state; a general view of each county; and a particular view of each town, settlement, stream, prairie, bottom, bluff, etc.—alphabetically arranged. Jacksonville. R. Goudy. 376 pp. (2d ed. rev., Philadelphia, Grigg & Elliott. 11 + 328 pp. 1837.)

1836 A new guide for emigrants to the west; containing sketches of Ohio, Indiana, Illinois, Missouri, and Michigan, with the territories of Wisconsin and Arkansas and the adjacent parts. Boston. Gould, Kendall & Lincoln. 374 pp.

1859 [Barrens of St. Clair co. in 1821.] Trans. Ill. State Agr. Soc. 3:407-412. (1857-8). "Timber stunted, shrubby, and scattering, with patches of prairie intermingled with patches of underbrush. of oak and hickory, growing from grub roots. On such tracts of new country the autumnal fires contend with the annual growth, and partially or wholly kill the young timber, until settlements are made, and the prairie grass killed out."

PEPOON, HERMAN S.

1904 The destruction of a farm flora. Plant World 7:44-45.

1909 An ecological survey of the driftless area of Illinois and Wisconsin. School Sci. and Math. 9:441-446; 522-527.

1910 The cliff flora of Jo Daviess County. Trans. Ill. State Acad. Sci. 2:32-37. (1909).

1911 The forest associations of northwestern Illinois. Trans. Ill. State Acad. Sci. 3:143-156. (1910).

1918 Peculiar plant distributions. Trans. Ill. [State] Acad. Sci. 9:128-137. (1916).

1918 The primrose rocks of Illinois. Trans. Ill. State Acad. Sci. 10:159-162. (1917).

1920 The forest lands of Jo Daviess County. Trans. Ill. State Acad. Sci. 12:183-202. (1919).

1922 [Article on Apple River Canyon, n. w. Ill.] See COWLES, SMITH, et al., 1922.

1927 An annotated flora of the Chicago region. Chicago Acad. Sci., Nat. Hist. Surv. Bull. no. 8. 554 pp. [Indispensable for Ill. studies of flora and vegetation.] See supplement by BUHL, 1934.

1928 The flora of the right of way of the Illinois Central Railway: Waddams to East Dubuque. Trans. Ill. State Acad. Sci. 20:92-98. (1927). 4 maps.

PERKINS, G. H.

1875 The vegetation of the Illinois lowlands. Am. Nat. 9:385-393. [Descriptions rather indefinite.]

PETERSEN, WALBURGA

1926 Seasonal succession in a Chara-cattail pond. Ecology 7:371-377. [Pond in L. Mich. dunes, n. w. Ind.]

PICKELS, G. W., AND LEONARD, F. B.

1921 Engineering and legal aspects of land drainage in Illinois. Ill. State Geol. Surv. Bull. no. 42. Revised ed. 1929. 334 pp., large folded drainage reclamation map in colors. [One sees from this how extensive the drainage operations over the flatter parts of Ill. have been, how great the change in environment resulting therefrom (cf. A. SAWYER, 1878), and how defective the original drainage of prairie uplands, cf. NORTON and SMITH, 1932.]

PHILLIPS, PHILIP LEE

1901 A list of maps of America in the library of Congress . . . Library of Congress, Washington, Govt. Printing Office. 1137 pp. [Illinois maps, 326-332; Indiana, 333-336; Iowa, 336-339; Kentucky, 349-353; Mississippi River, 437-442; Missouri, 442-445; Wisconsin, 1075-1082.]

1909 A list of geographical atlases in the Library of Congress, with bibliographical notes. Libr. of Congr., Washington. Vol. 1, Atlases. 13 + 1208 pp. (3265 atlases described). Vol. 2, Author list (pp. 1210-1313), and Index (pp. 1315-1659).

1914 Vol. 3. [Supplement to the above.] 137 + 1030 pp. Author list (pp. XI to CXXXVII), description of 822 additional atlases (pp. 1-692), and index (693-1030). [Illinois atlases, 1:804-816, 3:516-520.]

PINDAR, L. OTLEY

1889 List of the birds of Fulton County, Kentucky. The Auk 6:310-316. [181 native spp. listed, with brief notes.]

POGGI, E. MURIEL

1932 Settlement and development of the prairie province of Illinois. Trans. Ill. State Acad. Sci. 24:401-409. (1931).

1934 The Prairie Province of Illinois: a study of human adjustment to the natural environment. Ill. Studies in the Social Sciences 19 (3); Univ. of Ill. Bull. 31 (42). 124 pp., maps.

POOLEY, W. V.

1908 The settlement of Illinois from 1830 to 1850. Bull. Univ. Wis. Hist. Ser. 1:287-595.

POPE, T. E. B., AND DICKINSON, W. E.

1928 The amphibians and reptiles of Wisconsin. Bull. Publ. Mus. Milwaukee 8:1-138.

POTTER, GEORGE E. AND JONES, DAVID T.

1928 Compilation and revision of the fish records published for Iowa. Proc. Iowa Acad. Sci. 34:339-366. [Cites 26 papers containing records of Iowa fishes.]

POTZGER, J. E.

1932 Some observations on Pinus virginiana Mill. in Monroe county, Indiana, an ecological study. Proc. Ind. Acad. Sci. 41:153-174. (1931). [Rapid spread and establishment of new forest. All pines seeded from one parent tree planted about 60 years earlier.]

1933 (Grasses of Indiana). See DEAM, 1929.

POTZGER, J. E., AND FRIESNER, RAY C.

1934 Some comparisons between virgin forest and adjacent areas of secondary succession. Butler Univ. Bot. Studies 3:85-98. [Mauntel Woods, s. w. DuBois co., Ind.]

PRAIRIE CLUB OF CHICAGO

1915 Map of the Chicago region, 25 x 20 cm. 1.25 in. = 10 mi. Insert, 1915 Prairie Club Yearbook.

PRATTEN, HENRY

1855 Catalogue of south Illinois birds. Trans. Ill. Agr. Soc. 1:598-609. (1853-4). [Letters of transmittal, pp. 596-598: Pratten to J. G. Norwood to John A. Kennicott. Except for certain water birds from Ohio River, all records are for Wayne and Edwards counties. 184 spp. listed. Synonyms, but very little other information.]

PRESCOTT, G. W.

1928 A brief summary of work on Iowa algae. Proc. Iowa Acad. Sci. 34:111-113. (1927). [Bibl. of 16 titles.]

PRICE, GLADYS, AND WELCH, WINONA H.

1930 Enumeration of the vascular flora of a limestone area of the Bloomington quadrangle, Monroe county, Indiana. Proc. Ind. Acad. Sci. 39:127-131. (1929).

RADDIN, C. S.

1883 Catalogue of the phaenogamous plants of Evanston and vicinity, for 1883. Evanston, R. Vandercook. 26 pp. 706 spp. See also HIGLEY and RADDIN.

RAEDER, J. M.

1922 Studies of the phycomycetes of Iowa. Proc. Iowa Acad. Sci. 28: 283-291. (1921). [Records and notes of occurrence on particular hosts; host index, bibl.]

RAU, PHIL

1929 The habitat and dissemination of four species of Polistes wasps. Ecology 10:191-200. [They avoid competition by differentiation of nesting sites.]

RAU, PHIL AND NELLIE

1913 The biology of Stagmomantis carolina. Trans. Acad. Sci. St. Louis 22:1-58, and 18 pls.

RENSHAWE, G. H.

1924 Relief map of Kentucky. Ky. Geol. Surv. Frankfort.

REYNOLDS, JOHN

1855 My own times: embracing also the history of my life. [1st ed.] Belleville, Ill. 600 + 23 pp. 16mo.

1879 Reynolds' history of Illinois. My own times: etc. 2d ed. Chicago Historical Soc. 20 + 395 pp.

1887 The pioneer history of Illinois, 1673-1818. Chicago. Fergus Printing Co. 459 pp.

RHODES, J. W.

1933 An ecological comparison of two Wisconsin peat bogs. Bull. Publ. Mus. Milwaukee 7:305-362.

RICHARDSON, R. E.

1904 A review of the sunfishes of the current genera Apomotis, Lepomis, and Eupomotis, with particular reference to the species found in Illinois. Bull. Ill. State Lab. Nat. Hist. 7:27-35.

1913 Observations on the breeding habits of fishes at Havana, Illinois, 1910 and 1911. Bull. Ill. State Lab. Nat. Hist. 9:405-416.

1921 The small bottom and shore fauna of the middle and lower Illinois River and its connecting lakes, Chillicothe to Grafton; its valuation; its sources of food supply; and its relation to the fishery. Ill. State Nat. Hist. Surv. Bull. 13:363-522.—Review by F. C. BAKER in Ecology 5:416-418. 1923.

1928. The bottom fauna of the middle Illinois River, 1913-1925: Its distribution, abundance, valuation, and index value in the study of stream pollution. Ill. State Nat. Hist. Surv. Bull. 17:391-472.

1930 Notes on the simulation of natural aquatic conditions in fresh water by the use of small non-circulating balanced aquaria. Ecology 11:102-109. [Work done on Cook's Slough on Ill. river near Havana. Surface area requirements for fishes, plants for aquaria, etc.]

See also FORBES and RICHARDSON—1905, 1909, 1913, and 1919.

RIDDELL, JOHN L.

1835 Synopsis of the flora of the western states. Western Jour. of Med. and Physical Sciences. 7:329-374, 489-586. "Intended to cover Ohio, Ind., Ill., W. Tenn., Mo., and N. W. Territories." [Quoted from STANLEY COULTER, 1900.]

RIDGLEY, DOUGLAS C.

1921 The geography of Illinois. Univ. of Chicago Press. 385 pp. Many figs. and maps. Gen. refs. to study of geogr. of Ill., pp. 363-370.

RIDGWAY, ROBERT

1872 Notes on the vegetation of the lower Wabash Valley. I. Am. Nat. 6:658-665.

1872 II. Peculiar features of the bottom lands. 6:724-732.

1873 III. The woods and prairies of the upland portions. 7:154-157. [II mentions cypress swamps of Knox Co., Ind.; III: prairies, oak openings, and barrens, also prairie groves of pin oak and shingle oak.]

1873 The prairie birds of southern Illinois. Am. Nat. 7:197-203. [Fox prairie, 4 mi. w. of Olney.]

1874 The lower Wabash Valley, considered in its relation to the faunal districts of the eastern region of North America, with a synopsis of its avian fauna. Proc. Bost. Nat. Hist. Soc. 16:304-332.

1874 Catalogue of the birds ascertained to occur in Illinois. Ann. Lyc. Nat. Hist. N. Y. 10:364-394.

1875 Our native trees. The tulip tree—Liriodendron tulipifera. Field and Forest 1:49-53. [Data on its occurrence and size in lower Wabash valley.] (In Dec. no., 1875. Vol. completed Feb. 1876.)

RIDGWAY, ROBERT—*Continued*

1876 Notes on the catalpa. Catalpa bignonioides. Field and Forest 2:27-29. [Native trees and groves as far north as near Mt. Carmel, Ill., and in s. w. Ind.]

1876 The Little Cypress Swamp of Indiana. Field and Forest 2:93-96. [Part of the Knox co. cypress area of 20,000 acres. Tree and smaller-plant associates. Cane (Arundinaria). Growing-together of tree-trunks, in one case of 5 spp.]

1878 Notes on birds observed at Mt. Carmel, southern Illinois, in the spring of 1878. Bull. Nuttall Orn. Club 3:162-166.

1881 A revised catalogue of the birds ascertained to occur in Illinois. Bull. Ill. State Lab. Nat. Hist. 1 (4): 163-208.

1882 Native trees of the lower Wabash in Illinois and Indiana. Bot. Gaz. 7:102-103.

1882 Notes on the native trees of the lower Wabash and White River valleys, in Illinois and Indiana. Proc. U. S. Nat. Mus. 5:49-88. (Separate issued 1882; vol., 1883.)

1883 Additions and corrections to the list of native trees of the Lower Wabash Valley. Bot. Gaz. 8:345-352.

1889 The ornithology of Illinois. Part I. Descriptive catalogue. Final reports on the Nat. Hist. of Ill. 1: 520 pp., 33 pls.

1895 2: 282 pp., 33 pls.

1894 Additional notes on the native trees of the lower Wabash Valley. Proc. U. S. Nat. Mus. 17:409-421, with plates 10-15. (Separate was issued in 1894, vol. in 1895.)

1928 The ligneous flora of Richland County, Illinois. Trans. Ill. State Acad. Sci. 20:105-115. (1927).

RILEY, CHARLES V.

1868 The twig-girdler, Oncideres cingulatus, Say). Am. Ent. 1:76-77. Also 3: (new ser. 1:) 297. 1880. [Injures hickory, persimmon, pear, apple.—Its effects conspicuous today on persimmon in s. Ill. and s. Mo.—A. G. V.]

ROBERTSON, CHARLES

1887 Insect relations of certain Asclepiads. Bot. Gaz. 12:207-216, 244-250. [This and the many following papers are based on observations in Macoupin Co., Illinois, especially the vicinity of Carlinville.]

1889 to 1899 Flowers and insects. Series in Bot. Gaz. [Includes descriptions of insects' activities, etc.]

1889	I.	14:120-126.
	II.	14:172-178.
	III.	14:297-304.
1890	IV.	15:79-84.
	V.	15:199-204.
1891	VI.	16:65-71.
1892	VII.	17:65-71.
	VIII.	17:173-179.
	IX.	17:267-274.
1893	X.	18:47-54.
	XI.	18:267-274.
1894	XII.	19:103-112.
1895	XIII.	20:104-110.
	XIV.	20:139-149.
1896	XV.	21:72-81.
	XVI.	21:266-274.
	XVII.	22:154-165.
1898	XVIII.	25:229-245.
1899	XIX.	28:27-45.

ROBERTSON, CHARLES—*Continued*

1890 to 1896 Flowers and insects. Series in Trans. Acad. Sci. St. Louis. [Supplements the series in Bot. Gaz., 1889 to 1899.]

1890 5:449-460. Umbelliferae.

1891 5:569-598. Asclepiadaceae to Scrophulariaceae.

1892 6:101-131. Labiatae.

1894 6:435-480. Rosaceae and Compositae.

1896 7:151-179. Contributions to an account of the ecological relations of the entomophilous flora and the anthophilous insect fauna of the neighborhood of Carlinville, Illinois.

1895 The philosophy of flower seasons, and the phaenological relations of the entomophilous flora and the anthophilous insect fauna. Am. Nat. 29:97-117. [In part a discussion of article by H. L. CLARKE, Am. Nat. 27:769-781. 1893. Robertson's data from Carlinville.—An incidental foot-note: "In the interaction of organisms . . . a law of avoidance of competition is more obvious than that of the survival of the fittest."]

1899 to 1901 Flower visits of oligotropic bees. Series in Bot. Gaz. First article, 28:215. 1899.—"Another note on the . . ." 30:130. 1900.—III. 32:367-368. 1901. [See also Fls. and Insects XIX, Bot. Gaz. 28:27-45.—Oligotropic = confining visits to a few similar or related fls.]

1906 Ecological adaptation and ecological selection. Science 23:307-310. [General conclusions of great significance in relations between environment and evolution, based on work at Carlinville. Suggests ecological basis for morphology and for evolution. See 1924 article in Science.]

1910 Hosts of Strepsiptera. Can. Ent. 42:323-330. [List of bees on which Stylops parasites were found.]

1914 Origin of oligotropy of bees. Ent. News 25:67-73.

1917 to 1923 Flowers and insects. Later series in Bot. Gaz. [These articles are not mentioned in bibl. of 1929 vol.]

1917	XX.	63:307-316.
1922	XXI.	73:148-152.
1923	XXII.	75:60-74.
1924	XXIII.	78:68-84.

1918 Proterandry and flight of bees. Ent. News 29:340-342. [Male bees of many spp. appear earlier than females, which live for a considerable time after males disappear.]

1922 The sunflower and its insect visitors. Ecology 3:17-21.

1922 Synopsis of Panurgidae. Psyche 29:159-173. [Includes seasonal data and list of flowers visited by each bee species.]

1922 Flower seasons. Sci. Monthly 14:201-203.

1923 Flower visits of insects. [I.] Psyche 30:158-169.

1924 II. Psyche 31:93-111.

1924. Conditions of natural selection. Science 59:363-364. ["Natural selection is an ecological theory. Diversifications of food habits and of geographical and phenological ranges are its most important conditions."—"Species . . . separated first and got their differences afterwards."—See 1906 article in Science.]

ROBERTSON, CHARLES—*Continued*

1924 Phenology of entomophilous flowers. Ecology 5:393-407.

1925 Heterotropic bees. Ecology 6:412-436. [Differentiation as to flowers visited, among bees of similar adaptation to flowers. For correction to list of oligolectic bees, see Ecology 7:378-380.]

1926 Revised list of oligolectic bees. Ecology 7:378-380. [Orig. list in Ecology 6:426-427. Oligolectic = restricted to a limited group of related flower species, from which pollen is collected.]

1927 Flowers and insects, XXIV. Ecology 8:113-132.

1928 Flowers and insects, XXV. Ecology 9:505-526. [These not mentioned in 1929 vol. XXV is in part a criticism of CLEMENTS and LONG, 1923, Experimental pollination. Carn. Inst. Publ. 336.]

1929 Flowers and insects: Lists of visitors of four hundred and fifty-three flowers. Publ. by the author, Carlinville, Ill. Science Press Printing Co., Lancaster, Pa. 221 pp. (1928). [List of insects, pp. 8-20. Visitors of particular fls., 20-221. Fls. arr. alphabetically by families. Blooming dates for each sp. Visitors arr, under each fl. sp. by groups, e. g. long-tongued bees, short-tongued bees, other Hymenoptera, Diptera, etc. Extremely concise; character of visits is shown by abbreviations. Observations made within ten miles of Carlinville. The work is incidentally a catalogue of plants and insects of a local district in s. w. Ill.]

ROBERTSON, INA C.

1928 The Ozark orchard center of southern Illinois. Econ. Geogr. 4:253-266.

ROE, E. R.

1859 Notes on the great drouth in '53 and '54. Trans. Ill. State Agr. Soc. 3:680-681. (1857-8). [Read before Ill. State Nat. Hist. Soc., 1859. Evidence of molluscs that prairie ponds which dried up in this drouth had not done so before.]

ROLFE, DEETTE

1929 The Rock River country of northern Illinois. Ill. State Geol. Surv., No. 2 of Educational Series. 59 pp.

ROSS, H. H.

1931 Sawflies of the sub-family Dolerinae of America north of Mexico. Ill. Biol. Mon. 12(3):205-320. (1929). [Biol., life-hist., seasonal and habitat relations in Ill., pp. 217-223.] (Separate paged 1-115).

1934 [Chapters in HEBARD, 1934, q. v.]

RUFFIN, EDMUND

1835 Inquiry into the causes of the existence of prairies, savannas, and deserts; and the peculiar constitutions of soils which either favor or prevent the destruction of the growth of forests. Farmer's Register (orig. place of publication, fide Dr. H. J. Lutz.) Also in the following book, pp. 213-273:

1855 Essays and notes on agriculture. Publ. by J. W. Randolph, Richmond, Va. 8 + 407 pp.

RUSSELL, J. C., AND ENGLE, E. G.
1925 Soil horizons in the central prairies. Am. Soil Surv. Assoc. Bull. 6:1-18.

RUTHVEN, A. G.
1908 The faunal affinities of the prairie region of central North America. Am. Nat. 42:388-393.

RYDBERG, P. A.
1931 Taxonomic notes on the flora of the prairies and plains of central North America. Brittonia 1:79-104.

SALISBURY, ROLLIN D., AND ALDEN, WM. C.
1899 The geography of Chicago and its environs. Geogr. Soc. of Chicago. Bull. no. 1, 64 pp. Revised ed., 1920. 63 pp.

SALISBURY, R. D., AND BARROWS, H. H.
1918 The environment of Camp Grant. Ill. State Geol. Surv. Bull. no. 39. 75 pp.

SAMPSON, F. A.
1913 A preliminary list of the Mollusca of Missouri (exclusive of the Unionidae). Trans. Acad. Sci. St. Louis 22:67-108.

SAMPSON, HOMER C.
1921 An ecological survey of the prairie vegetation of Illinois. Ill. State Nat. Hist. Surv. Bull. 13:523-577. Preliminary report in Trans. Ill. State Acad. Sci. 9:123-125. (1916). 1918. [Gives location of a number of areas remaining in 1920 with native prairie vegetation.]

SANBORN, COLIN C.
1922 Chicago winter birds. Field Mus. Nat. Hist., Zool. Lflt. no. 2. 12 pp.
1925 The mammals of the Chicago area. Ibid. no. 8. 21 pp.

SANDERS, NELL JACKSON, AND SHELFORD, V. E.
1922 A quantitative and seasonal study of a pine-dune animal community. Ecology 3:306-320. In L. Mich. dunes of n. w. Ind.

SARGENT, CHARLES SPRAGUE
1889 Portions of the journal of André Michaux, botanist, written during his travels in the United States and Canada, 1785 to 1796. With an introduction and explanatory notes. Proc. Am. Phil. Soc. 26:1-145. [Pp. 120-128: "Cahier 9. 1795 et 1796." In Aug. 1795, from Ohio River up the Wabash to Vincennes; Aug. 23-30, across Illinois to Kaskaskia; Sept. 5 and 6 to Prairie du Rocher and Kaskia, 8 and 9 return to Kaskaskia. Oct. 2, toward mouth of Ohio River. Oct. 5 "passè encore les Prairies entrecoupèes de lisières de Bois. Mon guide tua un Elk nommé . . . Illinois Cerf." Oct. 8, arrived at Fort Cheroquis or Fort Massac. (On pp. 124 and 125, notes on trees, etc. along Miss. and Ohio Rivers.) Later he returned to Kaskaskia, Fort Chartres, and Prairie du Rocher. He started his return from s. Ill. Dec. 14, 1795.]
1895 The forests of the Wabash valley. Gard. & For. 8:101-102.
1897 Notes on cultivated conifers.—III. Juniperus. Gard. and For. 10:410-411. (J. communis in America: ". . . it is only on the bold and broken summits . . . in one district of southern Illinois that this Juniper attains the habit and size of a small tree . . .")

SARGENT, WINTHROP

1793 Lists of forest and other trees northwest of the river Ohio to the 38th parallel. Am. Acad. of Arts and Sci., Mem. 2:156-159.

SAUER, CARL O.

1916 Geography of the upper Illinois valley and history of development. Ill. State Geol. Surv. Bull. No. 27. 208 pp.

1920 . . . The geography of the Ozark highland of Missouri . . . Univ. of Chicago Press. 18 + 245 pp., maps, pls.

SAUER, C. O., AND OTHERS

1927 Geography of the Pennyroyal [Mississippian Plateau, w. Ky.] Geol. Surv. Ky., Ser. 6, Vol. 25. 303 pp., many maps. [The Barrens (prairie), causes of treelessness, pp. 123-130.]

SAUER, C. O., CADY, G. H., AND COWLES, H. C.

1918 Starved Rock State Park and its environs. Geog. Soc. Chicago, Bull. 6. 148 pp.

SAVAGE, T. E.

1916 The loess in Illinois: its origin and age. Trans. Ill. (State) Acad. Sci. 8:100-117.

1921 Geology and mineral resources of the Avon and Canton quadrangles. Ill. State Geol. Surv. Bull. No. 38B. 68 pp. (38:211-271. 1922).

SAVAGE, T. E., AND NEBEL, E. L.

1921 Geology and mineral resources of the LaHarpe and Good Hope quadrangles. Ill. State Geol. Surv. Bull. No. 43A. 89 pp. (43:9-93. 1923).

SAVAGE, T. E., AND UDDEN, J. A.

1921 Geology and mineral resources of the Edgington and Milan quadrangles. Ill. State Geol. Surv. Bull. No. 38C. 96 pp. (38:115-208. 1922).

SAWYER, AMOS

1878 On climatic change in Illinois—its cause. Trans. Acad. Sci. St. Louis 3:255-260. (1868-1877). [Chiefly attributed to more rapid drainage, by natural extension of streams, also artificial drainage. Increase of domestic animals a second factor.]

SAWYER, L. E.

1931 Aims and purposes of forestry extension in Illinois. Trans. Ill. State Acad. Sci. 23:180-184. (1930). [Mention of growth of volunteer pin oak of 3 to 8 inch diam. in 15 years in an abandoned field, Crawford co.] See also NORTON, E. A., 1934.

SAYLES, ROBERT W.

1931 Bermuda during the Ice Age. Proc. Am. Acad. Arts and Sci. 66:379-466. [Glacial chronology, with estimates of relative and absolute duration of successive stages, and comparison with estimates of KAY, 1931, for Iowa.]

SCHAFFNER, J. H.

1926 Observations on the grasslands of the central United States. Ohio State Univ. Studies, Contrib. in Bot. No. 178:1-56. [Ill. prairie, pp. 9-10.]

SCHANTZ, ORPHEUS

1919 Indiana's unrivaled sand dunes—a national park opportunity. Nat. Geogr. Mag. 35:430-441. (May no.)

1928 Birds of Illinois. State Dept. of Conservation, Publ. no. 6. 130 pp. [Popular treatment. Life-zone map: Lower Austral with three subdivisions.]

SCHMIDT, KARL P.

1929 The frogs and toads of the Chicago area. Field Mus. Nat. Hist., Zool. Lflt. no. 11. 15 pp.

1930 The salamanders of the Chicago area. Ibid., no. 12. 17 pp.

SCHMOLL, HAZEL M.

1920 Ecological survey of forests in the vicinity of Glencoe, Illinois. Trans. Ill. State Acad. Sci. 12:208-233. (1919).

SCHNECK, J.

1876 Catalogue of the flora of the Wabash valley below the mouth of White River, and observations thereon. Geol. Surv. Ind., Ann. Rept. 7:504-579. Supplemented by list of 26 additional spp. in Bot. Gaz. 2:83. 1877. [Incl. 4 Ill. counties. Field study mostly in Gibson and Posey counties, Ind., and Wabash co., Ill. 867 spp. listed.]

1884 Notes on Phoradendron flavescens, Nutt. Bot. Gaz. 9:94-96, 101-103. Additional note, 15:211. 1890. [Life-history, distribution, hosts, extension northward set back by cold winters.]

1892 Notes on the hardwood trees of Illinois. Hardwood 2: nos. 1, 4, 5.

1903 The cross-bearing Bignonia or Cross vine. Plant World 6:157-159.

SCHOCKEL, B. H.

1916 History of development of Jo Daviess County. Ill. State Geol. Surv. Bull. 26:173-228. (Chap. 10 of TROWBRIDGE, SHAW, and SCHOCKEL). [Historic references include other parts of Ill.]

SCHULTZ, CHRISTIAN, JR.

1838 Sketches of Illinois, descriptive of its principal geographical features, prominent districts, prairies, etc. Philadelphia. 321 pp., 1 map.

SCHOEWE, W. H.

1920 The interpretation of certain leached gravel deposits in Louisa and Washington counties, Iowa. Proc. Iowa Acad. Sci. 26:393-398. (1919).

SCHWARZ, G. F.

1903 The diminished flow of the Rock River in Wisconsin and Illinois. Bur. of Forestry, U. S. Dept. Agr. Bull. 44.

SCOTT, WILL

1916 Report on the lakes of the Tippecanoe basin (Indiana). Ind. Univ. Studies no. 31. 39 pp.

1926 Indiana. Pp. 372-377 of Naturalist's guide to the Americas. See SHELFORD 1926.

SERVICE, C. M.

1920 Parks and memorials of the State of Illinois. Dept. of Public Works and Bldgs. Springfield. 52 pp.

1925 Later ed. Freeport. 64 pp. See ILL. BOARD OF PARK ADVISORS, 1933.

SEAVER, FRED J.

1904 The Discomycetes of eastern Iowa. Bull. Lab. Nat. Hist. Univ. Iowa 5:230-297, with 25 pls.

SELLIER, L. M.

1924 Geographic map of Kentucky. Ky. Geol. Surv., Frankfort.

SHACKLEFORD, MARTHA W.

1929 Animal communities of an Illinois prairie. Ecol. 10:126-154.

SHALER, N. S., AND OTHERS

1884 Timber and botany [of Ky.]. Comprising seven reports [from earlier volumes] on the forests and botany of different parts of the state. Geol. Surv. Ky., New Ser. [2], 2d ed. [rearranged, related subjects together], vol. B. 239 pp. [Index, pp. 233-239; diagram of topogr. arrangement of forest belts on hills, pp. 26, 74.]

SHANNON, W. P.

1895 The range of the blue ash, Fraxinus quadrangulata. Proc. Ind. Acad. Sci. 1894:107-108.

SHAW, E. W.

1911 The infertility of southern Illinois. (Abstract). Ann. Assoc. Am. Geogr. 1:137.

1911 New system of quaternary lakes in the Mississippi basin. Jour. Geol. 19:481-491.

1915 Newly discovered beds of extinct lakes in southern and western Illinois and adjacent states. In Yearbook: Ill. State Geol. Surv. Bull no. 20:141-157.

SHAW, JAMES

1861 The great tornado of 1860. Trans. Ill. State Agr. Soc. 4:565-580. (1859-60). [Across n. Ill.]

1873 [Prairies of northwestern Illinois.] Geol. Surv. Ill. 5:11-14 (origin of prairie), 96, 134 (succession: marsh to low prairie), 140, 144, 185, 202.

1873 [Isolated groves of northwestern Illinois.] Geol. Surv. Ill. 5:56, 59, 82, 106, 125, 140, 166, 186. [Particular mention or brief description, in reports on different counties.]

1873 [Timbered or brushy "barrens" of northwestern Illinois.] Geol. Surv. Ill. 5:59, 82, 83, 95, 106, 140, 185.

SHEAR, G. M., AND STEWART, W. D.

1934 Moisture and pH studies of the soil under forest trees. Ecology 15:145-153. [Univ. of Ill. forest plantation.]

SHELFORD, V. E.

1909 Life histories and larval habits of the tiger beetles (Cicindelidae). Jour. Linn. Soc. Lond.—Zool. 30:157-184. 4 pls.

1911 Physiological animal geography. Jour. Morphol. 22:551-618.

SHELFORD, V. E.—*Continued*

1911 Ecological succession. Biol. Bull. I, 21:9-35; II, 21:127-151.

1912 III, 22:1-38; IV, 23:59-99; V, 331-370.

1913 The reaction of certain animals to gradients of evaporating power of air. Biol. Bull. 25:79-120.

1913 Animal communities in temperate America. Bull. Geogr. Soc. Chicago No. 5, publ. for the Society by Univ. of Chicago Press. 362 pp.

1914 An experimental study of the behavior agreement among the animals of an animal community. Biol. Bull. 26:295-315. Résumé in Trans. Ill. State Acad. Sci. 7:79-81.

1915 The original habitat and distribution of our native insect pests. Jour. Econ. Ent. 8:171-174.

1918 Physiological problems in the life histories of animals with particular reference to their seasonal appearance. Am. Nat. 52:129-154.

1927 An experimental investigation of the relations of the codling moth to weather and climate. Ill. State Nat. Hist. Surv. Bull. 16:311-440.

1929 Laboratory and field ecology. Williams and Wilkins Co., Baltimore. 608 pp.

1932 An experimental and observational study of the chinch bug in relation to climate and weather. Ill. Nat. Hist. Surv. Bull. 19:487-547.

Other articles by Shelford, involving organisms occurring in Illinois, are cited in his papers here listed.

SHEPHERD, FREDERICK

1932 The story of the dunes. Rocks and Minerals 7:41-48.

SHERFF, E. E.

1912 The vegetation of Skokie Marsh, with special reference to subterranean organs and their interrelationships. Bot. Gaz. 53:415-435. (Brief account in Trans. Ill. Acad. Sci. 5:125-127. 1913.)

1913 Vegetation of Skokie Marsh. Bull. Ill. State Lab. Nat. Hist. 9:575-614.

1913 Evaporation conditions at Skokie Marsh. Plant World 16:154-160.

SHIMEK, B.

1888 The Mollusca of eastern Iowa. Bull. Lab. Nat. Hist. Univ. Iowa 1:56-81.

1896 Notes on the flora of Iowa. Bull. Lab. Nat. Hist. Univ. Iowa 3:195-215.

1900 The distribution of forest trees in Iowa. Proc. Iowa Acad. Sci. 7:47-59, with map. (1899). [Most thorough discussion of prairie-forest relations. Many citations of infl. of fire, wind, soil, drainage, etc. Incl. discussion of topogr., exposure, and location as determinants of forest distr.]

1900 Iowa pteridophytes. Bull. Lab. Nat. Hist. Univ. Iowa 5:145-170.

1903 Iowa oaks. Trans. Iowa State Hort. Soc. 37:228-232, and 10 figs. (1902).

SHIMEK, B.—*Continued*

1904 Loess and the Iowan drift. Bull. Lab. Nat. Hist. Univ. Iowa 5:352-368.

1904 Evidences(?) of water-deposition of loess. Bull. Lab. Nat. Hist. Univ. Iowa 5:369-381.

1904 The native shrubs of Iowa. Trans. Iowa State Hort. Soc. 38:453-468, and 10 figs. (1903).

1904 The flora of the St. Peter sandstone in Winneshiek County, Iowa. Bull. Lab. Nat. Hist. Univ. Iowa 5:225-229.

1908 The genesis of loess a problem in plant ecology. Proc. Iowa Acad. Sci. 15:57-75. (1908).

1910 Prairie openings in forests. Proc. Iowa Acad. Sci. 17:16-19. (1910).

1911 The prairies. Bull. Lab. Nat. Hist. Univ. Iowa 6:167-240. 13 pls., 1 map. [Includes bibl. of papers on origin of prairie, with brief summary of causes ascribed by the authors, pp. 231-239. Refs. pertaining directly to Ill. are included here. Shimek's other refs. to prairie are on pp. 239-240. His own discussion of causes of treelessness permeates the article.]

1912 The significance of Pleistocene mollusks. Science 37:501-509.

1913 An artificial prairie. Bull. Lab. Nat. Hist. Univ. Iowa 6 (no. 4): 35-41.

1918 The sand flora of Iowa. Bull. Lab. Nat. Hist. Univ. Iowa 7 (no. 3): 6-24.

1925 Drainage in Iowa. Proc. Iowa Acad. Sci. 31:149-155. (1924).

1925 The prairie of the Mississippi River bluffs. Proc. Iowa Acad. Sci. 31:205-211. (1924). [McGregor-Prairie du Chien vicinity.]

1928 The prairies again. Science 68:321-322. [Comment on papers by P. M. JONES and A. M. MILLER.]

1930 Land snails as indicators of ecological conditions. Ecology 11:673-686. [Incl. the forest-and-prairie map of Iowa, and map of principal loess deposits of the Mississippi valley.]

1931 The relation between the migrant and native flora of the prairie region. Univ. Iowa Studies in Nat. Hist. 14 (2):10-16. [Prairie plants, on anything like equal terms, hold their own against weeds. . . . On p. 15, importance and local dominance of dicot herbs, notably composites in Iowa (and Illinois) prairie. Grasses by no means sole dominants.]

1931 The botanical manuals and the Iowa flora. Univ. Iowa Studies Nat. Hist. 14 (2):17-37. [Iowa habitats for many plants not as given in manuals.]

1931 Ecological conditions during loess deposition. Univ. Iowa Studies in Nat. Hist. 14:38-54.

1933 Quercus macrocarpa, var. depressa (Nutt.) Engelm. Rhodora 35: 295-297.

SHIMEK, B., AND KING, CHARLOTTE M.

1933 Dr. Louis H. Pammel. [Obituary notice by SHIMEK, with bibl. of his writings by Miss KING]. Proc. Iowa Acad. Sci. 38:55-68. (1932). [Bibl. arr. by subjects, incl. pollination and morphol. of seeds and seedlings, ecology (25 titles); phenology (12); forestry and floras (50); parks and conservation (59). Many of these articles are very short. The majority deal with Iowa plants or areas.]

SHIPTON, W. D.

1918 Bibliography of the Driftless Area. Proc. Iowa Acad. Sci. 24:67-81. (1917).

SHORT, C. W.

1836 A sketch of the progress of botany in western America. Transylvania Jour. Med. and Associate Sciences 9 (no. 34) : 1-30. [Brief acct. of early botanical explorations, incl.: André Michaux and his son; John Bradbury (1810-1811), Pursh, Correade Serra, Nuttall, McMurtrie of Louisville (publ. a catalogue of Ky. plants), Rafinesque. Collecting trips by Short, Peter, and Griswold through particular districts of Ky. are described.]

1845 Observations on the botany of Illinois, more especially in reference to the autumnal flora of the prairies. Western Jour. of Med. and Surgery, New Ser. 3:185-198. [One of the best descriptions of virgin prairie of Illinois. Quoted extensively by Lapham. Recognized prairie groves or forest islands and their relation to fire, and protection from it by water courses. Also the barrens.—The gregarious habit of certain herbs in the prairie: "Its leading feature is rather the unbounded profusion with which a few species occur, in certain localities, than the mixed variety of different species occurring anywhere. Thus from some elevated position in a large prairie, the eye takes in thousands of acres literally empurpled with . . . Liatris; in other situations . . . yellow flowered Coreopsis occur in . . . profuse abundance. . . . This peculiarity of an aggregation of individuals of one or more species to something like an exclusive monopoly of certain localities, obtains even in regard to those plants which are the rarest and least frequently met with; for wherever one specimen was found, there generally occurred many more in the same immediate neighborhood."]

SHORT, C. W., PETER, ROBERT, AND GRISWOLD, HENRY A.

1833 Catalogue of the native phanerogamous plants and ferns of Kentucky. Transylvania Jour. Med. 6:3-14. [About 1,000 spp. listed. No notes on habitat, abundance, or locality.]

1835 A supplementary catalogue of the plants of Kentucky. Transylv. Jour. Med. 8 (no. 32) : 1-8. [225 spp. added. By SHORT and PETER.]

1837 A second supplementary catalogue . . . . etc. Ibid. 10: [no. and page citations not available.]

1837 A third suppl. . . . . etc. 10 (no. 3) : no pages cited. [This, and probably the preceding, by SHORT alone. Incl. about 40 ferns, 40 mosses, and 60 angiosperms.]

1840 A fourth suppl. . . . . etc. Vol. 10 [About 200 spp. By SHORT.]

SHULL, CHARLES A.

1921 Some changes in the vegetation of western Kentucky. Ecology 2:120-124. [The Barrens; disappearance of Arundinaria from the Cane Hills.]

SIMMONS, LILLIAN M.

1921 Forest distribution at the ends of the Lake Chicago beaches. Trans. Ill. State Acad. Sci. 13:226-239. (1920).

SIMPSON, CHARLES T.

1896 On the Mississippi Valley Unionidae found in the St. Lawrence and Atlantic drainage areas. Am. Nat. 30:379-384. [Infl. of Wabash-Maumee divide and former connection upon distr. of aquatic organisms.]

SMITH, B. H.

1932 The algae of Indiana. Proc. Ind. Acad. Sci. 41:177-306. (1931).

SMITH, BERTRAM G.

1908 The spawning habits of Chrosomus erythrogaster. Biol. Bull. 15: 9-18. [At Lake Forest, Ill.]

SMITH, ERNEST RICE

1933 The physiographic features of Pine Hills Nature Study Park, Montgomery county, Indiana. Proc. Ind. Acad. Sci. 42:153-161. [The well-known Devil's Backbone is one feature of this park. Topographic map faces p. 153. See FRIESNER and POTZGER 1934.]

SMITH, F. B., AND BROWN, P. E.

1932 Methods for determining carbon dioxide production in soils. Iowa Agr. Exp. Sta. Res. Bull., 1932:25-51. (Res. Bull. no. 147.)

SMITH, FRANK

1900 Notes on species of North American Oligochaeta. III. List of species found in Illinois, and descriptions of Illinois Tubificidae. Bull. Ill. State Lab. Nat. Hist. 5:441-458.

1911 Double-crested cormorants breeding in central Illinois. The Auk. 28:16-19.

1913 Earthworms from Illinois. Trans. Ill. (State) Acad. Sci. 5:145-148. (1912).

1915 The relation of our shrubs and trees to our wild birds. Ill. Arbor and Bird Day Circ. no. 83, pp. 8-17. Publ. by Supt. of Public Instruction, Springfield.

1928 An account of changes in the earthworm fauna of Illinois. Ill. State Nat. Hist. Surv. Bull. 17:347-362.

1930 Records of spring migration of birds at Urbana, Illinois, 1903-1922. Ill. State Nat. Hist. Surv. Bull. 19:105-117.

SMITH, GUY D.

1934 Experimental studies on the development of heavy claypans in soils. Univ. Mo. Agr. Exp. Sta., Res. Bull. 210. 32 pp. [Applies to Mo. and Ill. claypan areas.]

SMITH, ISABEL

1910 Native trees of Morgan county. Trans. Ill. State Acad. Sci. 2:15-18. (1909).

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1927 Survey of trees and shrubs of Morgan county. Trans. Ill. State Acad. Sci. 19:200-204. (1926).

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SMITH, VERA G. (See DAVIDSON, VERA SMITH)

1928 Animal communities of a deciduous forest succession. Ecology 9: 479-500. [6 different habitats selected to "represent stages in two or more similar seres." 2 on dry stripland ridges, Vermilion co., Ill., 1 on ridge subject to flooding, 1 in bottomland, 2 in poorly-drained upland forest, Champaign co.]

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1924 James Watson Webb's trip across Illinois in 1822. Sycamore, Ill. 16 pp.

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1920 Ecological succession of mosses. Bot. Gaz. 69:449-491. [Dunes, Chicago area, and near Mt. Carroll, n. w. Ill.]

1921 Appearance of mosses in ecological habitats. Bryologist 23:81-84. (1920). [Chicago area and L. Mich. dunes.]

TAYLOR, ARTHUR E.

1907 The peat deposits of northern Indiana. Ind. Dept. Geol. and Nat. Resources, Ann. Rept. 31:73-298. (1906).

TAYLOR, FRANK BURSLEY

1908 A short history of the Great Lakes. Dryer's Studies in Indiana Geography, pp. 90-111. See DRYER, 1908.

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SEE MILLER AND TEHON 1929

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1880 Acrididae of Illinois. In 9th rept. Ill. State Entomologist. pp. 71-140.

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1880 [Brief notes on grasshoppers in so. Ill.] Am. Ent. 3: (new ser. 1:) 250, 251. [Local abund. of Acridium americanum (result of drought and heat), and tendency of Camnula pellucida to become long-winged and migratory. A pre-glimpse of an important modern discovery.]

1881 Relation of meteorological conditions to insect development. In 10th rept. Ill. State Entomologist, pp. 47-59.

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1889 Preliminary sketch of the aquatic and shore birds of the Kankakee region. Ind. Dept. Geol. and Nat. Hist., Ann. Rept. 16:162-164. (1888).

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TODD, JAMES E.

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TRACY, S. M.

1886 Catalogue of the phaenogamous and vascular cryptogamous plants of Missouri. Jefferson City, Tribune Printing Co. 106 pp. [Some brief habitat and abundance notes.]

TRANSEAU, E. N.

1913 The periodicity of algae in Illinois. Trans. Am. Micr. Soc. 32:31-40.

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1916 The periodicity of freshwater algae. Am. Jour. Bot. 3:121-133.

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TRELEASE, WM. AND GRAY, ASA (Editors)

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TRENK, FRED B.

1926 The occurrence of hickories in Iowa in relation to soil types. Proc. Iowa Acad. Sci. 32:143-155. (1925). [Includes classifications of Iowa soils by Iowa Agr. Exp. Sta., pp. 147-148.]

1928 [Same title.] Proc. and Papers 1st Internat. Congr. Soil Sci., Washington (1927). 4:318-322.

TROWBRIDGE, A. C.

1912 Geology and geography of the Wheaton quadrangle. Ill. Geol. Surv. Bull. No. 19. 79 pp.

1913 Some partly dissected plains in JoDaviess county, Illinois. Jour. Geol. 21:731-742.

1921 Erosional history of the Driftless Area. Univ. Iowa Studies Nat. Hist. 9 (3):5-127.

TROWBRIDGE, A. C., AND SHAW, E. W., AND SCHOCKEL, B. H.

1916 Geology and geography of the Galena and Elizabeth quadrangles. Ill. State Geol. Surv. Bull. no. 26. 233 pp.

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1923 Ecology of Rhus toxicodendron. Trans. Ill. State Acad. Sci. 15:208-211. (1922).

TURNER, LEWIS M.

1928 A preliminary report on an ecological problem in the Illinois River valley. Trans. Ill. State Acad. Sci. 20:137-139. (1927). [Infl. of levees, flooding, pollution.]

1930 The 1926-27 floods and the Illinois River valley vegetation. Trans. Ill. State Acad. Sci. 22:95-97 (1929). [Prolonged flooding and burial by sediment kill 90% of pin oaks, elms, cottonwoods, near LaGrange locks.]

1932 Plant succession on levees in the Illinois River valley. Trans. Ill. State Acad. Sci. 24:94-102. (1931).

1934 Grassland in the floodplain of Illinois Rivers. Am. Midland Nat. 15:770-780. [Near mouth of Apple Creek in Greene co., and near Hillview, Pike co.]

1934 Grassland in the floodplain of Illinois Rivers. Trans. Ill. State Acad. Sci. 26:71-72. (1933).

UDDEN, JOHAN A.

1898 The mechanical composition of wind deposits. Augustana Library Publications, No. 1. 69 pp. Augustana College, Rock Island, Ill. [Data for dune sands of L. Mich., and inland sands and dusts of Ill. and other prairie states. Bearing on loess problems discussed.]

1912 Geology and mineral resources of the Peoria quadrangle, Illinois. U. S. Geol. Surv. Bull. no. 506. 103 pp.

ULFFERS, H. A.

1855 Mollusca of southern Illinois. Trans. Ill. State Agr. Soc. 1:610-612 (1853-4). [Names only.]

ULLRICH, FRED THEODORE

1915 The relation of evaporation and soil moisture to plant succession in a ravine. Bull. Ill. State Lab. Nat. Hist. 12:1-16. [Ravine near Lake Michigan, north of Chicago.]

UPHOF, J. C.

1922 Ecological relations of plants in southeastern Missouri. Am. Jour. Bot. 9:1-18.

U. S. GEOLOGICAL SURVEY

Geologic atlas of the U. S.: folios of Illinois areas, no.:

1900 67 Danville.

1902 81 Chicago, Riverside, DesPlaines, and Calumet.

1904 105 Patoka.

U. S. GEOLOGICAL SURVEY (AND ILLINOIS GEOLOGICAL SURVEY)

Topographic maps of Illinois quadrangles. 289 quadrangles in the state. The 130 + available to Sept. 1, 1933, including advance photolithographic maps, are listed on p. 39 of the 1933 list of publications of the Illinois Survey. Their locations shown on the index map, p. 38.

Geologic atlas of the U. S.: folios of Illinois areas, no.:

1907 145 Lancaster-Mineral Point.

1913 185 Murphysboro and Herrin (1912).

1913 188 Tallula and Springfield.

1915 195 Belleville and Breese.

1916 200 Galena and Elizabeth.

1919 208 Colchester and Macomb.

1921 213 New Athens and Okawville.

1923 216 Carlyle and Centralia.

1926 220 Gillespie-Mount Olive.

VAN CLEAVE, H. J.

1928 The fairy shrimps of Illinois. Trans. Ill. State Acad. Sci. 20:130-132. (1927).

1928 A study of the characters for the identification of the snakes of Illinois. Trans. Ill. State Acad. Sci. 20:133-136. (1927). [41 spp. enumerated.]

VAN CLEAVE, H. J., AND MARKUS, H. C.

1929 Studies on the life history of the blunt-nosed minnow. Am. Nat. 53:530-539. Abstr. in Trans. Ill. State Acad. Sci. 22:185. (1929).

VAN HOOK, MARY L.

1905 Illinois ferns near Lake Michigan. Fern. Bull. 13:23-25.

VAN ZANDT, NICHOLAS BIDDLE

1818 A full description of the soil, water, timber, and prairies of each lot, or quarter section of the military lands between the Mississippi and Illinois Rivers. Washington City, P. Force. 127 pp. [Sample township description, p. 57: Range 6 W, Town 6 N: "Timber—oak, lynn, and hackberry—hazle. Prairie generally rolling." R 7 W, T 3 N: "Timber—oak. Half the town is prairie, residue principally brushy barrens."—Pp. 85-97, description of the Illinois Territory; pp. 98-115, Missouri Territory.]

VASEY, GEORGE

1859 Mosses of Illinois. Trans. Ill. State Agr. Soc. 3:676-679. (1857-8).

1861 Additions to the flora of Illinois. Trans. Ill. State Agr. Soc. 4:667-671. (1859-60). Also as: Additions to the Illinois Flora. Prairie Farmer 22: (new ser. 6;) 119. [Includes list of 58 spp. contr. by S. B. MEAD, of Augusta, Ill. Nearly half of these are introduced spp. Vasey adds 113 native plants.]

1870 [Southern Illinois plants.] Am. Ent. and Bot. 2:191. See also 2:288, and 2:384.

1870 The oaks. I. (White, bur, and post oaks). Am. Ent. and Bot. 2:249-250. [Bur oak the common tree of oak openings; post oak flats of so. Ill.]

VASEY, GEORGE—*Continued*

1870 Origin of prairie vegetation. Am. Ent. and Bot. 2:277-280. [Criticisms of WINCHELL'S rather extravagant ideas, with suggestions on upstream migration of trees into prairie.]

1870 New plants [Saxifraga Forbesii (n. sp.) and Heuchera sp., shaded cliffs, Cobden and Makanda.] Am. Ent. and Bot. 2:288. See p. 310, note by FORBES on the Heuchera.

1870 Maritime plants of the Great Lakes and the interior. Am. Ent. and Bot. 2:342-344. [Incl. remarks by WARNE. Mentions prickly pear in sandy fields n. of Chicago.]

VERINK, E. D.

1915 Preliminary report on the flora of Linn county, Iowa. Proc. Iowa Acad. Sci. 21:77-99. (1914). [Degree of abundance given for certain spp.]

VESTAL, ARTHUR G.

1913 An associational study of Illinois sand prairie. Bull. Ill. State Lab. Nat. Hist. 10:1-96. [Animals and plants, principally in Ill. River dunes near Havana. See HART and GLEASON, 1907.]

1914 A black-soil prairie station in northeastern Illinois. Bull. Torr. Bot. Club 41:351-363.

1914 Internal relations of terrestrial associations. Am. Nat. 48:413-445. [Based principally on studies of sand-prairie animals and plants of Ill.]

1920 Local inclusions of prairie within forest. Trans. Ill. State Acad. Sci. 11:122-126. (1918). [E. centr. Ill.]

1920 Invasion of forest land by prairie along railroads. Trans. Ill. State Acad. Sci. 11:126-128. (1918). [E. centr. Ill.]

1920 Preliminary account of the forests in Cumberland County, Illinois. Trans. Ill. State Acad. Sci. 12:234-245. (1919).

1931 A preliminary vegetation map of Illinois. Trans. Ill. State Acad. Sci. 23:204-217 (1930). 3 maps.

1931 Review of Weaver and Clements, "Plant Ecology" (McGraw-Hill, N. Y. 520 pp. 1929).—Ecology 12:232-239. [Possibility of Illinois prairie climax, and that prairie and forest each helps to determine its own climate.]

1932 Strategic habitats and communities in Illinois. Trans. Ill. State Acad. Sci. 24:80-85. (1931).

1934 Segregation of vegetation into associations and into less extensive units. (Abstract). Bull. Ecol. Soc. Am. 15:31. "Many regularly gregarious herbs are typical of Illinois prairie, making the prairie a patchwork superposed on a blended ground-fabric of many other species." Cf. SHORT, 1845.

VISHER, S. S.

1929 The climate of Kentucky. Ky. Geol. Surv., Ser. 6, 31:81-167.

VON SCHRENK, HERMANN

1898 The trees of St. Louis as influenced by the tornado of 1896. Trans. Acad. Sci. St. Louis 8:25-41. 6 pls. [Injuries, and growth reactions following storm. See NORTON, J. B. S., 1897.]

VON SCHRENK, HERMANN—*Continued*

1900 A severe sleet-storm. Trans. Acad. Sci. St. Louis 9:143-150. 4 figs. [Glaze storm, Feb. 27, 1900; Mo., Ill., Ind., Ohio. Effects on trees; their ability to withstand ice loads. Refs. to earlier descriptions.]

VOSS, JOHN

1932 Preliminary report on the paleo-ecology of a Wisconsin and an Illinois bog. Trans. Ill. State Acad. Sci. 24:130-137. (1931).

1933 Pleistocene forests of central Illinois. Bot. Gaz. 94:808-814. Abstract in Trans. Ill. State Acad. Sci. 25:130. 1933.

1934 Postglacial migration of forests in Illinois, Wisconsin, and Minnesota. Bot. Gaz. 96:3-43. [Pollen diagrams from bogs in n. Ill., Wis., and e. Minn., with conclusions as to succession of forests in the different localities. Postglacial climatic change gradual, with no indication of considerable fluctuation as suggested in other regions.]

WADMOND, S. C.

1910 Flora of Racine and Kenosha counties, Wisconsin. Trans. Wis. Acad. Sci., Arts, and Letters, 16 (part 2):798-888.

1933 The Quercus ellipsoidalis—Quercus coccinea complex. Trans. Wis. Acad. Sci., Arts, and Letters 28:197-203. Map.

WALKER, R. H., FIRKINS, B. J., AND BROWN, P. E.

1931 The measurement of the degree of saturation of soils with bases. Iowa Agr. Exp. Sta. Res. Bull., 1931:153-176. (Res. Bull. no. 139). [Data for prevailing soil types of Iowa.]

WALTER, HERBERT EUGENE, AND ALICE HALL WALTER

1904 Wild birds in city parks; being hints on identifying 145 birds, prepared primarily for the spring migration in Lincoln Park, Chicago. Rev. and enlarged ed. Chicago, A. W. Mumford. 66 pp., folding chart. (1st ed. 1903; 1905 ed. also.)

WANLESS, HAROLD R.

1928 Pleistocene and recent history of Alexis quadrangle and vicinity [Mercer and Warren counties]. Trans. Ill. State Acad. Sci. 20: 254-260. (1927).

1929 Nebraskan till in Fulton county, Illinois. Ill. State Acad. Sci. 21: 273-282. (1928).

1929 Geology and mineral resources of the Alexis quadrangle. [n. Warren co.] Ill. State Geol. Surv. Bull. No. 57. 230 pp.

WARD, LESTER F.

1878 St. Louis and botany. Field and Forest 3:170-172. [Iron Mountain district of e. Mo.; Cahokia Mound, Ill.]

WARNE, H. A.

1870 A list of plants growing in the vicinity of Chicago during March, April, and May. Am. Ent. and Bot. 2:313-314. [Prairie at Graceland and Hyde Park; forests of north branch, Chicago River, and of DesPlaines River; dunes and lake-shore veg.] Continued as Notes on plants collected near Chicago, pp. 345-348. [Calumet district, dunes and strand s. of Chicago and into Indiana, incl. bog habitats.]

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WATERMAN, W. G.

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1922 Preliminary report on the bogs of northern Illinois. Trans. Ill. State Acad. Sci. 14:79-84. (1921).

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1926 Ecological problems from the sphagnum bogs of Illinois. Ecology 7:225-272.

WEBER, JESSIE PALMER, AND OSBORNE, GEORGIA L.

1905 An outline for the study of Illinois State history. Ill. State Historical Library. Springfield. H. W. Rokker Co., Printers. 94 pp.

WEBSTER, F. M.

1880 Notes upon the food of predaceous beetles. Bull. Ill. State Lab. Nat. Hist. 1(3):162-166. 2d ed. 1903.

WEED, C. M.

1889 On an outbreak of injurious locusts in central Illinois. In 15th rept. Ill. State Entomologist, pp. 40-44.

1890 A descriptive catalogue of the Phalangiinae of Illinois. Bull. Ill. State Lab. Nat. Hist. 3:79-97.

WEESE, ASA ORRIN

1925 Animal ecology of an Illinois elm-maple forest. Ill. Biol. Monographs 9 (4):345-438. 7 pls. Bibl. pp. 411-415. [University woods, 5 mi. e. n. e. of Urbana.] (Paging of separate is 1-93).

WELCH, WINONA H.

1926 An ecological study of the flora of Fountain, Parke, and portions of adjacent territory, Jasper county, Indiana. Proc. Ind. Acad. Sci. 35:201-212. (1925).

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1931 Additions . . . 40:119-121. (1930).

1929 Phytoecology of southern Indiana, with special reference to certain Ericaceae in the limestone area of the Bloomington quadrangle. Proc. Ind. Acad. Sci. 38:65-83. (1928).

1930 Forest and prairie, Benton county, Indiana. Proc. Ind. Acad. Sci. 39:67-72. (1929). [Isolated prairie groves, as in Ill., in an Ind. extension of the Grand Prairie. See GORBY, 1886; GLEASON, 1912, 1913; and VESTAL, 1932.]

1932 An ecological study of the bald cypress in Indiana. Proc. Ind. Acad. Sci. 41:207-213. (1931).

WELD, LEWIS H.

1928 Cynipid galls of the Chicago area. Trans. Ill. State Acad. Sci. 20: 142-177. (1927). [146 gall varieties, arranged by hosts and otherwise.]

WELLER, J. MARVIN

1934 Tri-state geological field conference of the upper Mississippi valley. Science, n. s., 79:80-82.

WELLER, STUART, AND OTHERS

1920 [Brief form of] Geology of Hardin county and the adjoining part of Pope county. Ill. State Geol. Surv. Bull. no. 41A. 146 pp. (41: 1-75, 235-310).

WELLER, STUART, AND ST. CLAIR, STUART

1928 Geology of Ste. Genevieve county, Missouri [and parts of Perry and St. Francois counties]. [Repts.] Mo. Bur. Geol. and Mines, 2d ser., vol. 22. 352 + 10 pp. (index), large topogr. and geol. maps. [History, pp. 12-19; topogr., etc., 20-29. Pleistocene deposits, by E. W. SHAW, with note by F. LEVERETT, pp. 251-255.]

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WELLS, R. W.

1819 On the origin of prairies. Am. Jour. Sci. and Arts. (ser. 1) 1:331-337. [Believes prairies and barrens of Alleghany mts. and of Ohio, Ind., and Ill. were largely originated and continued by fire, that Indians set fires in forests, that continued fires destroyed forests, that new forests develop after cessation of fires, or where "prairie has been depastured by large herds of domestic cattle." Examples of newly forested areas near St. Louis and St. Charles, Mo.]

WENTWORTH, C. K.

1926 Methods of mechanical analysis of sediments. Univ. Iowa Studies Nat. Hist. 11 (11):1-52. See also v. 14, no. 3. 1931.

1931 The mechanical composition of sediments in graphic form. Univ. Iowa Studies Nat. Hist. 14 (3):1-127. [Includes Ill. lag gravel, dune and other sands, dusts (some from accumulations on trees), and till (boulder clay).]

WEST, JAMES A.

1910 A study of the food of moles in Illinois. Bull. Ill. State Lab. Nat. Hist. 9:14-22.

WHITBECK, R. H.

1911 Contrasts between the glaciated and driftless portions of Wisconsin. Bull. Geogr. Soc. Philad. 9:114-123.

1913 Economic aspects of glaciation in Wisconsin. Ann. Assoc. of Am. Geographers 3:62-87.

1920 Geography of southeastern Wisconsin. Wis. Geol. and Nat. Hist. Surv. Bull. no. 58. 160 pp.

1921 The geography and economic development of southeastern Wisconsin. Wis. Geol. and Nat. Hist. Surv. Bull. 58. 2d ed. 252 pp.

WHITE, HELEN L.

1931 The phytoplankton of a solution pond with special reference to the periodicity of certain algae. Proc. Ind. Acad. Sci. 40:123-140. (1930). [Pond near Bloomington, Ind. Extensive bibl. on ecol. of algae.]

WHITNEY, J. D.

1858 Physical geography [of Iowa]. Chapter 1 in: Report on the Geol. Surv. of the State of Iowa. Vol. 1, part 1: Geology. [Prairies in wide bottoms of Miss. R., p. 15-16; upland prairies and groves, pp. 20-27.]

1876 Plain, prairie, and forest. Am. Nat. 10:577-588; 656-667. [Distr. of forest and prairie independent of climate, therefore attributable to differences in soil and topography.—Includes discussion of particular areas in Ill., Iowa, Mo., Wis.]

WHITSON, A. R.

1927 Soils of Wisconsin. Wis. Geol. and Nat. Hist. Surv. Bull. no. 68 (Soil Ser. no. 49). 270 pp. Large colored map. List of reports on Wis. soils, pp. 259-261.

WHITSON, A. R., AND BAKER, O. E.

1928 The climate of Wisconsin and its relation to agriculture. Univ. Wis. Agr. Exp. Sta., Bull. No. 223, 2d ed. revised. 65 pp. (1st ed., 1912).

[Local climatic summaries are included in county soil reports.]

WHITSON, A. R., AND OTHERS

[Soil maps for southern tier of Wisconsin counties (not yet publ. for Grant and LaFayette counties).] Wis. Geol. and Nat. Hist. Surv. Bull. no.:

1922 53B (Soil Ser. no. 21) Rock co.

1923 56B (Soil Ser. no. 29) Racine-Kenosha area.

1924 56C (Soil Ser. no. 30) Walworth co.

1930 53C (Soil Ser. no. 22) Green co.

[For other Wis. soil maps see 18th Bienn. Rept., Wis. Geol. and Nat. Hist. Surv., 1932:20-38. Index map, p. 23.—Soil Survey transferred to Univ. of Wis., 1931.]

WICKHAM, H. F.

1899 The habits of American Cicindelidae. Proc. Davenport Acad. Nat. Sci. 7:206-228.

1909 A list of the Coleoptera of Iowa. Bull. Lab. Nat. Hist. State Univ. Iowa 6:1-40.

WIEBE, A. H.

1927 Biological survey of the upper Mississippi river with special reference to pollution. U. S. Bur. Fish. Bull. 43:137-167.

WILDE, S. A.

1933 The relation of soils and forest vegetation in the Lake States region. Ecology 14:94-105. [Correlation of forest types with soil texture, topography, water level.]

WILLARD, D. E.

1893 Some geological features of Jackson Park, Chicago. Science, Old Series 22:309-310.

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1920 The vegetative organs of some perennial grasses. Iowa Acad. Sci. 25:341-367. (1919). [Incl. native prairie dominants.]

WILLEY, HENRY

1877 List of Illinois lichens. Bot. Gaz. 2:77-78. [113 spp. and varieties, coll. by J. WOLF, of Canton, Ill. Some of them are "rail lichens."] See WOLF and HALL, 1878.

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WILLIAMS, F. E.

1914 The climate of Wisconsin. Jour. Geogr. 12:232-234.

WILLIAMSON, E. B.

1900 The dragonflies of Indiana. Ind. Dept. Geol. and Nat. Resources, Ann. Rept. 24:229-333. (1899).

WILSON, ALBERT C.

1931 Rules and regulations: Illinois seed and weed control laws. State Dept. Agr., Div. of Seed Inspection. Springfield Seed Laboratory, Bull. no. 330. 54 pp.

WILSON, BEN H.

1924 An excellent example of high clay bank erosion in Lee county, Iowa. Proc. Iowa Acad. Sci. 30:425-431. (1923).

WILSON, CHARLES BRANCH

1920 Dragonflies and damselflies in relation to pondfish culture, with a list of those found near Fairport, Iowa. U. S. Bur. Fish., Doc. 882. 86 pp. (Bull. U. S. Bur. Fish. 36:179-264. Bibl., pp. 260-264).

WILSON, CHARLES B., AND CLARK, H. WALTON

1912 The mussel fauna of the Maumee River. U. S. Bur. Fish., Doc. 757. 72 pp. [Geol. and geogr. of the Maumee and upper Wabash Basins, pp. 3-8. Biol. of the Maumee River, pp. 8-10.] See SIMPSON, 1896.

1912 The mussel fauna of the Kankakee Basin. U. S. Bur. Fish. Doc. no. 758. 52 pp. Map. [Physical features of the Kankakee Basin, pp. 4-7.]

WILSON, J. D.

1932 Environmental factors in relation to plant disease and injury: a bibliography. Ohio Agric. Exp. Sta., Tech. Ser., Bull. 9. 203 pp.

WINCHELL, ALEXANDER

1864 On the origin of the prairies of the valley of the Mississippi. Am. Jour. Sci. and Arts, 2d ser., 38:332-344. (An earlier version "in the Ladies' Repository for May, 1863.") [Believes in lake-deposit origin of prairies.]

1876 Treelessness of prairies. In Cochrane's Centennial History of Mason County.

See COCHRANE, J., 1876.

WINKENWERDER, H. A.

1902 Notes on the winter habits of the red-headed woodpecker. Bull. Wis. Nat. Hist. Soc. 2:69-74. [Correl. between woodpecker occurrence during winter, and storage of acorns by them.]

1902 The migration of birds. Bull. Wis. Nat. Hist. Soc. 2:176-263. [Incl. observations at Lake Forest, Ill.; Beloit, Madison, and other Wisconsin localities. Comprehensive review of the subject, especially as pertaining to the Mississippi Valley migration route.] Earlier article, 2:97-107.

WISCONSIN MAPS

1851 to 1931 [Appendix E. of MARTIN, 1932, q. v., pp. 494-513. A full list with essential information, of maps of Wis. and areas within Wis. Incl. base maps, topogr. maps, geol. maps and folios, native veg. (1882), rainfall and temp. (1882), forests of n. Wis. (1898), soils (1908, 1921, 1926), swamp lands (1915), glacial geol., hydrographic maps of upper Miss. River and Wis. lakes, etc.]

WISCONSIN SOIL SURVEY

[See WHITSON, A. R.—A copy of the index map showing soil maps and bulletins of Wis. areas is also published in MARTIN, 1932, q. v., p. 512.]

WOLF, JOHN, AND HALL, ELIHU

1878 A list of the mosses, liverworts, and lichens of Illinois. Bull. Ill. State Lab. Nat. Hist. 1 (2):18-35. See WILLEY, 1877, 1878.

WOOD, FRANK ELMER

1910 A study of the mammals of Champaign county, Illinois. Bull. Ill. State Lab. Nat. Hist. 8:501-613.

1910 On the common shrew-mole in Illinois. Bull. Ill. State Lab. Nat. Hist. 9:1-13.

WOOD, HARRY WARREN

1916 History of Indiana during the Glacial Period. Ind. Dept. Geol. and Nat. Resources 40:10-43. (1915).

WOOD, JUNIUS B.

1931 Illinois, cross-roads of the continent, with illustrations from photographs by CLIFTON ADAMS, staff photographer, and a special map supplement of Illinois. Nat. Geogr. Mag. 59:523-594. May no.

WOODARD, JOHN

1924 Origin of prairies in Illinois. Bot. Gaz. 77:241-261. Also, Trans. Ill. State Acad. Sci. 16:259-263. (1923).

1925 Factors influencing the distribution of tree vegetation in Champaign county, Illinois. Ecology 6:150-156.

WOODRUFF, FRANK M.

1897 Lake Michigan bird notes. The Auk 14:197-200.

1898 15:61-62.

1905 The prothonotary warbler. Birds and Nature 17:194.

1907 The birds of the Chicago area. Chicago Acad. Sci., Nat. Hist. Surv. Bull. no. 6. 221 pp. Extensive bibl., pp. 196-205.

1907 Rare northern birds near Chicago. The Auk 24:107.

WOODS, JOHN

1822 Two years residence in the settlement on the English Prairie in the Illinois country; a description of the principal towns, villages, etc., with the habits and customs of the back-woodsmen. London. 310 pp.

WOODWORTH, CHARLES W.

1887 Jassidae of Illinois. Part I. Bull. Ill. State Lab. Nat. Hist. 3:9-34.

WORTHEN, A. H.

1866 [Topography of prairie as cause of treeless condition.] Geol. Surv. Ill. 1:9-10. (Also in Econ. Geol. Ill. 1:1882.)

1866 [Soils, timber, and bottom prairies of Randolph, St. Clair, Madison, and Hancock counties.] Geol. Surv. Ill. 1:280 and 294, 297, 313, 327-328.

1868 [Soil, timber, etc. of Jersey, Greene, and Scott counties.] Geol. Surv. Ill. 3:121, 123, 134. [Incl. mention of prairies in Ill. River bottoms, and bald grassy knobs of loess bluffs.]

1873 [Timber, etc., of western Illinois.] Geol. Surv. Ill. 5:251, 253, 266-267, 306. [Peoria, McDonough, Monroe and Sangamon counties.]

1875 [Timber and prairie of counties bordering the Wabash; and Williamson county.] Geol. Surv. Ill. 6:21 (Clark); 22, 30 (Crawford); 37, 44 (Lawrence); 63-65 (Wabash, with list of trees and shrubs by SCHNECK); 74 (White); 113-121 (Williamson). [Mention of particular bottomland or terrace prairies of Wabash valley. Cane-brakes, p. 74.]

WORTHEN, A. H. (AND ENGELMANN, H.)

1868 [Topography and vegetation in Alexander, Union, Jackson, and Perry counties.] Geol. Surv. Ill. 3:20, 31; 34; 58, 82, 83; 84-86, 101-103. [Relation of prairie to post-oak flats; the barrens, covered with tall grasses, trees few or none. Other special types of veg.]

WORTHEN, A. H., AND OTHERS

1866 to 1890 [Descriptions of geology and physical geography of counties and other areas of Illinois. Publications of the original Geological Survey of Illinois, vols. 1, 3 to 6, 8. Contents detailed in list of publications of the State Geol. Surv. 1933:24.

1882 Economical geology of Illinois. Reprinted from the original reports of the Geological Survey, with additions and emendations. Springfield. 3 vols. 541, 615, and 596 pp.

See also BANNISTER, H. M., BRODHEAD, G. C., ENGELMANN, HENRY, AND SHAW, JAMES.

WRIGHT, G. F.

1890 The glacial boundary in western Pennsylvania, Ohio, Kentucky, Indiana, and Illinois. U. S. Geol. Surv. Bull. 58. 112 pp.

1918 Explanation of the abandoned beaches about the south end of Lake Michigan. Bull. Geol. Soc. Am. 29:235-244.

WRIGHT, HERMAN P.

1932 Aquatic mollusca of the Tippecanoe River system. Part I. Post-glacial migration and present distribution of four species of snails. Ecol. Monographs 2:233-259. See SIMPSON, 1896.

WRIGHT, JOHN S.

1898 Notes on the cypress swamps of Knox County. Proc. Ind. Acad. Sci. 1897:172-175.

YUNCKER, T. G.

1921 A list of Indiana mosses. Proc. Ind. Acad. Sci. 1920:231-248.
1922 [Additions and corrections to this list.] 1921:155-156.

ZETEK, JAMES

1920 The Mollusca of Piatt, Champaign, and Vermilion counties of Illinois. Trans. Ill. State Acad. Sci. 11:151-182. (1918).

ZIEGLER, E. A.

1904 Natural timber of northern and central Illinois. MSS. U. S. For. Serv.

TRANSACTIONS

OF THE

ILLINOIS STATE ACADEMY OF SCIENCE

Vol. 27 March 1935 Number 3

Announcement

Twenty-eighth Annual Meeting

Officers and Committees, General Program
Section Meetings, Junior Section
General Information

Friday and Saturday, May 3-4, 1935
Bloomington, Illinois

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Department of Registration and Education
Centennial Bldg., Springfield, Ill.

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OFFICERS AND COMMITTEES

1934-1935

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The Council is composed of the President, the two Vice-Presidents, the Secretary, the Treasurer, the last two retiring Presidents and the retiring Secretary.

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R. S. Smith, University of Illinois, Urbana.
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HARRY L. ADAMS and H. L. SLICHENMYER, Bloomington High School, *Local Arrangements.*

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LYELL J. THOMAS, University of Illinois, Urbana.

Delegate to the Conservation Council of Chicago:

V. O. GRAHAM, 4028 Grace Street, Chicago.

GENERAL PROGRAM

All Addresses and Section Meetings Are Open to the Public

THURSDAY, MAY 2, 1935

7:30 p. m. Meeting of the Council *(Tilden-Hall Hotel).*

FRIDAY, MAY 3, 1935

8:00 a. m. Registration by all members and guests. Securing of final programs and tickets for the annual banquet. Registration for Saturday Field Trips *(First Floor Corridor).*

8:00 a. m. Meeting of the Council with local committee and delegates from affiliated societies *(Board of Education Office).*

8:45 a. m. Preliminary business meeting of the Academy. Appointment of committees on nominations, resolutions and auditing. Adjournment until 11:15 a. m. *(Auditorium).*

GENERAL SESSION, HIGH SCHOOL AUDITORIUM

9:00 a. m. Address of Welcome, NATE CRABTREE, Secretary of Association of Commerce, Bloomington, Illinois.

Presidential Address, PRESIDENT CHARLES H. BEHRE, JR., Department of Geology and Geography, Northwestern University, Evanston. *"Some Problems in the Origin of Mineral Veins."*

Address: H. L. KELLOGG, State Planning Engineer, Chicago. *"History of Population Growth in Illinois and a Forecast of the Future."* This paper is the first of the Symposium of the Economics Section: *"Population Trends in Illinois and Their Relation to Economic Problems of the State."*

Address: JAMES R. HOLBERT, Senior Agronomist, U. S. Department of Agriculture, *"Modern Trends in Corn Breeding."*

1:15 a. m. Annual business meeting of the Academy, reports of officers and committees, other business, adjournment until 5:00 p. m.

2:00–1:00 p. m. Luncheon, High School Cafeteria, ground floor. Price 45 cents.

1:30 p. m. Section Meetings. Election of Chairman for 1935-36; papers; demonstrations and discussions.

5:00 p. m. Final business meeting of the Academy *(Room 114)*. Reports of committees, election of officers for 1935-36, appointments of standing committees, other business.

7:00 p. m. Annual Banquet (Informal), First Christian Church, 401 W. Jefferson Street. Reservations should be made in advance. Apply to L. K. Wright, High School, Bloomington, Ill., and secure tickets at the Registration Desk at time of registration. 75 cents per plate.

8:00 p. m. Address of Greeting—R. W. Fairchild, President, Illinois State Normal University, Normal.

Annual Public Lecture—Professor Charles T. Knipp, Physics Department, University of Illinois, Urbana. *"Electronics, Electrodeless Discharge,"* a demonstration lecture on electrical discharge phenomena. *(High School Auditorium.)*

SATURDAY, MAY 4, 1935

8:00 a. m. Meeting of the new Council *(Tilden-Hall Hotel)*.

9:00 a. m. Inspection trips leave from Bloomington High School. The local committee will arrange for transportation for those who do not have their own means of transportation if reservations are made in advance. Register for one of the trips at the time of general registration.

Geological Trip—This will include both glacial geology and coal geology and will be given under the auspices of the State Geological Survey. By automobiles the party will visit the Shelbyville, Bloomington and Normal moraines at points of vantage west of Bloomington, will observe outwash features from these moraines, and will see an exposure showing interglacial materials. In the Peoria-Pekin region, three coal horizons, horsebacks in No. 5 coal bed, possibly a sandstone cutout of No. 5 coal bed in a mine, and an occurrence of white-top in No. 6 coal bed will be seen. Surface exposures will give excellent examples of cyclical sedimentation. Those attending should wear hiking shoes and bring lunches. Maps will be provided.

Industrial Trip—S. A. Chester, Bloomington High School, H. W. Adams, Illinois State Normal University, H. S. Mortimer, Illinois Wesleyan University, are in charge of local arrangements. Chicago and Alton Railroad shops and the Bloomington-Normal Sewage Treatment Plant will be visited.

Biological Trip—J. C. Frazier, Illinois Wesleyan University, Blanche McAvoy, Illinois State Normal University, H. L. Slichenmyer, Bloomington High School, are in charge of local arrangements.

Complete details of Field Trips will be announced in the final program.

PROGRAM OF SECTION MEETINGS

FRIDAY, MAY 3—1:30 P. M.

AGRICULTURE

Room 204

Herbert W. Mumford, Dean of the College of Agriculture, University of Illinois, *Chairman*

Election of Chairman for 1935-36.

Symposium: Problems of Seed Production in Illinois.

1. The Physiology of Seed Germination—C. F. Hottes, Department of Botany, University of Illinois.
2. Canada Thistles in Illinois—Joseph E. Barnes, Analyst Division of Plant Industry, Department of Agriculture, State of Illinois.
3. Effect of Seed Injury on Germination, Vigor, and Yield of Corn—Benjamin Koehler, Department of Agronomy, University of Illinois.
4. Purity of Illinois Seed Stock as Revealed by Seed Analysis Studies—L. A. Moore, Superintendent, Division of Plant Industry, Department of Agriculture, State of Illinois.
5. Sweet Clover Seed Production—Walter Newlin, Vocational Agriculture Teacher, Casey Township High School, Casey.

6. Insects in Relation to Production of Red Clover Seed—J. H. BIGGER, Field Entomologist, Natural History Survey Division, State of Illinois.
7. Production of Hybrid Seed Corn—EARL SIEVEKING, Soil and Crop Specialist, Funk Brothers Seed Company, Bloomington.

ANTHROPOLOGY

Room 115

BRUCE W. MERWIN, Southern Illinois State Teachers College, Carbondale, *Chairman*

Election of Chairman for 1935-36.

1. Archaeological Excavations near Quincy—O. D. THURBER, Senior High School, Quincy.
2. A Method of Restoration of Indian Mounds—H. V. McCOY, Collinsville.
3. Early Indians of Central Illinois—R. V. JORDAN, Superintendent of Schools, Centralia.
4. Bannerstones and Related Ceremonial Objects from Southern Illinois—IRVIN PEITHMAN, Carbondale.
5. Condition of Teeth from Pre-historic Burials in Southern Illinois—VAN ANDREWS, Cairo.
6. Oral Structure of Indians of Illinois—J. B. RUYLE, Champaign.
7. The Eden of an Ancient Civilization—H. L. CHAPMAN, Jerseyville.
8. Archaeology in Southern Illinois—BRUCE W. MERWIN, Southern Illinois State Teachers College, Carbondale.

BOTANY

Room 105

W. M. BAILEY, Southern Illinois State Teachers College, Carbondale, *Chairman*

Election of Chairman for the year 1935-36.

1. Conservation of Wild Flowers—H. W. MAUNTEL, Mendota Township High School, Mendota (10 minutes).
2. Germination Behavior of the Rose Mallows—CHARLES A. SHULL, University of Chicago, Chicago (10 minutes, lantern).
3. Wild Life Sanctuaries—JENS JENSEN, Ravinia (10 minutes).
4. Types of Pitting in Conifers—ALAN S. PEIRCE, University of Illinois, Urbana (10 minutes, lantern).
5. Effects of Sulphur Deficiency on the Growth and Metabolism of the Soy Bean —SCOTT V. EATON, University of Chicago, Chicago (10 minutes).
6. The Problem of the Frost Flower—WILLARD N. CLUTE, Butler University, Indianapolis (10 minutes, lantern).
7. Some Effects of Fuel Oil on Potted Plants—MARGARET LEADBETTER and GEORGE D. FULLER, University of Chicago, Chicago (10 minutes).
8. Some Paleozoic Gymnospern Seeds and Their Evolution—A. C. NOÉ, University of Chicago, Chicago (10 minutes, lantern).
9. A Simple Apparatus for the Steam Method of Softening Woods for Microscopic Sections—GLENN DAVIS and E. L. STOVER, Eastern Illinois State Teachers College, Charleston (10 minutes).
10. Size and Ornamentation of Some Modern and Fossil Lycopod Spores—ORRIN J. HENBEST, University of Chicago, Chicago (10 minutes, lantern).
11. The Genus *Senecio* in Illinois—J. M. GREENMAN, Missouri Botanical Gardens, St. Louis (10 minutes).
12. Wild Flower Preservation—CATHERINE A. MITCHELL, Director of the Illinois Chapter of the Wild Flower Preservation Society, Riverside (10 minutes).
13. A Collection of Fleshy Ascomycetes from East Central Illinois—ICA MARKS and E. L. STOVER, Eastern Illinois State Teachers College, Charleston (10 minutes).
14. Some Thoughts of Popularizing Botany—C. F. GUMBART, Macomb (10 minutes).
15. The Status of the Southern Shortleaf Pine in the Northeastern Ozark Region —Abstract—LEWIS M. TURNER, University of Arkansas, Fayetteville (5 minutes).

16. A Preliminary Report of a Study of the Plants of Winnebago County, Illinois —Evelyn I. Fernald, Rockford College, Rockford (10 minutes).
17. Range Indicator Method in pH Determination of Living Plant Tissues— J. Fisher Stanfield, Knox College, Galesburg (10 minutes).
18. Germination of Seeds and Early Development of Seedlings of *Calopogon pulchellus* (sw) R. Br.—Margery C. Carlson, Northwestern University, Evanston (10 minutes).
19. The Paleobotanical Significance of Plant Structures in Coal—James Schopf, State Geological Survey, Urbana.
20. The Origin of Adventitious Roots from Leaf Cuttings of African Violet *(Saintpaulia ionantha Wendl.)*—Katherine L. Schmitkons, Northwestern University, Evanston.
21. Science and Art Organized to Express Beauty and Truth—Emma C. Crummer, Chicago (10 minutes).

CHEMISTRY

Room 215

Fred A. Dykins, Division of Highways, Springfield, *Chairman*

Election of Chairman for 1935-36.

1. The Detection of the Fortification or Adulteration of Meat Broth with Monosodium glutamate—Duane T. Englis and Bernard S. Friedman, University of Illinois, Urbana.
2. Some Qualitative Tests for Metals by Means of Organic Dyes—H. J. Long and H. M. Tenney, Greenville College, Greenville.
3. Economic Advantages of Water Softening—A. M. Buswell and H. W. Hudson, State Water Survey, Urbana.
4. An Inexpensive Ball Mill for General Use—Laurence L. Quill, University of Illinois, Urbana.
5. Some Physiological Responses to Vitamin E. Feeding—A. J. Pacini, Pacini Laboratories, Chicago.
6. Micro Methods in Qualitative Analysis—J. H. Reedy, University of Illinois, Urbana.
7. Onium Salts as Acids. Reactions of Ammonium Chloride at Higher Temperatures—Marvin T. Schmidt and L. F. Audrieth, University of Illinois, Urbana.
8. Fused Pyridine Hydrochloride as an Acid—Alfred Long and L. F. Audrieth, University of Illinois, Urbana.
9. Illinois Fluorspar as a Chemical Raw Material—Frank H. Reed and G. C. Finger, State Geological Survey, Urbana.

ECONOMICS

Room 302

Walter H. Voskuil, State Geological Survey, Urbana, *Chairman*

Election of Chairman for 1935-36.

Symposium: Population Trends in Illinois and Their Relation to Economic Problems of the State.

1. History of population growth in Illinois and a forecast of the future. (This paper was presented as part of the general program during the morning session.)
2. Occupational changes in the gainfully employed population of Illinois from 1870 to 1930 and the economic consequences thereof—H. L. Kellogg, State Planning Engineer, Chicago.
3. The future population in agricultural industry in the State of Illinois— D. E. Lindstrom, University of Illinois, Urbana.
4. Population problems in Illinois mining communities—Walter H. Voskuil.
5. Industrial opportunities in Illinois for the absorption of a growing wage earning population—W. H. Voskuil.
6. Discussion of the effect of population trends in Illinois upon rural schools, the rural community, the medium sized city and the large urban center of Chicago, upon employment opportunity and the need for providing for workers displaced in agriculture and mining.

GEOGRAPHY

Room 311

FLEMIN W. COX, Southern Illinois State Teachers College, Carbondale, Illinois, *Chairman*

lection of Chairman for 1935-36.

1. Corn Yields and Climate in Illinois—JOHN K. ROSE, University of Chicago, Chicago.
2. Land Utilization in the Town of Portland, Maine—MABEL P. CROMPTON, Illinois State Normal University, Normal.
3. Palestine in Transformation—W. O. BLANCHARD, University of Illinois, Urbana (lantern).
4. Surface Temperatures of the Gulf Stream and the Waters on Its Margins—PHIL E. CHURCH, Evanston Township High School, Evanston.
5. Industrial Survey of LaSalle-Peru-Oglesby—MARY A. ROBINSON, LaSalle-Peru High School (moving pictures).
6. Land Utilization and Crop Production of Illinois by Counties—EMERSON HALL, Southern Illinois State Teachers College, Carbondale.
7. A Guatemalan Farm—ROBERT S. PLATT, University of Chicago, Chicago.
8. A Gazetteer of the Origin of Illinois Nomenclature—ALDEN D. CUTSHALL, University of Illinois, Urbana.
9. Coal in Illinois—HARRY L. ADAMS, Bloomington High School, Bloomington.
10. A Field Study of Bloomington—Normal—CLARENCE B. ODELL, University of Chicago, Chicago.
11. London and Paris—A Comparison of their Locations—E. MURIEL POGGI, University of Illinois, Urbana.

GEOLOGY

Room 114

D. JEROME FISHER, Department of Geology, University of Chicago, *Chairman*

Election of Chairman for 1935-36.

A. COAL

I. PALEONTOLOGY (1:35 to 2:05 p. m.)

1. Recent Attempts to Correlate the later Paleozoic of America and Europe—A. C. NOÉ, University of Chicago and State Geological Survey (10 minutes).
2. Some Spores Characteristic of Illinois No. 6 Coal—JAMES M. SCHOPF, State Geological Survey (5 minutes, lantern).
3. Results Obtained by Chromic-sulphuric Acid Etching of Illinois Coals—W. S. MCCABE, State Geological Survey (10 minutes, lantern).

II. SYMPOSIUM (2:05 to 3:00 p. m.)

4. Geologic Dating of Time of Coalification—D. JEROME FISHER, University of Chicago (10 minutes, lantern).
5. Bearing of Field Relations in the Illinois Coal Field on the Time of Coalification—HAROLD R. WANLESS, University of Illinois and State Geological Survey (10 minutes).
6. Possible Relation of Mineral Matter in Coal to the Time at which Coalification Occurs—CLAYTON G. BALL, State Geological Survey (10 minutes, lantern).
7. Some Evidences of the Shrinkage of Certain Illinois Coal Beds since their Burial—GILBERT H. CADY, State Geological Survey (10 minutes, lantern).

III. MISCELLANEOUS (3:00 to 3:40 p. m.)

8. Status of the Carbon-ratio Theory in Illinois—ALFRED H. BELL, State Geological Survey (10 minutes, lantern).
9. Temperature During Coal Formation—GILBERT THIESSEN, State Geological Survey (10 minutes, lantern).
10. Local Calorific Value Variations in Coal No. 6 and the Geological Implications—E. T. BENSON, State Geological Survey (5 minutes).
11. Significance of Banded Ingredients in Coal—LOUIS C. MCCABE, State Geological Survey (5 minutes).

B. Paleontology and Stratigraphy (3:40 to 4:30 p. m.)

12. Taxonomy of Certain Mississippian Productidae—A. H. Sutton, University of Illinois (10 minutes, lantern).
13. Grassy Creek Shale—J. Marvin Weller, State Geological Survey (10 minutes, lantern).
14. Geological Setting of the Aurora Mastodon Remains—Wm. E. Powers, Northwestern University (10 minutes, lantern).
15. Mastodon and Other Finds at Aurora—Clarence R. Smith, Aurora College (10 minutes, lantern).

C. Miscellaneous (4:30 to 5:00 p. m.)

16. The Bottom Sediments of Southern Lake Michigan—J. L. Hough, University of Chicago (10 minutes, lantern).
17. New Medium for Teaching Geology in the Middle West—G. Frederick Shepherd, Museum of Science and Industry (5 minutes, lantern).
18. California Submarine Canyons—Francis P. Shepard, University of Illinois (15 minutes, lantern).

MEDICINE AND PUBLIC HEALTH

Room 401

B. F. Whitmore, Beatrice Meadow-Gold Dairies Inc., Bloomington, *Chairman*

Election of Chairman for 1935-36.

1. Rickets—Its Cause, Effect and Prevention—J. Howard Beard, M. D., University Health Officer, University of Illinois (30 minutes).
2. Significance of Occupational Diseases—C. O. Sappington, M. D., Consulting Industrial Hygienist, Chicago (30 minutes).
3. Some Studies on Milk Pasteurization—J. M. Brannon, Dairy Bacteriologist, University of Illinois (20 minutes).
4. Examination of Pasteurized and Unpasteurized Milk for *Brucella abortus*—J. P. Torrey, Animal Pathologist, University of Illinois (20 minutes).
5. Efforts to Control Quality of Foods in the United States—Fred W. Tanner, Head of Department of Bacteriology, University of Illinois (30 minutes).
6. Some Implications of Vibro-Tactile Research—Robert H. Gault, Department of Psychology, Northwestern University, Evanston (20 minutes).

PHYSICS

Room 304

Lester I. Bockstahler, Northwestern University, Evanston, *Chairman*

Election of Chairman for 1935-36.

1. The Definitive System of Units—Henry Crew, Northwestern University, Evanston (35 minutes, lantern).
2. The Concept of Oscillations in Present Physical Theory—Jakob Kunz, University of Illinois, Urbana (20 minutes).
3. Use of the Ripple Tank—S. E. Boomer, Southern Illinois State Teachers College, Carbondale (10 minutes, demonstration).
4. New Demonstrations of Alternating Current Phenomena—Leonard R. Crow, Educational Electric Mfg. Co., Terre Haute (15 minutes).
5. Design of Some Pieces of Apparatus for the Elementary Laboratory—C. J. Overbeck, Northwestern University, Evanston (10 minutes, demonstration).
6. Atomic Disintegration or Modern Alchemy—A. J. Dempster, University of Chicago, Chicago (35 minutes, lantern).
7. The Atomic Jet as a Spectroscopic Light Source—B. Carpenter, Northwestern University, Evanston (10 minutes, lantern).
8. A Modified Form of the Fabry-Perot Interferometer—R. C. Machler, Northwestern University, Evanston (10 minutes, lantern).
9. Protecting Voltmeters in the Laboratory—O. L. Railsbach, Eastern Illinois State Teachers College, Charleston (10 minutes, demonstration).
10. A Convenient Chart for Correcting Barometric Readings—Scott Anderson, Illinois Wesleyan University, Bloomington (10 minutes, demonstration).

1. The Temperature of the Gas in an Interrupted Carbon Arc—WM. T. GRAY, Northwestern University, Evanston (10 minutes, lantern).
2. Thermodynamic Models—FRANK VERWIEBE, Eastern Illinois State Teachers College, Charleston.
3. On Growing Bismuth Crystals—J. A. BOYAJIAN, Northwestern University, Evanston (10 minutes, lantern and models).
4. Discussion of Certain Problems of Vital Interest to Physics Teachers.

PSYCHOLOGY AND EDUCATION

THOMAS E. BENNER, Dean, College of Education, University of Illinois, Urbana

No program has been planned for this section for the 1935 meeting.

ZOOLOGY

Room 216

C. L. FURROW, Dept. of Biology, Knox College, Galesburg, Illinois

Election of Chairman for 1935-36.

1. Some Observations on the Cell and Its Place in Organic Life—H. J. REYNOLDS, Chicago.
2. Value and Density of a Population of Illinois Prairie Mice—CARL O. MOHR, University of Illinois, Urbana.
3. The Bionomics of the Lady Beetles—W. V. BALDUF, University of Illinois, Urbana.
4. Dental Variations of the Dog—L. A. ADAMS, University of Illinois, Urbana.
5. The Effect of X-Rays on the Incubation Period, Sexual Development, Egg-laying Capacity and Brooding Tendencies in the White and Brown Leghorn Chickens—J. M. ESSENBERG, Loyola University, School of Medicine, Chicago.
6. The Family-Life of the Black-bellied Tern—CHARLES K. CARPENTER, Chicago.
7. Studies on the Biology of the Crayfish, *Cambarus propinquus*, Girard—WILLIAM C. VAN DEVENTER, Rochester, New York. (To be read by title.)
8. Radular Characters in Snails of the Genus Viviparus—EMILY MCDAVID RICHEY, University of Illinois, Urbana.
9. Some Interesting Pre-Linnaean Names—HARLEY J. VAN CLEAVE, University of Illinois, Urbana.
10. A New Genus and Species of Kathlanid Nematodes from *Crytobrachus alleganiensis*—A. C. WALTON, Knox College, Galesburg. (To be read by title.)
11. Visual Cells of a Nocturnal Animal—MARGARET PENNINGTON, Knox College, Galesburg.
12. Sex Conditions in the Japanese *Valvata*, a preliminary report—C. L. FURROW, Knox College, Galesburg.
13. Effects of Thyroxin on Plumage of the English Sparrow, *Passer domesticus* (Linnaeus)—DOROTHEA STARBUCK MILLER, Knox College, Galesburg.
14. The Technique of Laboratory Experiments for Codling Moth Control.—M. D. FARRAR and E. R. MCGOVRAN, University of Illinois, Urbana.
15. The Little Known Willow Sawfly in Illinois—HERBERT H. ROSS, University of Illinois, Urbana.
16. The Occurrence of the American Eagle Along the Ohio River in Illinois—CLARENCE BONNELL, Harrisburg Township High School, Harrisburg.
17. (Title to be given in final program)—W. P. FLINT, Entomologist, State Natural History Survey, Urbana.
18. Destruction of Bird Life by Hail—JOHN D. MIZELLE, University of Illinois, Urbana.
19. The European Starling as a Disseminator of Seeds—M. S. FERGUSON, University of Illinois, Urbana.
20. Annular Rings in the Long Bones of Turtles and their Correlation with Size—N. T. MATTOX, University of Illinois, Urbana.

ILLINOIS STATE ACADEMY OF SCIENCE

JUNIOR SECTION

HIGH SCHOOL SCIENCE AND CLUBS

LOUIS A. ASTELL, 137 N. Evergreen Ave., Kankakee, *Chairman*

HARRY L. ADAMS AND H. L. SLICHENMYER, Bloomington High School, in charge of local arrangements.

FRIDAY, MAY 3

8:00 a.m. Registration (Registration desk in the gymnasium).

8:00-11:00 a.m. Arrangement of competitive entries—gymnasium. Exhibits of scientific equipment by scientific companies.

12:00 m. Luncheon, Bloomington High School Cafeteria, 45 cents.

1:15 p.m. Annual business meeting of the official delegates of the Junior Section, High School Auditorium.

1:45 p.m. Round Table Discussion, "What Makes a Science Club Effective."
Elmer Decker, Edisonian Science Club, Kankakee.
Delegate, Teachers College Science Club, Charleston.
Glen Simmons, Edisonian Science Club, West Chicago.
Summary by Philip Wehner, Honorary Vice-President, Des Plaines.

2:25 p.m. Science Clubs in Action: Ten minute talks and demonstrations by student delegates. Charles Meyer, Vocational Science Club, Granite City, Honorary President presiding.
Junior High Schools: "The Diesel Engine in Land Transportation" (lantern), John DeTurk, Thornburn Science Club, Urbana.
Human Biology: "Lessons from an Epidemic," Dorothy VanCleave, Science Club, H. S., Urbana.
Chemistry: "My Experiences in Crystal Growing" (illustrated), Merle Reed, Dupo Chemistry Club, Dupo.
Radio: "Modulation in Radio Telephony" (demonstration), Joe Luczak, Morton Physics Club, Cicero.
The names of the speakers on Astronomy, Geology, Botany, Zoology, Physics, and Science in General will be given on the final program.

6:00 p.m. Annual Banquet, First M. E. Church, Southwest corner of East and Grove Streets, three blocks west and two blocks south of the High School (60 cents).
Presentation of awards—Charles H. Behre, Jr., President, Illinois State Academy of Science.

7:00 p.m. Annual Public Lecture. High School Auditorium. (Speaker to be announced).

HEADQUARTERS OF THE ACADEMY

BLOOMINGTON HIGH SCHOOL

BLOOMINGTON, ILLINOIS

Registration Desk in First Floor Corridor

Telegrams and other messages may be sent to individuals in care of L. K. Wright, Tilden-Hall Hotel, Bloomington, and called for at the hotel or registration desk in the High School.

Changes of schedule or program and other special announcements will be posted at the registration desk.

Secure tickets for banquets and register for trips at the registration desk before 11:30 a. m.

Members and guests of the Academy expecting to attend the Annual informal Banquet May 3rd, are asked to notify the Local Chairman previous to May 3rd.

Housing facilities for out-of-town guests attending the Junior Section will be provided free. Sponsors of Science Clubs wishing these accommodations for students should communicate before May 1, with H. L. Adams, High School, Bloomington, Illinois.

HOTEL RATES

Tilden-Hall:
Single room with bath $2.50; without bath $1.75.
Double room with bath $3.50; without bath $2.75.

Rogers Hotel:
Single room with bath $2.00; without bath $1.50.
Double room with bath $3.50; without bath $2.50.

Hamilton Hotel:
Single room with bath $2.00; without bath $1.50.
Double room with bath $3.00; without bath $2.00.

Illinois Hotel: Will have a limited number of rooms.

Persons planning to stay in hotels should send reservations in advance. The Illinois Women's Professional Organization is holding its annual convention here the same dates.

New Secretary

Dr. L. L. Quill, Secretary of the Academy for 1934-35, has resigned because he is leaving the state. The Council has appointed as his successor Dr. W. M. Luce, *Department of Zoology, University of Illinois, Urbana.*

Index to Volumes 1-25

A General Index to Volumes 1-25 of the Academy's *Transactions* is now in press. Copies will be available to members upon request to the Secretary at the address given above.

TRANSACTIONS

OF THE

ILLINOIS STATE ACADEMY OF SCIENCE

VOLUME 27 | JUNE, 1935 | NUMBER 4

Minutes of Council Meetings
Minutes of Twenty-eighth Annual Meeting
Reports of Officers and Committees
Constitution and By-Laws
Index to Volume 27

EDITED BY DOROTHY E. ROSE

PRINTED BY THE ILLINOIS STATE ACADEMY OF SCIENCE

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STATE OF ILLINOIS

Hon. Henry Horner, *Governor*

DEPARTMENT OF REGISTRATION AND EDUCATION

Hon. John J. Hallihan, *Director*

STATE MUSEUM DIVISION

A. S. Coggeshall, *Chief*

ILLINOIS STATE ACADEMY OF SCIENCE

Affiliated Division of the
State Museum

Officers for 1934-35

President, Charles H. Behre, Jr.,
Northwestern University, Evanston, Illinois

First Vice-President, Charles D. Sneller,
Peoria, Illinois

Second Vice-President, L. K. Wright,
Bloomington High School, Bloomington, Illinois

Secretary, Laurence L. Quill,
University of Illinois, Urbana, Illinois

Treasurer, George D. Fuller,
University of Chicago, Chicago, Illinois

Librarian, Arthur S. Coggeshall,
State Museum Division, Springfield, Illinois

Editor, Dorothy E. Rose,
State Geological Survey, Urbana, Illinois

Council: The President, First and Second Vice-Presidents,
Secretary, Librarian, last two retiring presidents,
and the retiring secretary.

Printed August, 1935

TRANSACTIONS OF THE ILLINOIS STATE ACADEMY OF SCIENCE

Volume 27 June, 1935 Number 4

CONTENTS

Minutes of Meetings of the 1934-1935 Council

First Meeting

The meeting was called to order by President Behre at 7:00 a. m., May 5, 1934, at the Orlando Hotel, Decatur. The members present were George D. Fuller, B. Smith Hopkins, and H. R. Wanless. Mr. L. K. Wright of Bloomington was also present at the meeting.

The Council appointed B. S. Hopkins and H. R. Wanless as a special committee to select the Secretary of the Academy for the year 1934-35, as this position was not filled at the Annual Business Meeting of the Academy.

Miss Dorothy E. Rose was re-elected Editor of the *Transactions* for the year 1934-35.

The following were named as the Committee on Ecological Survey for the year 1934-35:

A. G. Vestal, University of Illinois, Urbana, *Chairman.*
W. G. Waterman, Northwestern University, Evanston.
V. O. Graham, 4028 Grace Street, Chicago.
V. E. Shelford, University of Illinois, Urbana.
W. C. Allee, University of Chicago, Chicago.
L. E. Sawyer, State Natural History Survey, Urbana.
C. E. Montgomery, State Teachers College, DeKalb.
John Voss, Manual Training High School, Peoria.
Mary M. Steagall, State Teachers College, Carbondale.
George D. Fuller, University of Chicago, Chicago.

The secretary was authorized to find out whether the Bibliography of Illinois Ecology, prepared by this committee, may be made ready for publication during the coming year.

The following were chosen as members of the Committee on Conservation for the year 1934-35:

T. H. Frison, State Natural History Survey, Urbana, *Chairman.*
Henry C. Cowles, University of Chicago, Chicago.
M. M. Leighton, State Geological Survey, Urbana.
Jens Jensen, Landscape Architect, Ravinia.
Paul Houdek, 410 Gross Street, Robinson.
R. B. Miller, State Department of Conservation, Springfield.
R. S. Smith, Department of Agronomy, Urbana.
H. F. Ferguson, Department of Public Health, Springfield.

The following were designated as members of the Committee on Legislation and Finance:

Don L. Carroll, State Geological Survey, Urbana, *Chairman.*
John R. Neal, Springfield, Illinois.
W. A. Noyes, University of Illinois, Urbana.
Edson S. Bastin, University of Chicago, Chicago.
Mary M. Steagall, State Teachers' College, Carbondale.

The members of the Committee on High School Science and Clubs were not chosen, because of the absence of Mr. L. A. Astell, the chairman of this committee for the year 1933-34.

Dr. Lyell J. Thomas was appointed Delegate to the American Association for the Advancement of Science for the December meeting at Pittsburg. Mr. V. O. Graham was re-elected to the Conservation Council of Chicago.

It was voted that the invitation of the McLean County Academy of Science and other organizations at Bloomington-Normal for the annual meeting in 1935 be accepted, and that tentative plans be made for holding the 1936 annual meeting at Rock Island, at a time when a new science building at Augustana College might be ready for dedication. Mr. L. K. Wright was named chairman of the Committee on Local Arrangements for the 1935 Annual Meeting, and Second Vice-President of the Academy. At his suggestion, Mr. H. L. Adams was appointed to the Committee on High School Science and Clubs to arrange for the meeting of the Junior Section.

It was voted that an honorarium of $150.00 be granted to the Secretary for the year 1934-35, and that a similar honorarium be granted to the Editor. The Secretary was authorized to expend the necessary money to execute his office, not to exceed $100.00. It was voted that the Editor be authorized to incur the necessary expenses, not to exceed $25.00.

Dean H. W. Mumford was reappointed Chairman of the Agriculture Section, if he should consent to serve. The President agreed to appoint Chairmen of the Economics and the Medicine and Public Health Sections, reporting these appointments to the Council at its next meeting.

It was decided to arrange for the publication of brief memorial articles about the late O. C. Farrington and the late Jesse L. Smith in the *Transactions.*

The Committee on Publications was authorized to find what portion of the funds appropriated for publishing the *Transactions* has been expended thus far, in order to determine what size publications will be possible during the ensuing year.

The meeting adjourned at 9:00 a. m.

Second Meeting

The second meeting was called to order at 1:00 p. m., November 10, 1934, at the University Club, Urbana, Illinois. President Behre was in the chair, and the others in attendance were B. S. Hopkins, H. R. Wanless, Miss Dorothy Rose, G. D. Fuller, L. J. Thomas (for the Junior Academy), L. L. Quill, L. K. Wright, and C. D. Sneller.

Miss Rose reported a balance amounting to about $250—$450 in the printing budget, which if unexpended by June, 1935, would lapse. It was suggested that an index of the first twenty-five volumes of the *Transactions* be published as a means of using this sum. Miss Rose suggested that for the present each author be allowed two printed pages and one illustration.

It was agreed (1) that all abstracts should be published, (2) that only such papers as were approved for publication by the Committee on Publications should be published gratis, (3) that any additional papers can be published only at the expense of the author at a cost of about three dollars per page.

It was moved and approved to ask Mr. Don Carroll to have Mr. Coggeshall ask for an appropriation of $4000 for the next biennium, and to ask his cooperation in securing this sum.

Announcement was made that a list of possible speakers would be available in about two weeks.

Dr. Thomas, speaking for Mr. Astell, presented the estimated budget of the Junior Academy. It was moved and approved that the Academy support the Junior Academy to the extent of $53, the amount of the estimated deficit which might occur.

The membership committee was granted $75 for expenses.

The following speakers were suggested for the popular lecture for the Bloomington meeting: Birdseye on "Aerial Photography," Herskovitz on "Anthropological Investigations," Stearns on "Volcanoes," and Dr. Knipp on "Demonstrations with Vacuum Tubes." The last named was most favored.

The question of transfer of the Library of the State Academy to the University was referred to a committee of H. R. Wanless, M. M. Leighton, D. L. Carroll and L. L. Quill.

The meeting adjourned at 3:30 p. m.

Third Meeting

The third meeting of the Council was held at the University Club, Urbana, with President Behre in the chair. Those present were C. D. Sneller, L. K. Wright, L. L. Quill, G. D. Fuller, and H. R. Wanless.

It was announced that former President H. F. Ferguson had passed away. The Secretary was asked to write a note of condolence to Mrs. Ferguson.

The question of the distribution of the reprints of the Bibliography of the Ecological Survey was referred to the Publications Committee, with the suggestion that the Natural History Survey do the distribution, if possible.

The Publications Committee was requested to suggest a permanent plan for publishing future issues of the *Transactions* at the business sessions at Bloomington.

It was agreed that letters should be sent to the affiliated societies, notifying them of the forthcoming Academy meeting, and asking that their delegate act as a member of the Membership Committee of the Academy.

The program for the Bloomington meeting was tentatively arranged, since all sectional programs were essentially complete.

The meeting adjourned at 3:45 p. m.

Fourth Meeting

The fourth meeting of the Council was held at the Tilden-Hall Hotel, Bloomington, May 2, 1935. President Behre called the meeting to order, the others present being C. D. Sneller, L. L. Quill, H. R. Wanless, L. K. Wright, and G. D. Fuller.

The library committee reported that the University Comptroller Mr. Morey, had been approached relative to a transfer of the Library to the University. The committee was delegated to continue its functions.

The invitations of Rockford for the 1936 meeting, and of Northwestern University for the 1937 meeting, were discussed.

It was agreed that papers read by title should be published if they were approved by the Committee on Publications.

The meeting adjourned at 9:30 p. m.

Fifth Meeting

The Council met with the Committee on Local Arrangements and the Delegates of the Affiliated Societies in the Board of Education Office, Bloomington High School, May 3, 1935, at 8:00 a. m. Those attending the meeting were O. B. Young of Carbondale, H. L. Slichenmyer and J. C. Frazier of

Bloomington, F. R. Jelliff of Galesburg, H. R. Wanless and L. L. Quill of Urbana, G. D. Fuller of Chicago, and President Behre.

The Secretary reported that it was planned to have a list of speakers available as soon as school opened in the fall. This list of speakers would be for the use of the affiliated societies.

A discussion of the meeting places for the next two or three years was held, with Quincy, Rockford, Carbondale, and Northwestern University being mentioned. No definite agreement was reached.

Mr. Young brought up the question about the improper care of the Indian Mounds located near Carbondale. It was agreed that the resolutions committee should bring a resolution to the business session regarding this matter.

The meeting adjourned at 8:50 a. m.

(Signed) L. L. Quill, *Secretary*.

Reports of Officers and Committees For 1934-1935

REPORT OF THE SECRETARY

MINUTES OF THE TWENTY-EIGHTH ANNUAL MEETING, BLOOMINGTON

First Business Session

The first business session of the Twenty-Eighth Annual Meeting of the Academy was called to order by President Behre at 9:15 a. m., May 3, 1935, in the Auditorium of the Bloomington High School. There were about fifty members in attendance.

President Behre announced the appointment of the following special committees to prepare reports for the final business session of the Academy:

Auditing Committee: Scott V. Eaton, *Chairman*, C. A. Shull, and A. C. Noé.

Resolutions Committee: Fred R. Jeliff, *Chairman*, L. A. Bockstahler, and H. R. Wanless.

Nominating Committee: B. S. Hopkins, *Chairman*, M. M. Leighton, and H. J. Van Cleave.

Announcements relative to the purchase of luncheon tickets, and for the luncheon for the Psychology and Education Section were made.

Mr. Smith gave an address of welcome to the Academy.

The business session adjourned until 11:15 a. m.

General Session

The general session of the Twenty-eighth Annual Meeting was opened at 9:15 a. m. in the Auditorium of the Bloomington High School. About two hundred fifty people were in the audience.

President Charles H. Behre, Jr., gave his Presidential Address on "Some Problems in the Origin of Mineral Veins."

Mr. James R. Holbert, Senior Agronomist, U. S. Department of Agriculture, spoke on "Modern Trends in Corn Breeding." He was followed by Mr. H. L. Kellogg, State Planning Engineer, Chicago, who presented a paper on the "History of Population Growth in Illinois and a Forecast of the Future."

This paper was the first of the Symposium of the Economics Section: "Population Trends in Illinois and Their Relation to Economic Problems of the State."

Second Business Session

The second session of the business meeting of the Academy was called to order by President Behre at 11:15 a. m. in the High School Auditorium. About seventy-five members were present.

The minutes of the first business session were read and approved.

The following reports were read and approved: Reports of the Treasurer, Editor, Librarian, Committee on Affiliation, Committee on Ecological Survey, Committee on Conservation, Committee on Publications, Committee on High School Science and Clubs, Delegate to the Conservation Council of Chicago.

It was moved and approved that the Academy should commend Mr. Astell for his excellent work with the Junior Section.

Dr. Fuller commented on the excellent work of the Conservation Council of Chicago.

It was announced that a list of speakers for the use of the affiliated societies would be available early in the fall.

The meeting adjourned at twelve noon.

Third Business Session

The third business session of the Academy was called to order by President Behre in Room 116 of Bloomington High School at 5:10 p. m. The attendance was about thirty, the small number undoubtedly being due to a change in rooms at the last minute.

The minutes of the second session were read and approved.

The report of the Auditing Committee was presented by Scott V. Eaton, and was accepted by the vote of those present.

The Committee on Nominations made the following recommendations:

For President, C. D. Sneller, M. D., Peoria; *for First Vice-President*, C. L. Furrow, Knox College, Galesburg; *for Secretary*, L. L. Quill, University of Illinois, Urbana; *for Treasurer*, Geo. D. Fuller, University of Chicago, Chicago; *for the elective member of the Publications Committee*, H. R. Wanless, University of Illinois, Urbana; *for the Committee on Membership*, A. H. Sutton, Urbana, L. I. Bockstahler, Evanston, Geo. M. Link, Springfield, and John Voss, Peoria, *Chairman*, the fifth member to be named after the meeting place for 1936 was selected; *for the Committee on Affiliation*, H. H. Radcliff, Decatur, Rosalie M. Parr, Urbana, Mary M. Steagall, Carbondale, H. O. Lathrop, Normal, and Clarence Bonnell, Harrisburg, *Chairman*.

The Secretary was instructed to cast a unanimous ballot for those recommended.

The report of the Committee on Resolutions was presented by Chairman Jelliff. Dr. Wanless read a supplementary resolution on the conservation of some lands near Kankakee. The reports were accepted.

It was reported by Dr. Gault of the Psychology Department of Northwestern University that those interested in Psychology and Education desired to have the section continued in the future.

The meeting adjourned at 5:25 p. m.

Junior Section Meeting

The meeting of the Junior Section is described in the Report of the Committee on High School Science and Clubs. Following is the list of awards given in the various competitions.

WINNERS OF AWARDS

Loving Cups

All-round Club: Edisonian Science Club, West Chicago Community High School, West Chicago.

Astronomy: Vocational Science Club, Granite City Community High School, Granite City.

Biology: Joliet Science Club, Joliet Township High School, Joliet.

Chemistry: Maine Chemistry Club, Maine Township High School, DesPlaines.

Physics: Morton Physics Club, J. Sterling Morton High School, Cicero.

Junior High School: David Prince Junior High School, Jacksonville.

Outstanding Exhibit, Unclassified: Edisonian Science Club, Kankakee. (This cup is offered instead of the Geology cup for this year because there was not sufficient competition in the Geology field.)

Astronomy

First place: Granite City Vocational Science Club, Granite City.
Second place: West Chicago Edisonian Science Club, West Chicago.

Individual Poster

1. William Rapp, Granite City High School. Spectrum of the Stars.

Commercial Products

1. Charles Meyer, Granite City High School. Planet Finder.
2. Allen Fairbank, West Chicago Community High School. Telescope Lens Grinding.

Collections

1. Virgil Blevins, Granite City High School. Pictures of Astronomical Interest.

Group Poster

1. Granite City High School. Instruments of Astronomy.

Commercial Products, Group

3. Granite City Community High School. Phases of the Moon.

Biology

First place: Joliet Township High School, Joliet.
Second place: Parker Senior High School, Chicago.
Third place: Kankakee High School, Kankakee.
Fourth place: Visitation High School, Chicago.

Individual Poster

1. Juanita Crunk, Kankakee High School, Arthropodes and Vermes.
2. Lucille Trombly, Visitation High School. Anatomy of the Body.

Individual Project

1. Beverly Baker, Parker Senior High School. Life Histories of Plants.
2. John Fitzer, Joliet Township High School. Mounted weasel.
3. Marie O'Donnell, Visitation High School. Insects.

Models

1. Robert Bradburn, Joliet Township High School. Life History.

Science Notebook

1. West Chicago Community High School.
2. Beverly Baker, Parker Senior High School.
3. Adeline Mather, Joliet Township High School.

Group Poster

1. Joliet Township High School. Tree Map.
2. Visitation High School. Furs.

BIOLOGY—*Continued*

Commercial Products

2. Edward Hanson, Joliet Township High School. Medical Plants and their Products.

Collections

1. Bradley Gilbert, Parker Senior High School. Skulls.
2. Charles Mason, Joliet Township High School. Insects.

Group Project

1. Joliet Township High School. Models.
2. Kankakee High School. Drawings.
3. Joliet Township High School. Bird Eggs.

Commercial Products, Group

1. Joliet Township High School. Aquarium.

CHEMISTRY

First place: Maine Township High School, DesPlaines.
Second place: Visitation High School, Chicago.
Third place: Normal Community High School, Normal.
Fourth place: J. Sterling Morton High School, Cicero.

Individual Poster

1. Bernice O'Malley, Visitation High School. Halogens.
2. Paul Huxmann, Maine Township High School. Rare Metals.
3. Mary Joye Hines, West Chicago Community High School. Solvay Process.

Individual Project

1. Jack Risley, Maine Township High School. Bomb Calorimeter.
2. Luba U. Kowalski, Visitation High School. Dyeing.
3. Nicholas Adele, Dupo Community High School. Crystals.

Commercial Products

1. Rachel Kron, Normal Community High School. Mirror.

Collections

1. Robert Grigsby, Maine Township High School. Coal Derivatives.
2. Braderick Smith, Normal Community High School. Patent Medicines.

Models

1. Bernice Krupka, J. Sterling Morton High School. Structure of Atoms.
2. Gustav Graupner, Maine Township High School. Ballistic Pendulum.
3. Ellen Shine, Visitation High School. Barometer.

Science Notebook

1. Richard Koehler, Normal Community High School.
2. Mary Kennedy and Rita Mitchell, Visitation High School.

Group Poster

1. Maine Township High School. Temperature Chart.
2. Visitation High School. Old King Coal.
3. Siena High School. Sugar and Spice.

Group Project

1. Maine Township High School. Diorama.
2. Visitation High School. Cosmetic Display.
3. Visitation High School. Pyrotechnics.

Commercial Products, Group

1. Dupo Community High School. Crystals.
   J. Sterling Morton High School. Drying Oven.
3. Visitation High School. Fabrics.

Geology

Individual Poster

1. Parker Senior High School.

Models

1. Robert Miller, Granite City Community High School. Volcano.

Group Project

1. Kankakee High School. Geological charts.

Commercial Products, Group

1. West Chicago High School. Anemometer.

Mineral Identification

1. James Fuhrman, Granite City Community High School.
2. Richard Sudholt, Granite City Community High School.
3. Edward Woods, Granite City Community High School.

Physics

First place: J. Sterling Morton High School, Cicero.
Second place: West Chicago Community High School, West Chicago.
Third place: Visitation High School, Chicago.

Individual Poster

1. Edward Vocelka, J. Sterling Morton High School. Optical Instruments.
2. Arlin Gilmore, Visitation High School. Evolution of Motor Car.

Individual Project

1. Fred Horep, J. Sterling Morton High School. Color Apparatus.
2. Hartmann Egger, Urbana High School. Public Address System.
3. Margaret Hanifan, Visitation High School.

Commercial Products

1. John Hruby, J. Sterling Morton High School. Public Address System.

Collection

1. William Mraz, J. Sterling Morton High School. Radio Tubes.

Models

1. West Chicago Community High School. Airplane.
2. Leon Messier, Kankakee High School. Airplane.
3. Donald Koss, J. Sterling Morton High School. Flea Motor.

Science Notebook

1. Edward Vocelka, J. Sterling Morton High School.

Group Poster

1. J. Sterling Morton High School. Electro Magnetic Radiation.

Group Projects

1. West Chicago Community High School. Tesla Coil.
2. J. Sterling Morton High School. Depth Bomb.

Commercial Products, Group

1. J. Sterling Morton High School. Wind Tunnel.

Newsletters

Printed and Handwork

1. Maine Township High School, "Lab. News."
2. Visitation High School, "Chem. Flashes."
3. Joliet Township High School, "Joliet News."

Mimeographed

1. Kankakee High School, "KESCI."
2. Arlington Heights High School, "Beacon."

Radio Notebook

1. E. Pyzdrowski, Kankakee High School. Science and its Heroes.
2. Eleanor Dilworth, West Chicago Community High School. CBS Radio Notes.

Junior High School

First place: David Prince Junior High School, Jacksonville.
Second place: West Chicago Junior Science Club, West Chicago.
Third place: Richard Byrd Science Club, Kankakee.
Fourth place: Thornburn Junior High School, Urbana.

Collections

1. Glen H. Sims, David Prince Junior High School. Fossils.

Models

1. Marlew Schneider, Richard Byrd Science Club. Airplane.
2. Fred Hopke, David Prince Junior High School. Dinosaurs, Age of Reptiles.

Science Notebook

1. West Chicago Junior Science Club.
2. Arthur Vorkes, David Prince Junior High School.

Group Projects

1. David Prince Junior High School. Diorama (formation of rocks).
2. West Chicago Junior Science Club. History of Transportation.
3. Thornburn Junior High School. Airplane models.

Other Events

The afternoon of Friday May 3, 1935, was devoted to the section meetings, held in various rooms of the Bloomington High School. All section chairman reported good attendance in spite of the poor weather.

The annual banquet was served at the First Christian Church, with 100 members attending. Following the banquet, R. W. Fairchild, President, Illinois State Normal University, Normal, gave a short address of greeting to the members and guests assembled in the Auditorium of Bloomington High School. The Annual Public Lecture was a demonstration by Professor Charles T. Knipp, Physics Department, University of Illinois, on "Electronics and Electrodeless Discharge."

On Saturday morning, May 4, 1935, three field excursions were conducted for the Academy members and guests. Dr. M. M. Leighton and Dr. G. H. Cady conducted a field trip which included the Shelbyville, Bloomington, and Normal moraines, and certain coal horizons in the Peoria-Pekin region. The industrial trip to the Chicago and Alton shops and the Bloomington-Normal Sewage Treatment Plant was conducted by S. A. Chester, H. W. Adams and F. S. Mortimer. A biological field trip and an inspection of the soil erosion control project near Bloomington was in charge of the Soil Erosion Service, U. S. Department of Agriculture, and J. C. Frazier, Blanche McAvoy, and H. L. Slichenmyer.

REPORT OF THE TREASURER

For Year Ending April 30, 1935

Receipts

Balance on hand May 1, 1934		$468.95	
Initiation fees and dues		716.00	
Allowance from A. A. A. S., 1934		3.00	
Interest on savings account		2.61	
Junior Academy		84.50	$1275.06

Expenditures

Expenses of annual meeting, 1934:			
Programs	$68.26		
Registration	25.27		
Officers' expenses	38.95		
Speaker	37.00		
Junior Academy	12.25		
		$181.73	
Chairmen of sections, postage, etc.		14.73	
Council meetings		21.23	
Printing *Transactions*		135.65	
Postage, *Transactions*		68.54	
Addressograph supplies		54.20	
Secretary, Salary		150.00	
Secretary, expense of office		84.56	
Editor, salary		150.00	
Editor, expense account		14.75	
Treasurer, expense of office		55.43	
Junior Section		109.21	
Speaker for 1935 meeting		25.00	$1065.03
Balance in University State Bank			210.03
			$1275.06

Statement of resources as of April 30, 1935

Balance in University State Bank	$210.03
Mortgage Bonds, face value	600.00
Office supplies	5.00
Total resources	$815.03

In presenting the annual financial report the Treasurer would direct attention to the fact that the income from members' dues has remained stationary for the past three years but that from other sources has decidedly decreased. Expenditures have tended to increase. There is now the announcement that the annual contribution from the A. A. A. S. is being discontinued. This has amounted to $175.00 per year. This is a very considerable proportion of our income and taken in connection with the fact that our annual balance at the end of each year has been growing smaller presents a serious problem. As the only unusual expenditure during the past year was that of $54.20 for addressograph plates, to replace those destroyed by fire, it would seem that some means must be devised to avoid a serious deficit at the end of the coming year.

The present membership of the Academy consists of 85 life members, 484 fully paid up annual members, 176 members one year in arrears, 85 members two years in arrears, and 138 members who are three years in arrears and are being dropped from the rolls at this meeting. We have received 58 new members during the year, 28 have resigned, and 9 have been lost by death.

The net membership on May 1, 1935, not including those being dropped at the present annual meeting but including the new members to May 1, consists of 886 personal members and 85 societies and clubs.

The entire report is respectfully submitted.

(Signed) George D. Fuller, *Treasurer*

REPORT OF THE AUDITING COMMITTEE

This will certify that we have audited the report of the Treasurer and have examined his accounts which appear to have been correctly kept. The expenditures have been checked against vouchers made by the President and the Secretary. The balance of $210.03 in the bank account and the face value of the Mortgage Bonds agrees with the statement.

(Signed) Scott V. Eaton
C. A. Shull
A. C. Noé
Auditing Committee

REPORT OF THE PUBLICATIONS COMMITTEE

The aim of the Committee on Publications has been to formulate a tentative set of regulations which will serve for the present exigency and which can easily be expanded for future use. The following instructions were transmitted to each section chairman and to each author presenting a paper at the 1935 meeting.

(1) At the time of presentation of papers, each author *must* hand in to the Chairman a short abstract of 1000 words or less. Full-length manuscripts may also be submitted at the same time with the understanding that printing in full will depend upon available funds and favorable action of the referees.

(2) Each author is allowed 1000 words per article, the above mentioned abstract. (This is approximately two pages of the *Transactions.)* In other words, all abstracts shall be published, with the exception of those articles published in full.

(3) Only such papers shall be published in full, gratis, as shall be approved by the Committee on Publication. These are subject to the following regulations:

(a) Referees shall be consulted by the Committee on Publications before a final decision on the publication of any paper in full shall be made. Such referees shall be selected from members of the staffs of the universities, colleges, or various State Survey groups, for example, the State Geological Survey. The referees shall decide upon the advisability of publishing any paper in full. The plan of submitting the papers to referees for review before they are published is in accordance with the plans for publication used by other societies.

(b) In case funds are not available, and in case the referees have advised the publication of the full-length manuscript, the longer paper may still be published, provided the author will pay for the printing of the pages in excess of the two which are allowed each author for his abstract. (The cost will be aproximately $3.00 per page.)

(4) Each author shall be allowed one illustration per article, at the sacrifice of text. (For example, 1000 words without a figure; 500 words with a full-page illustration, etc.) Additional illustrations *must* be paid for by the author.

(5) Addresses for the General Session shall naturally be exempt from the above qualifications.

(6) Full-length manuscripts which are not published will be returned to the authors.

It should be noted that the limit has been increased from 500 words (the suggested limit for 1934) to 1000 words for 1935.

(Signed) LAURENCE L. QUILL, *Chairman*

REPORT OF THE EDITOR

During the past year the fourth number of Volume 26 and the first three numbers of Volume 27 of the Academy's *Transactions* have been issued at the following costs:

	State	*Academy*
Vol. 26, No. 4, June, 1934		$135.65
Vol. 27, No. 1, Sept., 1934	$100.46	
Vol. 27, No. 2, Dec., 1934	561.48	
Vol. 27, No. 3, March, 1935		68.26
Total	$661.92	$203.91

The dates of distribution were respectively September, November, February, and April. A general index of the first 25 volumes of the *Transactions* is in preparation.

The publication of the general index and the purchase of mailing envelopes will take the larger share of the remaining printing allotment; the unused portion, which may be about $200, will lapse July 1, 1935. It appears that next biennium if the same amount is avilable ($1000 per year), the printing allowance for each author may be increased somewhat.

(Signed) DOROTHY E. ROSE, *Editor*

REPORT OF THE LIBRARIAN

During the year many requests for copies of the *Transactions* were received from individuals and institutions not only in the United States, but in various foreign countries. A request recently coming from Kashmir, India, indicates the extent of the circulation of the *Transactions*.

About seventy-five publications were received in exchange for *Transactions*, and several of these were foreign, including the following countries: Canada, Brazil, China, Japan, England, and Germany.

The approximate number of *Transactions* on hand that were published since volume 26, number 1, are:

Volume 26,	Number 2	300	Volume 27,	Number 1	500
26,	3	150	27,	2	500
26,	4	550	27,	3	50

Respectfully submitted,

ARTHUR STERRY COGGESHALL, *Librarian*

REPORT OF THE COMMITTEE ON AFFILIATION

No request for affiliation has come to the attention of the committee during the past year; consequently there has been no occasion for a meeting of the committee.

Respectfully submitted,

JOHN C. HESSLER, *Chairman*

REPORT OF THE COMMITTEE ON ECOLOGICAL SURVEY

The committee reports that Part 1 of the Bibliography of the Ecology of Illinois has been published in a recent number of the *Transactions* (Volume 27, No. 2). Reprints are available from Dr. Laurence L. Quill, Secretary of the Academy. Progress is being made in the work on Part 2 of the Bibliography.

The Committee regrets that one of its members, Dr. Waterman, feels unable to continue actively, and it recommends that the council appoint someone in his place.

Respectfully submitted,
A. G. Vestal, *Chairman*

REPORT OF COMMITTEE ON LEGISLATION AND FINANCE

No meeting of the committee was called during the past year, inasmuch as the funds appropriated by the State for the last biennium have been available for Academy use. The sum of $2,000 has been requested for the next biennium and included in the budget of the State Museum Division of the Department of Registration and Education. The appropriation bill is now in the hands of the legislature and will probably be up for consideration within a few weeks. Should it be necessary, the committee will act to assure the release of the requested sum of money for the use of the Academy. However, the unfortunate situation which arose two years ago, and which for a time occasioned grave concern regarding the fate of the Academy is not expected to develop again; and the Academy members and officers are justified in planning a program of publication of *Transactions* on the same basis as during the past two years.

Respectfully submitted,
Don L. Carroll, *Chairman*

REPORT OF THE COMMITTEE ON HIGH SCHOOL SCIENCE AND CLUBS

The work of the Illinois Junior Section of the Academy of Science has progressed along the lines proposed at the last annual meeting in Decatur and at the Council meeting in Urbana, November 23, 1934. The most important aspects of the work are summarized below.

Reorganization and Expansion

The initial step of dividing the state into Divisions, corresponding in outline with those of the State Teachers' Association, has been carried out. These Divisions were found logical in insuring contacts between sponsors, students and clubs with the least possible expense. Chairmen for the Divisions were selected from those sponsoring affiliated clubs of more than one year's standing in the belief that there is no surer foundation for permanence and progress than to depend on people who have delivered "the goods." More than 50 counties of the state are now operating under Division Chairmen. During the past year, these chairmen acted under the direction of the General Chairman, and used various means of promoting the work without cost to the Academy. Several held Science Club Guest Nights to which delegates from all schools in the Division were invited. Others appeared on the Teachers' Association programs in behalf of the Junior Academy or held separate meetings at the time. Still others made personal calls on effective science teachers in the area assigned. A number of newly affiliated clubs are directly traceable to the personal efforts of these Division Chairmen.

The publicity service for the Junior Section rendered through the facilities of the Senior Academy and in the immediate care of Mr. Carroll Chouinard was a most effective piece of work.

Radio Service

The facilities of Station W. I. L. L. (University of Illinois, 890 kilocycles), made available through the initial efforts of Dr. H. R. Wanless, were used regularly for a broadcast at 9:30 A. M., Saturday mornings, throughout the entire school year. The name of the series was "Science and Its Heroes." Many of the University's leading scientists, including President Willard, spoke under the auspices of the Junior Section of the Academy. To insure consumer use of these radio lectures, awards in the annual competition are being made for the three best note books including 20 or more of the lectures as taken directly from the radio by the students.

The Committee in charge of the Junior Section is deeply appreciative of the efforts made by the University scientists and wishes that more than key quotations might have been made available in permanent printed form. On personal request, the President of the University contributed 100 copies of his lecture for the purpose of servicing all affiliated clubs, many of which are beyond the range of Station W. I. L. L.

It is hoped that it will be possible to include the presentation developed by various science clubs over this and other radio stations, next year. The Edisonian Science Club of Kankakee High School will present two numbers over W. I. L. L. on Saturday, May 11th as a test of these possibilities. Members of the Senior Academy are urged to listen and to have others listen to these numbers for the primary purpose of evaluating the idea of such club presentations. All such listeners are urged further to notitfy Mr. Frank E. Schooley, Assistant to the Director of Station W. I. L. L. concerning their personal reactions to such work.

The first of these numbers will be included in the regular period devoted to "Science and its Heroes" while the second number will be broadcast in the "Amateur Radio" period. It should be remembered in connection with these broadcasts that the continuities were developed by students at the secondary school level.

Editorial Service

Again a pioneer feature of the pioneering Junior Section, the second volume in three numbers of "Science Club Service," has served a number of important purposes. It is the only medium in the field written from the standpoint of the all-important factor in science club work; namely, the sponsor. In its columns have been abstracted addresses on science club work which would not have been published otherwise. The progress and variations of similar work in other states has been made available to all. These leaflets were used to service the affiliated clubs and for sample copies in locating new clubs. Three hundred copies were sold from one issue to the Kentucky Junior Academy which, incidently, issued three numbers of its own printed service leaflet during the year. Copies of the January and April issues were sold to the Indiana Junior Academy of Science for use in circularizing the affiliated clubs of that state.

The Chairman of this Committee, among others, has made proposals to the Committee of the State Academies of Science operating under the auspices of the American Association for the Advancement of Science for a most effective and inexpensive form of servicing affiliated science clubs in all states *pending some final action* by the Academies and Association.

These personal proposals are:

(1) Sale of columns to the various Junior Academies in the future issues of "Science Club Service" with proportionate share of copies going to those Junior Academies making such purchases. Advertising in such case would take care of much of the cost of publication. There are other desirable features of this plan.

(2) Exchange of issues of the Service leaflets from the various states with purchase, at cost privilege, for extra copies where one Junior Academy required more copies than another.

"Science Club Service" should be continued pending final decisions and action indicated above.

Competition

The competition work has been divided into two parts; one of group entries and one of individual entries, each with a co-chairman in charge. Provisions have been made for a third co-chairman in charge of the Junior High School entries since the latter phase of the Junior Academy is developing at a rapid rate.

One of the several new features in the annual competition is a Geological test where students are given a minute each to examine and classify from knowledge certain minerals. This work is under the immediate direction of Doctor T. T. Quirke of the University of Illinois. This type of activity is thought to be most commendable, because it is such an unmistakable test of individual knowledge. The Chairman recommends that in the future competitions, standardized tests be made available in the science subjects with awards for the winners in these fields. The names of the tests, etc., would not be known, of course, to the contestants, and the tests would be changed from year to year. With elimination through Division contests, it would be possible to locate the most able biology, chemistry, physics and other science students in the state.

Annual Program

The annual program, this year, represents a departure from the past procedures in several respects:

(1) the afternoon session, except for the business period, is entirely given over to the student delegates as speakers.

(2) the honorary student officials from the various clubs are given definite duties in the program and other activities of the day.

(3) the annual guest speaker's number is included with the banquet and all the evening activity of the Junior Academy is scheduled for provisions to start home early in the evening, or for attendance at the Senior program (annual public lecture).

Affiliation and Finance

A cumulative financial record has been made from week to week directly to the Treasurer of the Senior Academy, Doctor Fuller. An elaborate summary and analysis of the Junior Section finances was made to him under date of April 27, 1935.

It is to be noted that the more than 60 affiliated clubs (representing some 3,000 science students over the state) is an all-time record of maintained affiliations, paid to date. This is of particular significance since 220 school districts in the state are financially destitute and the teachers are accordingly a most disheartened group with little courage to take on added duties.

A summary of club affiliations maintained in the history of the Junior Academy is as follows:

	No. Clubs
1919-1929 average maintained	5
1930	28
1931	41
1932	40
1933	27
1934	52
1935	64

The following recommendations for the Junior Section of the Illinois Academy of Science were made at Bloomington, May 4, 1935.

I. *Reorganization and expansion:*

(1) Continuation of the practice of placing successful sponsors of affiliated clubs (with more than two years standing) as Division Chairman. The duties of these Chairmen shall be to encourage other science teachers to organize and affiliate science clubs. The means: through guest night programs and visitation, etc., without expense to the Academies. The present plan divides the state into 20 divisions, four of which are in Cook County. More than half of the counties in the state were under Division Chairmen this year.

II. *Radio Service:*

(1) Continuation, if possible, of the "Science and Its Heroes" series over W. I. L. L. next year.

(2) Preparation of electrical transcriptions on the club work and affiliation for use in local radio stations over the state . . . . These transcriptions to be used in the interim between issues of "Science Club Service." Two or three, in the form of a series with suitable press data should be made available to Division Chairmen. This material could be used without cost over local stations. It should contain no data fixing its age, in order that the series might be used from year to year. Duplicates should be made. If there is but time to originate one of these a year, that should be done. Only those stations giving time gratis should be used.

(3) An effort be made to obtain and use some time on one of the larger stations such as W. G. N.

III. *Editorial Service:*

(1) Pending the final action of the State Academies and the American Association for the Advancement of Science with reference to the problem of servicing the science clubs, there should be three issues of "Science Club Service" per year for the present at least. The Kentucky Junior Academy of Science has published four such leaflets this year. If the two Academies were to alternate in their publications and exchange enough copies for the clubs in each state, there would be service for six of the nine or ten months. One more state in the plan would give us almost monthly service, at less cost to Kentucky than trying to issue four numbers and at no more cost to Illinois.

(2) Separation of the Editorial work from that of the General Chairmanship, with a system of routing all correspondence through the Editor's hands and insuring the freshest copy possible for the numbers of "Science Club Service."

IV. *Annual Competitions:*

(1) Inclusion of standardized informational tests in various fields of science, with possible Division tests where Divisions are sufficiently developed, with loving cup and other awards—preferably the latter, for recognition.

V. *Annual Program:*

(1) The same plan as used for the Bloomington meeting, May 3, 1935.

VI. *Finances:*

(1) Continued support of the Senior Academy on the present scale.

(2) Use of the provision for a special assessment for 1935-6 from all Junior Academy Clubs in the amount of one dollar additional to annual dues.

The concluding paragraph of my last annual report is more appropriate: "It is believed that no organization ever worked under a more harmonious influence, and that every thing possible has been done to make the work efficient, effective, and economical."

LOUIS A. ASTELL, *General Chairman*

REPORT OF THE COMMITTEE ON CONSERVATION

One major proposition has been considered by your Committee on Conservation since the time of the last meeting. In October, 1934, the American Forestry Association and the Central States Section of the Society of American Foresters brought to the attention of the Chairman of this Committee that there was a movement under way in Washington to transfer the United States Forest Service from the Department of Agriculture to the Department of the Interior.

Since it was the unanimous opinion of all those actively associated with forestry work in this country that this change would be a serious mistake, your Committee took action to prevent such a transfer. A letter was formulated stating why this transfer was objectionable and would not be in the best interests of forestry or of conservation in general. Copies of this letter protesting the change were sent to the President of the United States, the Secretary of Agriculture and all Illinois members of the United States House of Representatives and the United States Senate.

This letter was acknowledged by the White House, the Secretary of Agriculture and most of our Senators and Representatives in Washington. It, together with the opposition of many other forestry and conservation agencies in the country, aided in preventing the transfer of the Forestry Service to the Department of the Interior. In April a letter was sent to your Chairman by Mr. F. A. Silcox, Chief of the United States Forest Service, as follows:

> "Secretary Wallace, to whom the President sent your letter of December 11, 1934, protesting against the transfer of the Forest Service from the Department of Agriculture, has asked me to make sure that you are kept informed in the matter.
>
> "I am, therefore, calling attention to the fact that, following a conference with President Roosevelt on January 23, the Secretary of Agriculture made public the following statement:
>
> 'I am authorized to say that the Administration has not contemplated, and does not now contemplate, transferring the Forest Service and the Biological Survey from the Department of Agriculture.' "

It is evident from this letter of Mr. Silcox that conservation agencies in the Department of Agriculture are not now in any immediate danger of being shifted to another department where they would be dissociated from scientific investigations essential to the advancement of their best interests.

I believe that one of the most important functions of your Committee on Conservation is to keep in touch with and further sound state and national legislation affecting the preservation and intelligent utilization of our natural resources as well as their administration and impartial scientific study.

Respectfully submitted,

(Signed) T. H. Frison, *Chairman*

REPORT OF THE DELEGATE TO THE ILLINOIS CONSERVATION COUNCIL

The conservation council has completed another year of work in education and in suggestions for action by the delegated bodies represented in the council.

Since the last report one year ago, the Everglades National Park bill has passed Congress and another fine park of 2500 square miles has been added to our national system. In Chicago a fine bird sanctuary in Jackson Park has been established. Illinois Dunes Park north of Waukegan has for the present been leased and made a bird sanctuary. The hope is that eventually it may be added to the state parks of Illinois.

"Ghost" towns may be defined as those which were built around the lumber industry. When all lumber had been cut, the towns remained without work for the inhabitants. A plan in Minnesota to give work towards support of 30,000 families in the planting of 150,000,000 trees has been projected by the U. S. Forest Service.

In Oregon 800,000,000 feet of lumber are cut per day. This will cut all the lumber in the state in twelve years. In Europe one may not do as he pleases with his own land. Some such regulations must be established in the United States to stabilize industry in forestry, and to prevent the coming of "ghost" towns.

Considerable newspaper controversy has developed this year concerning crow killing in Illinois. Actual researches should be considered. In Canada research revealed every egg of fifteen duck nests destroyed by crows, and five bushels of shells under one crow's nest. The damage by crows to our song birds in egg destruction is very great. The crow is indeed one of the greatest destroyers of wild life.

The advancement of purchase in our own National Forest units is going forward. 150,000 acres are now in the hands of the federal government, either by direct purchase or option.

The plan of the State Park Board for 250,000 acres of state parks by 1940 has been retarded by the difficulties encountered by the state in finances. Eventually Illinois may occupy a position among the states of the United States such as we might expect them to hold.

Respectfully submitted,

V. O. Graham, *Delegate*

REPORT OF THE COMMITTEE ON RESOLUTIONS

(1) *Whereas:* There are abundant valuable, historical and anthropological remains in Illinois which have not yet been adequately studied by competent scientists, and

Whereas: There has been much destruction of these remains in connection with excavation projects and by thoughtless individuals, be it

Resolved: That the Academy recommend to its Committee on Conservation that a member or subcommittee undertake to aid in the protection, preservation and scientific study of these remains.

(2) *Whereas:* The following suggestions were made to the Committee on Resolutions by A. G. Vestal, University of Illinois, and W. N. Clute, Butler University:

"Early in 1934 a group of biologists and others at the University of Illinois recommended the preservation and acquisition of forests, dunes, and boggy flats in several parts of the broad valley of the Kankakee River, as a part of the Federal Game Restoration project done through the State Department of Conservation. Since the lands are of low productive power, and are largely uncultivated because of the usually high water table they could be bought for one to ten dollars per acre.

"It is unlikely that federal projects will include this area. It is now suggested that a study be made of means and agencies which might protect, preserve, and acquire these most interesting parts. Interested citizens of Joliet will be glad to help with the western part, notably the country east and southeast of Braidwood, which includes a cranberry bog, peaty flats, and well preserved prairie, sand-prairies, and dune vegetation and a location near the Boy Scout camp near Essex is also desirable.

"Rock Creek Canyon, 11 miles west north-west of Kankakee, and a river island near Altdorf are likewise of interest.

"About 60 square miles of forested dunes, meadows, and boggy flats in southeastern Kankakee County and northeastern Iroquois County constitutes a little-known wilderness which is very sparsely populated and of very low productive capacity. Study should be made of it to determine whether it may be suitable for a state park and animal refuge.

"Individuals well acquainted with these wild parts of the Kankakee valley are L. E. Sawyer, Extension Forester at Urbana, A. G. Vestal of the Botany Department at the University of Illinois, and Professor Willard N. Clute of Butler University, Indianapolis. Professor Clute has written a popular book, "Swamp and Dune," on the western part of the valley.

"The Academy's influence, that of the Conservation Council of Chicago, of citizens of Joliet (who are well-known to Dr. Clute) and that of the State Department of Conservation, and the Natural History Survey, should be focused upon efforts directed toward preservation of the better parts of the valley. The cumulative effect of recent dry years has made possible misguided attempts at cultitvation of some of the boggy flats. The new fields will later be drowned upon re-establishment of the normal water-level, but meantime the original vegetation will be destroyed"—Be it therefore

Resolved: That the Academy work in conjunction with the above mentioned groups toward the proper preservation of these areas.

(3) Resolved: That we greatly regret to report the deaths during the year of the following members: A. W. Bennett, Peoria; Carl Buhl, Chicago; Dr. Harry F. Ferguson, Springfield; Stephen Dicharz, Techny; Dr. E. W. Washburn, Washington, D. C.; Berthold Laufer, Chicago; Louis Mohr, Chicago; Professor F. L. Stevens, Urbana; J. J. Golembiowski, Chicago.

We feel that in their deaths the Academy has suffered a great loss and we herewith express our great appreciation of the service that they have rendered the cause of science.

(4) Resolved: That we express our great appreciation of the successful arrangements made by L. K. Wright and his associates on the local committee to make this meeting a success and to all others who have contributed, and *The Daily Pantagraph* for the generous space allowed the announcements and proceedings of this meeting.

(5) Resolved: That the Academy express its thanks and appreciation to Mr. Louis A. Astell for the enthusiastic and energetic support which he has given to the development of the Junior Section of the Academy during this and preceding years.

(6) Resolved: That the Academy express its appreciation to Mr. Chouinard, of the Illinois State Natural History Survey, for his able direction of the publicity for the 1935 annual meeting.

(7) Resolved: That we express our sincere thanks to the officers of the State Academy and to the editor of our publications for their faithful and efficient services during the past year.

(8) Resolved: That the resolutions adopted at this meeting be placed on record and that copies of pertinent resolutions be duly transmitted to interested persons.

(Signed) Fred R. Jelliff
H. R. Wanless
L. J. Bockstahler

CONSTITUTION AND BY-LAWS
OF THE
ILLINOIS STATE ACADEMY OF SCIENCE

CONSTITUTION

Article I. Name

This Society shall be known as The Illinois State Academy of Science.

Article II. Objects

The objects of the Academy shall be the promotion of scientific research, the diffusion of scientific knowledge and scientific spirit, and the unification of the science interests of the State.

Article III. Members

The membership of the Academy shall consist of two classes as follows: *National Members and Local Members.*

National Members shall be those who are members also of the American Association for the Advancement of Science.

Local Members shall be those who are members of the local Academy only. Each member, except life members of the Academy, shall pay an admission fee of one dollar and an annual assessment of one dollar.

Both national members and local members may be either *Life Members, Active Members, or Non-resident Members.*

Life Members shall be national or local members who have paid fees to the Academy to the amount of twenty dollars at one time or completed payments before the annual meeting of 1928. The dues from such a source are to be placed as a permanent fund and only the income is to be used.

Active Members shall be national or local members who reside in the State of Illinois.

Non-resident Members shall be active members or life members who have removed from the State of Illinois. Their duties and privileges shall be the same as active members except that they may not hold office.

Charter Members are those who attended the organization meeting in 1908, signed the constitution, and paid dues for that year.

For election to any class of membership, the candidate's name must be proposed by two members, be approved by a majority of the committee on membership, and be acted upon favorably by a majority vote of the Council.

Article IV. Officers

The officers of the Academy shall consist of a President, a First Vice-President, a Second Vice-President, a Secretary, a Treasurer, a Librarian, and an Editor. These officers, with the exception of the Second Vice-President, the Librarian, and the Editor, shall be chosen by ballot at the annual meeting and shall hold office for one year or until their successors qualify.

The Second Vice-President, who may be a resident of the town in which the next annual meeting is to be held, may be appointed by the Council each year when the next meeting place shall have been decided upon, in order that he may serve as ex-officio chairman of the Committee on Local Arrangements.

The Chief of the State Museum Division of the Department of Registration and Education of the State of Illinois shall be the Librarian of the Academy.

The Editor shall be selected by the Council upon the recommendation of the Committee on Publication.

The above officers shall perform the duties usually pertaining to their respective offices.

It shall be one of the duties of the President to prepare an address which shall be delivered before the Academy at the annual meeting at which his term of office expires.

The Librarian shall have charge of all the books, collections, and material property belonging to the Academy.

The Editor, under the direction of the Committee on Publication, shall have entire charge of the editing and printing of the annual volume of the *Transactions* and also of such other papers as the Committee on Publication shall deem advisable.

Article V. Council

The Council shall consist of the President, First Vice-President, Second Vice-President, Secretary, Treasurer, Librarian, the retiring president and his immediate predecessor, and the Secretary of the preceding year. To the Council shall be entrusted the management of the affairs of the Academy during the intervals between regular meetings.

At the Annual Meetings the presiding officer of each of the affiliated scientific societies of the State shall meet with the Academy Council for the discussion of policies.

Article VI. Standing Committees

The Standing Committees of the Academy shall be a Committee on Publication, a Committee on Membership, and a Committee on Affiliation and such other committees as the Academy shall from time to time deem desirable.

The Committee on Publication shall consist of the President, the Secretary and a third member chosen annually by the Academy. It shall pass upon the papers published by the Academy, subject to review by the Council.

The committees on Membership and Affiliation shall each consist of five members chosen annually by the Academy.

Article VII. Meetings

The regular meetings of the Academy shall be held at such time and place as the Council may designate. Special meetings may be called by the Council, and shall be called upon written request of twenty members.

Article VIII. Publications

The regular publications of the Academy shall include the Transactions of the Academy and such papers as are deemed suitable by the Committee on Publication.

All paid up members shall receive gratis the current publication of the Academy except in case of emergency.

Article IX. Affiliation

The Academy may enter into such relations of affiliation with other organizations of appropriate character as may be recommended by the Council, and may be ordered by a three-fourths vote of the members present at any regular meeting.

Article X. Amendments

This constitution may be amended by a three-fourths vote of the membership present at an annual meeting, provided that notice of the desired change has been sent by the Secretary to all members at least twenty days before such meeting.

BY-LAWS

I. The following shall be the regular order of business:

1. Call to order.
2. Reports of officers.
3. Reports of standing committees.
4. Election of members.
5. Reports of special committees.
6. Appointment of special committees.
7. Unfinished business.
8. New business.
9. Election of officers.
10. Program.
11. Adjournment.

II. No meeting of the Academy shall be held without thirty days previous notice by the Secretary to all members.

III. Fifteen members shall constitute a quorum of the Academy. A majority of the Council shall constitute a quorum of the Council.

IV. No bill may be incurred against the Academy by officers or committees in excess of five dollars, except as provided for in By-law IX, unless approved by the Council. No bill against the Academy shall be paid without an order signed by the President and the Secretary.

V. Members who shall allow their dues to remain unpaid for three years, having been annually notified of their arrearage by the Treasurer, shall have their names stricken from the roll.

VI. The Librarian shall have charge of the distribution, sale, and exchange of the published Transactions of the Academy, under such restrictions as may be imposed by the Council.

VII. The presiding officer shall at each annual meeting appoint a committee of three who shall examine and report in writing upon the account of the Treasurer.

VIII. No paper shall be entitled to a place on the program unless the manuscript or an abstract of the same shall have been previously delivered to the Secretary. No paper shall be presented at any meeting, by any person other than the author, except on vote of the members present at such meeting. Manuscript of papers must be handed to the Secretary at the time of the Annual meeting. All papers are limited to twenty pages, additional pages are to be paid for by the author. Except by invitation of the Council, no paper may be accepted for the program unless the author is a member of the Academy or an applicant for membership. No paper shall be accepted for publication which has already been published elsewhere.

IX. The Secretary and the Treasurer shall have their expenses paid from the Treasury of the Academy while attending council meetings and annual meetings. Other members of the Council may have their expenses paid while attending meetings of the Council, other than those in connection with annual meetings.

X. These by-laws may be suspended by a three-fourths vote of the membership present at any regular meeting.

XI. The Treasurer shall maintain a permanent fund for the Academy, only the interest on which may be used. This permanent fund shall consist of (1) life membership dues, (2) donations, and (3) funds as the Council may see fit from time to time to add from accumulations in the treasury.

CONSTITUTION AND BY-LAWS
OF THE
JUNIOR SECTION
ILLINOIS STATE ACADEMY OF SCIENCE

CONSTITUTION

Article I. Name

This organization shall be known as the Junior Section of the Illinois State Academy of Science.

Article II. Objects

The object of this organization shall be to create and foster the best interest of science together with the spirit of American democracy through scientific, moral, and social activities in the various high schools and communities of the state.

Article III. Membership

The membership shall consist of the active members of the various scientific clubs affiliated with the Illinois State Academy of Science, under the rules and regulations prescribed by the latter Society.

Article IV. Delegates

The number of delegates from each club shall be the same regardless of the size of the club.

This number of delegates will be determined annually by the Governing Committee as prescribed in Article VI below.

Only the official delegates of the various clubs shall vote on the matters representing the official business of the organization.

These provisions shall not be construed as barring additional guests from the several clubs as far as accommodations can be provided.

Article V. Officers

The officers of the Junior Section of the Illinois State Academy of Science shall consist of a President, a Vice-President, a Secretary, and a Treasurer.

These officers shall be elected by the delegates from the several clubs represented at the regular annual meetings of the organization.

The above officers shall perform the duties usually pertaining to their respective offices.

Article VI. Governing Committee

The Governing Committee shall consist of the chairman of the Section of the Illinois State Academy of Science designated as "High School Science Clubs," together with such other members as may be elected by the Junior Section.

This committee shall in turn be governed through the Council of the Illinois State Academy of Science, through constitution and by-laws of the latter society in-so-far as they may involve the activities of the Junior Section of the Illinois State Academy of Science.

Article VII. Limitation of Expenses

No bills in excess of $5.00 shall be incurred by the Junior Section without the authorization of the Council of the State Academy.

Article VIII. Bills

No bill against the Junior Section of the Illinois State Academy of Science shall be paid without an order endorsed by the President, Secretary, and Treasurer of the Illinois State Academy of Science and the chairman of the Governing Committee of the Junior Section.

Article IX. Meetings

The regular meeting of the Junior Section of the Illinois State Academy of Science shall be held at such time and at such place as the Council of the Illinois State Academy of Science may designate. Special meetings may be called by the chairman of the Governing Committee, by written notice to the several members of the said committee.

Article X. Affiliation

Affiliation of the various clubs with the Illinois State Academy of Science shall obtain in the manner prescribed by that Society.

Article XI. Dues and Special Assessments

Dues and special assessments in addition to the fees for affiliation above, may be made by the Governing Committee, providing such levies are in keeping with the provisions of Articles VII and VIII above.

Article XII. Amendments

This constitution may be amended by a three-fourths vote of the official delegates present at an annual meeting, and subject to ratification of the Council, provided that notice of the desired change has been sent to the chairman of the Governing Committee and to the Secretaries of the State Academy and the Junior Section of the Illinois State Academy of Science at least twenty days before such meeting.

BY-LAWS

I. The following shall be the regular order of business:

1. Call to order.
2. Reports of officers.
3. Reports of standing committees.
4. Election of members; i. e., recognition of new clubs affiliated with the Academy, etc.
5. Reports of special committees.
6. Appointment of special committees.
7. Unfinished business.
8. New business; roll call of clubs for reports of outstanding activity.
9. Election of officers.
10. Program.
11. Adjournment.

II. The Chairman of the High School Section shall at each annual meeting appoint a committee of three who shall examine and report in writing upon the account of the Treasurer.

III. These by-laws may be suspended by a three-fourths vote of the official delegates present.

AFFILIATED HIGH SCHOOL SCIENCE CLUBS

Arlington Heights: Arlington Heights Science Club, High School. (1930.)
Aurora: Aurora General Science Club, Junior High School. (1934.)
Bloomington: Amateur Burroughs Club, High School. (1931.)
Bloomington Geology Club, High School. (1933.)
Edwards School Science Club, Edwards School. (1935.)
A. Lincoln Science Club, Lincoln Junior High School. (1935.)
Modern Alchemists, High School. (1929.)
Carlock: Carlock High School Science Club. (1935.)
Charleston: Teachers College Science Club, High School. (1934.)
Chicago: Botchemzo Club, Parker High School. (1930.)
Bowen Bird Boosters, Bowen High School. (1934.)
Crane Tech. Zoa-Phyta Club, Crane Tech. High School. (1934.)
Garden Club, Hyde Park High School. (1935.)
Harrison Biology Club, Harrison Tech. High School. (1930.)
Mendel Science Club, Visitation High School. (1932.)
Siena Biology Club, Siena High School. (1932.)
Siena Chemistry Club, Siena High School, (1931.)
University Science Club, High School, University of Chicago. (1934.)
Visitation Chemistry Club, Visitation High School. (1932.)
Volta Science Club, Visitation High School. (1931.)
Chicago Heights: Bloom Audubon Club, Bloom High School. (1932.)
Cicero: Morton Biology Club, Morton High School. (1934.)
Morton Chemistry Club, Morton High School. (1934.)
Morton Physics Club, Morton High School. (1933.)
Morton Radio Club, Morton High School. (1934.)
Clinton: Bugology Club, High School. (1935.)
Crossville: The Crossville Scientists, High School. (1935.)
Danville: Danville Science Club, High School. (1920.)
DesPlaines: Maine Chemistry Club, Maine High School. (1930.)
Dupo: Dupo Chemistry Club, High School. (1934.)
East St. Louis: East St. Louis Junior Scientific Society, High School. (1934.)
Lansdown Science Club, Lansdown Junior High School. (1934.)
Rock Junior Experimental Science Club, Rock Junior High School. (1935.)
East Moline: Bio-Chemics Science Club, United Twp. High School. (1935.)
Fairbury: Society of Alchemists, High School. (1935.)
Fairfield: Fairfield Science Club, High School. (1932.)
Glen Ellyn: Science Club, Glenbard High School. (1930.)
Granite City: Vocational Science Club, High School. (1930.)
Grant Park: General Science Club, High School. (1934.)
Gurnee: Warren Biology Club, High School. (1930.)
Henry: Henry Science Club, High School. (1935.)
Jacksonville: Science Club of the David Prince Junior High School. (1934.)
Joliet: Joliet Biology Club, High School. (1934.)
Joliet Junior Chapter, National Rocks and Minerals Association, High School. (1934.)
Kankakee: Edisonian Science Club, High School. (1933.)
Richard E. Byrd Science Club, High School. (1935.)
Kewanee: Nature Club, High School. (1935.)
Lawrenceville: Ridgeway Science Club, High School. (1935.)
Maywood: Senior Science Club, Proviso High School. (1935.)
McLeansboro: McLeansboro Science Club, High School. (1933.)
Mt. Pulaski: Mt. Pulaski Science Club, High School. (1930.)

Normal: Chem-Mystery Club, High School. (1933.)
Pittsfield: Pittsfield Chemistry Club, High School. (1933.)
Pontiac: Bi-Fi-Ki Society, High School. (1935.)
Riverside: Catalyst Club, Riverside-Brookfield High School. (1935.)
Rockford: Rockford Biology Club, Senior High School. (1930.)
Rockton: Mote Scientifique, Hononegh Community High School. (1931.)
Urbana: Thornburn Junior Science Club, Thornburn Junior High School. (1935.)
Urbana Science Club, High School. (1934.)
West Chicago: Edisonian Science Club, High School. (1928.)
Junior Science Club, High School. (1935.)
Wilmette: Wilmette Junior Astronomers, Stolp School. (1935.)
Winchester: Win-Co-Hi Radio Club, High School. (1935.)
Winnetka: New Trier Geology Club, New Trier High School. (1931.)
New Trier Ornithology Club, New Trier High School. (1931.)

SCIENTIFIC SOCIETIES AFFILIATED WITH THE ACADEMY

Chicago Academy of Science, Lincoln Park, Chicago, Ill. (1925.)
Chicago Nature Study Club, 3842 Byron St., Chicago, Ill., care of Dr. H. S. Pepoon. (1927.)
Illinos Association of Biology Teachers, Mary R. Earnest, Sec'y, Decatur High School, Decatur, Ill. (1928.)
Illinois Association of Chemistry Teachers, H. L. Slichenmyer, Bloomington High School, Bloomington, Ill. (1928.)
Illinois Nature Study Society of Elgin, Mrs. H. M. Armstrong, Sec'y., 395 DuPage St., Elgin, Ill. (1924.)
Illinois State Library, State House, Springfield, Ill. (1934.)
Knox County Academy of Science, Galesburg, Ill., C. L. Furrow, President. (1923.)
McLean County Academy of Science.
Normal Science Club, Illinois State Normal University, care of Bessie I. Hibarger, Treas., 200 W. Mulberry St., Normal, Ill. (1923.)
Peoria Academy of Science, Peoria, Ill. (1931.)
Rockford Nature Study Society, care of Miss Frances S. Dobson, 312 N. Avon St., Rockford, Ill. (1923.)
Sigma Xi, University of Chicago Chapter, University of Chicago, Chicago, Ill. (1925.)
Sigma Xi, University of Illinois Chapter, Urbana, Ill. (1925.)
Science Club, Teachers College, Macomb, Ill.
Springfield Nature League, Springfield, Ill.
Southern Illinois Science Club, Southern Illinois State Teachers' College, Carbondale, Ill. (1926.)
Theta Chi Delta, Alpha Eta Chapter, Carthage College, Carthage, Ill. (Chemistry.) (1929.)
Theta Chi Delta, Alpha Chapter, Lombard College, Galesburg, Ill. (1934.)
University of Illinois, Branch of the American Chemical Society, Urbana, Ill.

LIBRARIES RECEIVING THE TRANSACTIONS

Academy of Natural Science, Logan Square, Philadelphia, Pa.
American Museum of Natural History, 77th and Central Park West, New York City.
Antioch College, Yellow Springs, Ohio.
Armour Institute of Technology, Chicago, Ill.
Augustana College, Rock Island, Ill.
Boyce Thompson Institute for Plant Research, Yonkers, N. Y.

Bradley Polytechnic Institute, Peoria, Ill.
British Museum of Natural History, Cromwell Road, London, England.
Brooklyn Botanic Gardens, Bronx Park, Brooklyn, N. Y.
Butler University, Indianapolis, Ind.
Carnegie Library, Pittsburgh, Pa.
Carnegie Museum, Schenley Park, Pittsburgh, Pa.
Carthage College, Carthage, Ill.
Cleveland Museum of Natural History, 2717 Euclid Avenue, Cleveland, Ohio.
Cleveland Public Library, Cleveland, Ohio.
Colgate University, Hamilton, N. Y.
Colorado Scientific Society, Denver Public Library, Denver, Colo.
Columbia University, New York, N. Y.
Dartmouth College, Hanover, New Hampshire.
Davenport Public Museum, Davenport, Ia.
De Paul University, Chicago, Ill.
Elmhurst College, Elmhurst, Ill.
Enoch Pratt Free Library, Baltimore, Md.
Eureka College, Eureka, Ill.
Geological Survey of Canada, Ottawa, Canada..
Greenville College, Greenville, Ind.
Harvard University (Arnold Arboretum Library), Jamaica Plain, Mass.
Highland Park Public Library, Highland Park, Ill.
Illinois College, Jacksonville, Ill.
Illinois State Geological Survey, Urbana, Ill.
Illinois State Library, Springfield, Ill. (3 copies.)
Illinois State Natural History Survey, Urbana, Ill.
Illinois Wesleyan University, Bloomington, Ill.
Illinois Womans' College (MacMurray College), Jacksonville, Ill.
Imperial Bureau of Plant Genetics, School of Agriculture, Cambridge, England.
Institute de Biologia Vegetal, Jardin Botanico, Rio de Janeiro, Brazil, South America.
Iowa State College, Ames, Iowa
James Millikin University, Decatur, Ill.
Kenyon College, Gambier, Ohio.
Knox College, Galesburg, Ill.
Lake Forest College, Lake Forest, Ill.
Lewis Institute, Chicago, Ill.
Lincoln College, Lincoln, Ill.
Los Angeles Museum, Los Angeles, Calif.
Louisiana State University (Hill Memorial Library), Baton Rouge, La.
Loyola University, Chicago, Ill.
Massachusetts Institute of Technology, Cambridge, Massachusetts.
McKendree College, Lebanon, Ill.
Missouri Botanical Garden, St. Louis, Mo.
Missouri School of Mines, Rolla, Mo.
Monmouth College, Monmouth, Ill.
Montana State College, Bozeman, Montana.
Museum of Northern Arizona, Flagstaff, Ariz.
Natural History Museum, San Diego, Calif.
New York State College of Agriculture, Agr. Exp. Sta., Ithaca, N. Y.
New York State College of Forestry (Forest Library), Syracuse University, Syracuse, N. Y.
North Central College, Naperville, Ill.
Northwestern University, Evanston, Ill.
Oberlin College, Oberlin, Ohio.
Ohio State Archeological and Historical Society, Columbus, Ohio.
Ohio State University Library, Columbus, Ohio.
Oregon State Agriculture College, Corvallis, Oregon.
Rockford College, Rockford, Ill.
Rosenwald Museum of Science and Industry, Chicago, Ill.
Scripps College, Claremont, Calif.
Senckenbergische Bibliothek Viktoria-Allee 9, Frankfurt (Main), Germany.
Smithsonian Institution, Washington, D. C.
St. Norbert's College, West De Pere, Wis.
St. Procopius College, Lisle, Ill.
St. Viator College, Bourbonnais, Ill.
Shurtleff College, Alton, Ill.
State Normal University, Normal, Ill.
State Teachers College, Carbondale, Ill.
State Teachers College, Charleston, Ill.
State Teachers College, DeKalb, Ill.
State Teachers College, Macomb, Ill.
Texas Christian University, Fort Worth, Tex.
Toledo Public Library, Toledo, Ohio.
United States Department of Agriculture, Washington, D. C.
United States Geological Survey, Washington, D. C.
University of Arkansas, Fayetteville, Ark.
University of California, Berkeley, Calif.
University of Chicago, Chicago, Ill.
University of Illinois, Urbana, Ill.
University of Kansas, Lawrence, Kansas.
University of Kentucky, Lexington, Ky.
University of Michigan (General Library), Ann Arbor, Mich.

University of Montana (School of Mines), Butte, Montana.
University of Nebraska, Lincoln, Neb.
University of North Carolina (Department of Geology), Chapel Hill, N. C.
University of Oklahoma, Norman, Okla.
University of Texas, Austin, Tex.
University of Washington (Main Library), Seattle, Wash.
University of Washington (Oceanographic Library), Seattle, Wash.
University of West Virginia, Morgantown, W. Va.
Vanderbilt University (Department of Geology), Nashville, Tenn.
Western Reserve University, Cleveland, Ohio.
Weston College, Weston, Mass.
Wheaton College, Wheaton, Ill.
Yale University (Department of Geology), New Haven, Conn.
Yale University (Peabody Museum of Natural History), New Haven, Conn.

NOTCE:—Exchanges from state academies should be addressed to THE LIBRARIAN, STATE MUSEUM, SPRINGFIELD, ILL.

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