





LIBRARY  
OF THE  
UNIVERSITY  
OF ILLINOIS

506

IL

v.28-29, cop.4

GEOLOGY

UNIVERSITY OF  
ILLINOIS LIBRARY  
AT URBANA-CHAMPAIGN  
GEOLOGY

Return this book on or before the  
**Latest Date** stamped below.

GEOLOGY LIBRARY

University of Illinois Library

JUN 4 1965

AUG 13 1969

NOV 10 1969

JAN 21 1972

FEB 1 1980

JUL 1 1983

JUL 2 1996

JUL

L161—H41



Digitized by the Internet Archive  
in 2019 with funding from  
University of Illinois Urbana-Champaign

<https://archive.org/details/transactions2829illi>

STATE OF ILLINOIS  
HENRY HORNER, Governor

---

TRANSACTIONS  
OF THE  
ILLINOIS STATE  
ACADEMY OF SCIENCE

---

VOLUME 28      SEPTEMBER, 1935      NUMBER 1

---

Papers Presented in General Session at the  
Twenty-eighth Annual Meeting  
Memoirs



EDITED BY DOROTHY E. ROSE

DEPARTMENT OF REGISTRATION AND EDUCATION  
STATE MUSEUM DIVISION, CENTENNIAL BUILDING  
SPRINGFIELD, ILLINOIS

PRINTED BY AUTHORITY OF THE STATE OF ILLINOIS

---

PUBLISHED QUARTERLY

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

STATE OF ILLINOIS  
HON. HENRY HORNER, *Governor*  
DEPARTMENT OF REGISTRATION AND EDUCATION  
HON. JOHN J. HALLIHAN, *Director*  
STATE MUSEUM DIVISION  
ARTHUR S. COGGESHALL, *Chief*

---

ILLINOIS STATE ACADEMY OF SCIENCE  
AFFILIATED DIVISION OF THE  
STATE MUSEUM

OFFICERS FOR 1935-36

*President*, CHARLES D. SNELLER,  
Peoria, Illinois

*First Vice-President*, C. L. FURROW,  
Knox College, Galesburg, Illinois

*Second Vice-President*, O. D. THURBER,  
Quincy High School, Quincy, Illinois

*Secretary*, WILBUR M. LUCE,  
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 October, 1935



(58226)

506  
IL  
v.28-29  
cop.4

Geal

TRANSACTIONS OF THE ILLINOIS STATE ACADEMY OF SCIENCE

Volume 28

September, 1935

Number 1

CONTENTS

	Page
CHARLES H. BEHRE, JR., Some Problems in the Origin of the Mineral Veins ( <i>Address of the Retiring President</i> ).....	5
H. L. KELLOGG, History and Forecast of Population of the State of Illinois	19
MEMOIRS	
HARRY FOSTER FERGUSON.....	33
ROBERT EARL RICHARDSON.....	35
FRANK LINCOLN STEVENS.....	37
EDWARD DWIGHT WASHBURN.....	39



# Some Problems in the Origin of the Mineral Veins\*

Charles H. Behre, Jr.

*Department of Geology, Northwestern University, Evanston, Illinois*

OF THE VARIOUS MINERAL DEPOSITS which man finds useful, by far the greater number fall into two general classes. One of these classes results primarily from the action of the surface agencies of sediment formation. The outstanding problems relating to this class lie largely in the realm of sedimentation and secondarily in the field of structural geology.

The second important class presents other, and to my mind, even more difficult questions. The temperatures prevailing in the interior of the earth are enormous. Daly<sup>1</sup> suggests maxima of about 1400-1600° C. The rocks here have a composition wholly different from those at the surface; the essential distinction consists in their carrying in solution large quantities of volatile matter, especially water or steam. Much of this internal material of the earth becomes a true liquid as it progresses outward toward the surface, where the confining and solidifying pressures existing at greater depths are reduced. This molten magma contains within it in embryo most of the metallic and many of the non-metallic minerals of industrial civilization. Mineral deposits formed from such solutions may be described as of magmatic origin, the word "magmatic" being here used in the larger, genetic sense.

Among deposits of magmatic origin there are again many sub-heads, based upon genesis. These subheads do not merit consideration here: the excellent discussion by Niggli,<sup>2</sup> who first dealt with their segregation in quantitative terms, has become a classic by now and is known to all students of the science. The segregated products from such hot solutions or magmas make up the greater part of what is here called the "mineral veins". It is with such rising solutions and with their relations to the mineral veins that I wish to deal in what follows. As will be noted, the term "mineral vein" is extended, for the purposes of this paper, to mineral deposits in all kinds of openings, whether fissures or not—an extension dictated by a need to show the relations between various types whose similarity in genesis but dissimilarity in form is conspicuous.

\* Address of the retiring President, May 3, 1935.

<sup>1</sup> Daly, R. A., *Igneous rocks and the depths of the earth*, McGraw-Hill Book Co., New York, 1933, pp. 234, 303.

<sup>2</sup> Niggli, Paul, *Versuch einer naturlichen Klassifikation der im weiteren Sinne magmatischen Erzlagertaetten*, Wilhelm Knapp, Halle, 1925, especially pp. 4-15.

Time is too short to discuss the composition of these mineralizing solutions. Suffice it to say here that they were formerly regarded as highly alkaline, but there is now strong reason to believe that in their early stages they are acid, rich in chlorine and fluorine, and that they become neutral or alkaline only as they approach the surface and reach late stages in their activity.<sup>3</sup>

#### APPROACHES TO THE PROBLEM

The reader may well ask, courteously but insistently, how anything at all is known about the behavior of the solutions underground and about their rôle in the deposition of minerals. Is the concept entirely subjective? Such a question frankly asked deserves at least a brief answer. The reply is of interest to the layman because it sheds light on geologic methodology. It may be of interest to the geologist because it carries in its train observations and conclusions of possible far-reaching significance.

There are three kinds of evidence. The first we may designate as geologic field observation of end products, followed by inference. The danger of such an approach formerly lay in the first step, the observation. Today, with perfected observational technique, it lies more frequently in the inference. An ideal case of observation followed by deduction (so simple as to be matched by the experience of many geologists) was observed in the IbeX mine at Leadville, Colorado: here a room had been opened by the removal of all ore in a certain body; five years later when revisited the room showed on the floor a deposit of green copper carbonate an inch thick, clear evidence of one kind of mineral deposition at the present day. Since the water by which the deposit was made dripped from the roof, we may conclude that descending waters form peculiar kinds of copper ores, in which the carbonate, rather than the sulphide radicle, predominates.

A more complex illustration of a similar reasoning may be cited. Many fissure veins, apparently formed by deposition of mineral matter in rock crevices, include fragments of the surrounding rock. It has been suggested from the position of such rock inclusions that the mineralizing solutions were dense and viscous, so as to buoy up the separate blocks of the country rock.<sup>4</sup> To this Emmons has replied with the demonstration from observations in mines that the progressive deposition of mineral matter around a rock fragment, still loosely attached to the wall or resting against it, may separate the rock fragment gradually from that wall until it comes to lie in the middle of the newly deposited mineral matter.<sup>5</sup> Moreover, Talmage has shown by observation that fragments that seem to be isolated may, in another section

---

<sup>3</sup> Bowen, N. L., *The broader story of magmatic differentiation, briefly told: Ore deposits of the western United States*, Am. Inst. Min. Met. Eng., New York City, 1933, pp. 119-122, 128.

<sup>4</sup> Spurr, J. E., *The ore magmas*, McGraw-Hill Book Co., New York City, 1923, pp. 86-156.

<sup>5</sup> Emmons, W. H., *The state and density of solutions depositing metalliferous veins*: Amer. Inst. Min. Met. Eng., Trans., vol. 76, pp. 314-317, 1928.

farther away, be found still to be attached to the wall and hence not really "floating" in the vein matter at all; they merely appear to be unattached to the wall because they are not immediately contiguous to it at the point where studied.<sup>6</sup> These and numerous other field observations, plus inference and experimentation, lead us, after some pitfalls, to the conclusion that the solutions from which our mineral veins are deposited have low viscosity, despite the apparently contrary testimony of included fragments of wall rock.

Finally, in some cases the mine and its ore bodies are no longer accessible because of flooding, and the facts themselves must be inferred. Thus, at the Hilltop Mine, near Alma, Colorado (Fig. 1), the question arose as to why the ore occurred where it was found. A study of the plan of the stopes or openings as shown on the mine map pointed clearly to the occurrence of ore along fissures, though all ore had been removed and the mine itself was flooded and could therefore not be visited. A careful examination of the surface geology served to confirm this conclusion.

In recent years the microscope has been one of our most useful allies in outlining the laws that govern mineral genesis. For this purpose the petrographic microscope with transmitted light was not greatly helpful because most of the ore minerals are opaque. But about 1915 the reflecting microscope came into general use, and microscopic observation of the behavior of unknown minerals when treated with various reagents soon grew to be the readiest means for identification. A recent innovation now in general use is the reflecting microscope with polarizing nicols. The light enters through a polarizer, the plane of polarization is rotated by reflection, and the analyzer is then used much as in the petrographic microscope. Anisotropic minerals, such as marcasite, have at least a slight extinction which frequently serves to contrast them with isotropic ones, such as pyrite, despite identity in other characteristics, especially chemical composition.

Less readily resorted to but of increasing importance lately as bearing on the origin of the mineral veins is a second kind of evidence, chemical experimentation, in which the ultimate products resemble those of nature. I shall mention only one illustration. Buehler<sup>7</sup> and his associates have shown that soluble salts of lead may be made to react slowly with hydrogen sulphide in a U-tube filled with silica gel. The two reagents are placed in opposite arms of the tube. The products are small but well-formed crystals of galena (PbS). The possibility that our galena deposits are formed by analogous reactions from warm chloride solutions is thus brought to our attention.

By far the most striking and newest is the sort of evidence that is intermediate between field observation and laboratory experimenta-

<sup>6</sup>Talmage, S. B., The significance of "unsupported" inclusions: *Econ. Geol.*, vol. 24, pp. 601-610, 1929.

<sup>7</sup>Buehler, H. D., and Monroe, C. J., Laboratory formation of minerals: *Mo. Geol. Survey 57th Bienn. Rept.*, Appendix V, pp. 1-4, 1933.

tion. Near the southeastern edge of the Aleutian Archipelago of Alaska is an active volcano, Mount Katmai. If previous reasoning, already outlined, is correct, this is a region in which ore deposition might well

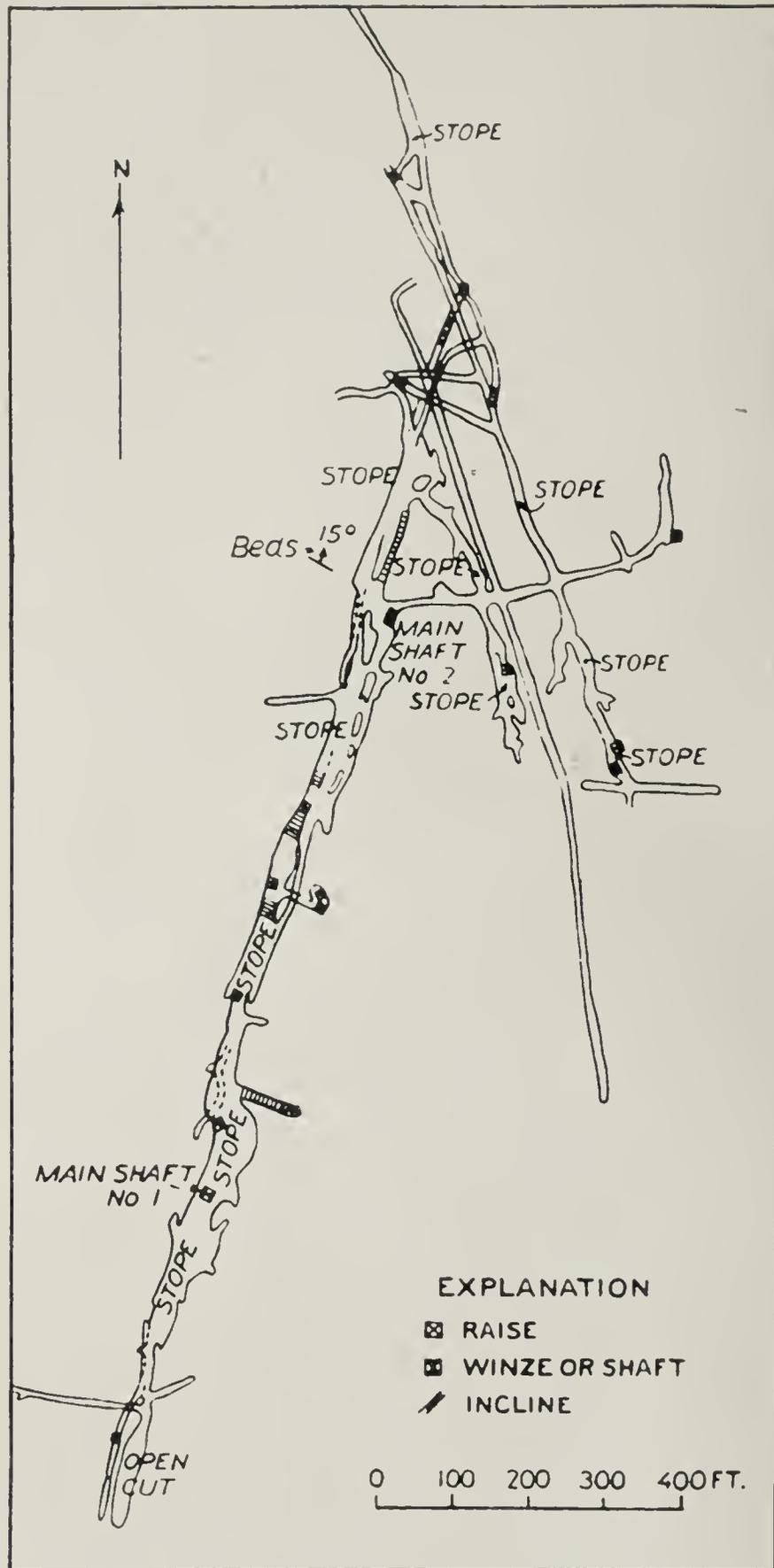


Fig. 1. Plan of Hilltop mine, Leadville, Colorado. The major part of the stoping is on northeast and northwest trending fissures.

be anticipated. The bordering area, loosely referred to as the Valley of Ten Thousand Smokes, has therefore repeatedly been visited by scientists from the Geophysical Laboratory of Washington. In 1919 one of the porous lava fields was carefully surveyed and its minerals

studied. At one little gas vent Allen and Zies<sup>8</sup> recorded a temperature of 239° C., together with the formation of noteworthy amounts of magnetite. This locality was revisited in 1923 by Fenner,<sup>9</sup> who found that the temperature of the rock at the identical spot had fallen to 97° C., and that magnetite was no longer present; instead sulphides of lead, zinc and copper abounded. Here, then, was a natural experiment, as it were, enabling us to picture and to partially understand the sources and processes of ore deposition and to connect a change in temperature with a change in mineral character.

### THE MODERN PICTURE OF MINERAL VEIN FORMATION

From evidence acquired by methods just suggested, we may outline our present-day concept of deposition of the mineral veins. As large masses of molten and highly heated igneous rock approach the surface they set up strains and mineralogic changes in the country rock that develop fractures. Along the resulting openings, the volatile constituents rise to regions of reduced pressure. In such openings they gradually deposit their contents, building up mineral crusts rich in the metals, rich also in such nonmetallic products as fluorite and barite, calcite and the ubiquitous silica gels and quartz. The fascinating story of the acceptance of this viewpoint has been well outlined by Adams,<sup>10</sup> and need not be further reviewed here.

The principal question, "Through what agency and from where did most of the mineral veins receive their contents?", may be regarded as settled, but many lesser problems remain to occupy us and to three of these I wish to direct your attention, however briefly, in the time remaining. That which has gone before is a mere restatement of what is now generally accepted. What follows is original and largely controversial matter.

### PROBLEMS IN THE ORIGIN OF THE CONTACT METAMORPHIC ORES

In many mining districts the magma came close to the surface by intruding its way through the overlying sedimentary rocks before cooling and solidifying. Commonly the form assumed is that of a plug. The Bingham, Utah, district is such a region. Here an igneous mass, roughly cylindrical, about a mile wide, and made up of a granite-like rock, forced its way across beds of sandstone and limestone. At its edges its intense heat has altered the friable sandstone and made of it a dense, well-cemented quartzite. The greatest change is found in the calcareous sediments, however. Near the intrusion the former limestone is hard and dense and consists of calcium silicates, new minerals such as garnet having been developed. Farther away such new min-

<sup>8</sup> Zies, E. G., *The Valley of Ten Thousand Smokes,—the fumarolic incrustations and their bearing on ore deposition*: Natl. Geogr. Soc., Contributed Techn. Papers, Katmai Series, Vol. 1, pp. 5-6, 1929.

<sup>9</sup> Zies, E. G., *Op. cit.*, pp. 18-20.

<sup>10</sup> Adams, F. D., *Origin and nature of ore deposits, an historical study*: Geol. Soc. Amer., Bull., Vol. 45, pp. 375-424, 1934.

erals are lacking and the rock consists only of its normal constituent,  $\text{CaCO}_3$ ; but its color, elsewhere blue-gray, is here altered to white and the rock is marmorized. Still farther from the intrusion the limestone is unaltered. With these changes in the country rock goes a general occurrence of ore. The ore minerals, chiefly galena, sphalerite, chalcopyrite, and pyrite, are especially conspicuous near the intrusion, forming irregular masses in the limestone where it has been most altered.

The recognition of the relation between ore and contact alteration can be traced through the studies of Van Cotta in 1865, of Von Groddeck in 1879, and of Vogt at Kristiania, Norway, in 1894<sup>11</sup> to those of Spurr, Garrey and their associates in the Mexican mining camps in 1908.<sup>12</sup> Spurr and Garrey reported a regular sequence of mineral development: the metasilicates formed nearest the intrusion; orthosilicates (strangely enough) were farther away; sulphides of iron were generally found still farther away; and quartz and carbonates were most distant. Thus it is suggested that the temperatures obtaining in successively more remote shells were dominating factors in determining where a particular mineral should be found with relation to the intrusive igneous rock, and that the minerals transported farthest were the most soluble at lower temperatures.

The fact that temperature is perhaps the prime factor in the distribution of contact metamorphic minerals is indicated in another way also. Emmons<sup>13</sup> has recently pointed out that few if any important contact metamorphic deposits are found around the larger stocks—those exceeding five miles in diameter. If we look upon the stock as the source of the ore minerals, the surprising absence of ore around large, as opposed to smaller, stocks can best be accounted for by the dispersing effect of the greater heat that is yielded by the larger body; smaller bodies carry no such great quantities of surplus heat; they do not “distil” the available ore to such great distances and hence the ore is found in denser quantity near the intrusion; even though the aggregate amount of mineralization may actually be less, concentration is greater.

To date most geologists have looked upon the metamorphism as essentially static; all the products involved were commonly supposed to have been deposited at one and the same time, the more remote as well as the closer halos; the ore minerals as well as the contact metamorphic silicates. Moreover, the time interval occupied by these changes was believed to have been relatively short. But a careful examination of the mineralogic relations shows certain anomalies inimical to this interpretation. Thus, at Ducktown, Tennessee, the primary copper and iron minerals, representing the chief values in that district, were found to be

---

<sup>11</sup> Vogt, J. H. L., *Beitrage zur genetischen Klassifikation der magmatischen Differentiations-Prozesses u. s. w.*: *Zeitschr. f. prakt. Geol.*, pp. 381-399, 1894.

<sup>12</sup> Spurr, J. E., and Garrey, G. H., *Ore deposits of the Velardena district, Mexico*: *Econ. Geol.*, vol. 3, pp. 688-725, 1908. Spurr, J. E., Garrey, G. H., and Fenner, C. N., *Study of a contact-metamorphic ore deposit, the Dolores mine, etc.*: *Econ. Geol.*, vol. 7, pp. 444-484, 1912.

<sup>13</sup> Emmons, W. H., *On the origin of certain systems of ore-bearing fractures*. *Am. Inst. Min. Met. Eng., Trans.* vol. 115, p. 11, 1935.

distinctly later than the silicates characteristic of the inner halos; specimens of zoisite and other silicate minerals even bear chalcopyrite on their cleavage faces (Fig. 2). At Bingham,<sup>14</sup> as well as at Bisbee, Arizona,<sup>15</sup> geologists have found evidence suggesting, though perhaps not proving beyond doubt, that the metallic sulphides were formed later than the silicates.

We are today about in a position to revise our earlier conception and to more fully outline the process of contact metamorphism, and my suggestion would be that we tentatively recognize several separate steps, as follows. The first effect of the intrusion, as already shown by Barrell,<sup>16</sup> is to produce fractures, partly because the magma forces its way by jostling the superincumbent rock, partly because the latter undergoes chemical changes which reduce its volume and thus result in shrinkage

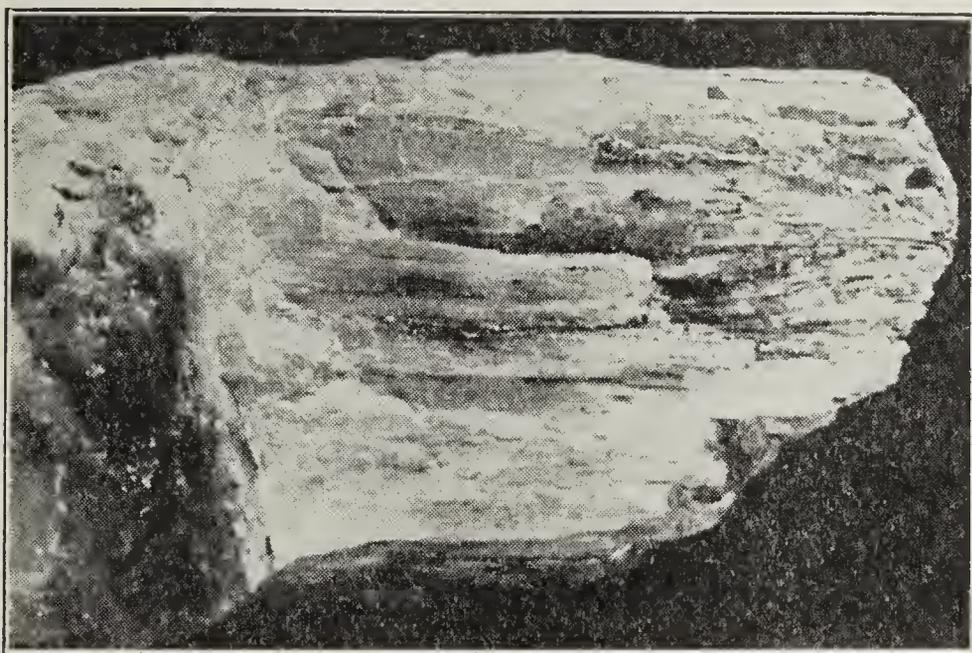


Fig. 2. Large zoisite crystal (white) bearing chalcopyrite (dark) on cleavage faces, Mary mine, Ducktown, Tenn.

cracks. The second step, to a certain extent overlapping the first, is silicate development, silicic anhydride coming largely from the juices of the intruding rock, but calcium, magnesium, and possibly iron ions being furnished by the sediments.<sup>17</sup> Third in the sequence of events, apparently, comes iron oxide deposition. That this is a later stage is shown by several observations, among them the fact, as reported from the Calumet district, Colorado,<sup>18</sup> that veinlets and masses of iron oxides "chink in" around the silicates formed in Step 2 (Fig. 3). Moreover, this iron oxide development may actually follow solidification of much of

<sup>14</sup> Butler, B. S., Loughlin, G. F., Heikes, V. C., and Others, The ore deposits of Utah: U. S. Geol. Survey Prof. Paper III, p. 361, 1920.

<sup>15</sup> Ransome, F. L., The geology and ore deposits of the Bisbee quadrangle: U. S. Geol. Survey Prof. Paper 21, pp. 132-133, 150-153, 1904.

<sup>16</sup> Barrell, Joseph, Physical effects of contact metamorphism: Am. Jour. Sci., 4th ser., vol. 13, pp. 279-296, 1902. Barrell, Joseph, Geology of the Marysville district, Montana: U. S. Geol. Survey Prof. Paper 57, pp. 105-123, 1907.

<sup>17</sup> See, for example, Winchell, A. N., Petrographic studies of limestone alterations at Bingham: Am. Inst. Min. Met. Eng., Trans., vol. 70, pp. 884-899, esp. pp. 897-899, 1924.

<sup>18</sup> Rainwater, E. H., Osborn, E. F., and Behre, C. H., Jr., Geology of the Calumet district, Colorado: Geol. Soc. Amer., Proc. for 1933, pp. 103-104, 1934.

the igneous mass itself, for at Iron Springs, Utah, Leith and Harder<sup>19</sup> found veinlets of hematite cutting the intrusive rock that produced the metamorphism.

But after the iron oxides are formed the juices coming off from the deep, still liquid parts of the parent magma apparently change in composition and produce a fourth stage. Sulphide ions become prominent and the excess of oxygen is no longer present, for reasons already discussed by others.<sup>20</sup> Hence several minerals, the first among which is generally pyrite, fill crevices cutting across earlier minerals, or replace these earlier minerals. Crevice filling is well shown at Cornwall, Pennsylvania, where I observed a vein four inches wide and six feet long, consisting largely of pyrite but subordinately of chalcopyrite, which cut the magnetite ore body; similar facts are recorded by Callahan and

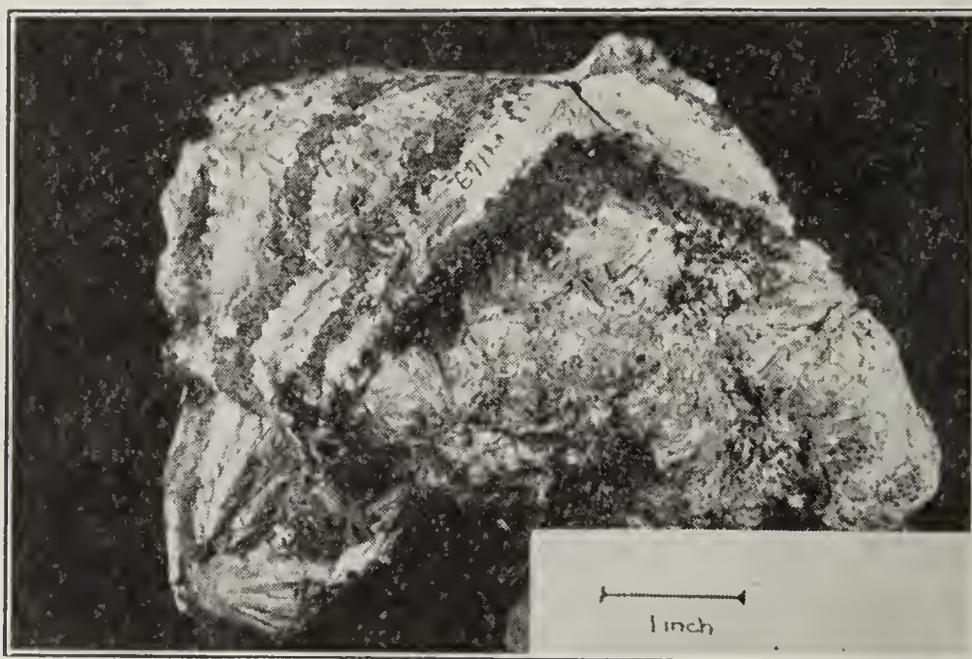


Fig. 3. Magnetite filling "chinks" between bands and crystals of a contact-metamorphic silicate (diopside), Calumet district, Colorado.

Newhouse.<sup>21</sup> At Leadville, Colorado, pyrite replaces crystals of hematite in the contact metamorphic halo.<sup>22</sup> Thus, the fourth stage is represented by sulphide deposition following the deposition of the metallic oxides.

A fifth stage, finally, is shown by the substitution of other sulphides, such as pyrrhotite, for those first formed. It is under these conditions, for example, that chalcopyrite and pyrrhotite fill cracks in pyrite at Ducktown.<sup>23</sup>

<sup>19</sup> Leith, C. K., and Harder, E. C., Iron ores of the Iron Springs district, southern Utah: U. S. Geol. Survey Bull. 338, p. 71, fig. 10, 1908.

<sup>20</sup> Butler, B. S., Some relations between oxygen minerals and sulphur minerals in ore deposits: Econ. Geol., vol. 22, pp. 233-245, 1927. Gilbert, Geoffrey, The significance of hematite in certain ore deposits: Econ. Geol., vol. 21, pp. 560-577, 1926. Lasky, S. G., The systems iron oxides; CO<sub>2</sub>: CO and iron oxides: H<sub>2</sub>O: H<sub>2</sub> as applied to limestone contact deposits: Econ. Geol., vol. 26, pp. 485-495, 1931.

<sup>21</sup> Callahan, W. H., and Newhouse, W. H., A study of the magnetite ore body at Cornwall, Pennsylvania: Econ. Geol., vol. 24, pp. 403-411, 1929.

<sup>22</sup> Emmons, S. F., Irving, J. D., and Loughlin, G. F., Geology and ore deposits of the Leadville mining district, Colorado: U. S. Geol. Survey Prof. Paper 148, pp. 147-148, and fig. 45, 1927.

<sup>23</sup> Emmons, W. H., and Laney, F. B., Geology and ore deposits of the Ducktown mining district, Tennessee: U. S. Geol. Survey Prof. Paper 139, pp. 42-58, 1926.

We are led, then, to the conclusion that the oxide ore minerals in our great contact metamorphic ore bodies are not simultaneous with the contact halos but represent, in the main at least, a subsequent deposit formed by solutions after cooling has progressed a ways. By the same token, the deposition of the sulphides is an even later step incidental to a further fall in the temperature of the intrusion.

Finally, we are tempted to venture the opinion, here offered only casually, that our so-called "contact metamorphic ore deposits" are not actually of contact metamorphic origin at all. Instead they are true mineral veins, at least as to genesis, and are only *found* at the contact. They occur there for two reasons: first, because sulphide ore bodies, like the contact halo, being in the last analysis the products of igneous emanations, generally accompany intrusions, the relations between contact aureole and sulphide ore being purely concomitant, not causal; and, second, because sulphide ores will be deposited by preference in pre-existing openings, and a contact halo affords just such openings. In this possible explanation of the origin of the so-called contact metamorphic ore deposits we see again the importance of the ore-bearing liquors as a source of our mineral veins.

#### PROBLEMS IN THE ROUTES OF MINERALIZING SOLUTIONS

Until the beginning of this century a concrete picture of the movements of the solutions through the rocks was not available and, like the House of Peers in Gilbert and Sullivan's charming opera "Iolanthe", we

"————— Did not itch  
To speculate on matters which  
We *could* not understand."

Today we grasp this process better. I have mentioned the famous copper mining districts of Bingham and Bisbee. Most of the metal produced in each of these two camps comes from huge hills of igneous rocks, essentially quartz monzonite. A careful examination of such rock shows it to be intensely shattered. Tiny fissures, running through it in every direction, bear ore. In such a case the mode of ingress of the mineralizing solutions is therefore well established by geologic observation and inference, and mineralization must have followed the solidification of the rock.

In most deposits the fractures that might serve as channels of ingress are even more conspicuous and outline the mineral body, because they ultimately become choked with the deposit itself. Any of the well known fissure veins might be used to illustrate this type of origin. The form of such channels may be determined by studying the vein itself, or through inference from vertical sections drawn through the workings, or through a study of the ground plan, as illustrated in the Hilltop mine already mentioned.

In the case of still other mineral deposits there are reasons for assuming that the solutions have entered the rock from moderately distant

igneous sources, but the channel of ingress itself is not obvious. We look for fractures or faults extending across the bedding planes and can find few or none. In such cases the burden of proof rests upon any geologist who might seek to maintain that the ore was derived by deposition from solutions travelling for appreciable distances through the rock mass.

For years, now, geologists have contended that the great lead and zinc deposits of Illinois and Wisconsin, as well as those near Joplin, Missouri, could not have been formed by solutions emanating from igneous rocks down deep because there seemed to be no recognizable larger fissures, no recognizable faults that carried to sufficient depth to serve as channelways.

The lead-zinc mines in northern Illinois are no longer accessible, but in two mines in the same general district, the Crawford and Trewartha mines near Hazel Green, Wisconsin, which we have recently carefully studied, we have been able to find just such fissures. They break across

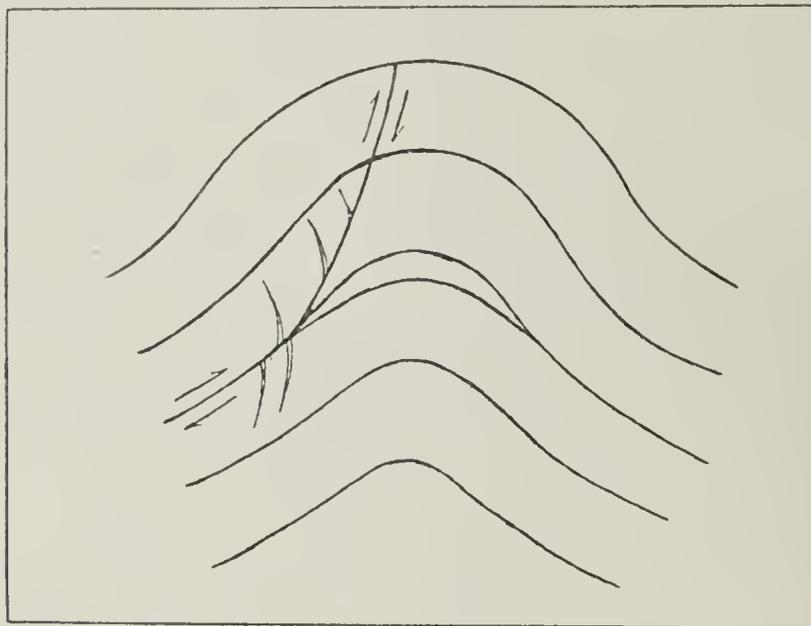


Fig. 4. Diagram of folded anticline composed of relatively competent beds. Arrows show direction in which faulting tends to move. Note minor tensional fissures subsidiary to the major fault.

the beds, they displace the strata, and they are mineralized, that is, they carry openings in which ore is actually found. Along them, therefore, ore solutions were able to travel. It is well to remind ourselves that these observations do not prove that the solutions rose upward from igneous masses, but they do make possible acceptance of an ingress from such deep sources.

Why, in certain districts like that just cited, are the fractures that serve as channelways so difficult to find? I believe that the answer lies in our failure to recognize the form which they might typically assume. In this connection I wish to direct attention to a diagram showing what happens if we compress a series of strata (Fig. 4). Let us remember that these beds already possess well-defined planes of parting, the bedding

planes. When folded, the beds glide upon each other, the stratigraphically higher beds moving uphill with respect to the lower ones. Such movements produce shear by friction in the rock adjacent to the bedding plane along which the gliding occurred. Thus, even in advance of visible faulting that transected the beds, gliding planes and subordinate shear openings may be formed. On the crest of the fold, however, the gliding movement passes into a fault, generally a reverse fault. Accessory tensional fissures and, if the fault plane is curved, further movement between beds are likely to result and thus to furnish added channels.

Without seeking to analyze the process any further, we may note that the recognizable fault plane passes downward parallel to the bedding and seems to disappear. But the movement, the consequent shattering, and the development of channels for ingress of ore solutions have now taken place, and the faulting may continue along the bedding, difficult to recognize though it be.

#### PROBLEMS RESPECTING THE SHALLOW-VEIN TYPE OF ORE

I now wish to turn to a more strictly mineralogic problem, represented by a class of ore deposits peculiarly interesting to the people of this State, the lead and zinc deposits of northwestern Illinois. In a local audience their former importance need scarcely be emphasized. Our lead ores have been worked since 1690, when, at Peoria, Illinois, lead was purchased from Indians by French traders. As recently as 1913 Wisconsin and Illinois together still produced 3 per cent of the world's zinc and it has been estimated that previous to 1905 the value of zinc produced by Illinois, Iowa, and Wisconsin totalled \$10,000,000 and that of lead \$50,000,000.<sup>24</sup> This mining industry was formerly the mainstay of the great smelters at LaSalle and Peru, Illinois.

The ores in Illinois and Wisconsin resemble in a most striking way other deposits widely scattered over the world. If the figures for 1913 are taken, such deposits produce annually about 20 per cent of the world's lead and more than 40 per cent of its zinc.<sup>25</sup> The Belgian zinc deposits of Moresnet, the center where large-scale zinc smelting methods were first developed, belong here; so do the yet more important ones of Silesia, now controlled by Poland. In Sardinia and in northern Spain there are others of the same general type. The class is best displayed, however, in the interior of the United States. Here it is represented by the deposits in Illinois, Iowa, and Wisconsin; by the so-called Tri-State district (actually embracing contiguous parts of the four states Oklahoma, Missouri, Arkansas and Kansas); by the lead, zinc, fluorite, and barite deposits of southern Illinois, eastern Missouri, and western Kentucky; and by the several zinc deposits in the Paleozoic rocks of the folded

<sup>24</sup> Compiled from data furnished by the U. S. Bureau of Mines and the U. S. Geological Survey.

<sup>25</sup> Smith, G. O., and Others, World atlas of commercial geology, U. S. Geol. Survey, Washington, D. C., pp. 42-46, Plates 33-40, 1921.

Appalachians. In the United States this class of deposits has by common consent been designated the Mississippi Valley type of ore.

Certain features characterize these deposits wherever they are found. The mineralogy is simple. The common primary ore minerals are the usual iron sulphides (pyrite and marcasite), galena, sphalerite, and small amounts of chalcopyrite. The gangue minerals, too, are few and uniform. They consist chiefly of dolomite; calcite, in two contrasting habits whose crystal forms are essentially scalenohedral and rhombohedral respectively; well-crystallized barite; and, to a lesser extent but locally important, fluorite. Finally there are present in some deposits large quantities of crystalline and cryptocrystalline silica—quartz and chalcidony (chert) respectively. Peculiar interest attaches to the recognition of tetrahedrite in mines at Picher, Oklahoma;<sup>26</sup> to the finding of small amounts of enargite<sup>27</sup> in similar ores from northern Arkansas; and to the occurrence of small but distinct quantities of arsenic in ores from the Illinois-Wisconsin district. Tetrahedrite and enargite are generally regarded as minerals formed only from solutions of magmatic origin and the presence of arsenic in an ore suggests the presence of these minerals at least in small quantity.

There has been so much discussion as to the origin of ore deposits of this type that I hesitate to add another voice to the clamor. Yet there is one significant feature in their mineralogy that has, to my knowledge, only been touched upon in the most hesitant manner. This is their striking resemblance to certain facies of weak mineralization in districts where that mineralization has been universally attributed to solutions derived from magma bodies, solutions which may well be referred to as “rising” and “hot”, without meaning to imply that they everywhere rose directly vertically or that they everywhere showed very high temperatures.

In order to illustrate the resemblance between the Mississippi Valley ores and the deposits made by weakly mineralizing but admittedly rising hot solutions, I shall take a leaf from some of my earlier work in Colorado mining camps. For an idea of a typical ore deposit where the mineralization is strong, Leadville, Colorado, may serve as an example. In such a deposit we would notice that the ore bodies follow fractures, the solutions having penetrated the country rock laterally, progressing along the bedding planes and selectively replacing certain layers. Such ores generally contain as much as 15 or 20 per cent zinc and 10 per cent lead, together with other metals, and represent bodies comparable in size to those in the Joplin district and far larger than those in northern Illinois; from these facts a picture is gained of the intense action of the mineralizing solutions. In such regions of concentrated mineralization even relatively insoluble siliceous rock, such as quartzite, may be replaced. Moreover, the mineral association is highly complex,

---

<sup>26</sup> Bastin, E. S., Personal communication, 1933; Shipton, W. D., Personal communication, 1934.

<sup>27</sup> McKnight, E. T., Personal communication, 1934.

and the deposit thus appears to differ greatly from the Mississippi Valley ores mineralogically as well as structurally.

At a more distant part of the same district (Leadville), however, an entirely different picture confronts us. It should be borne in mind that ores containing 5 per cent or less of lead or zinc cannot ordinarily be worked in remote regions, such as the Rocky Mountains. Even the ore bodies that *can* be worked are "spotty" and small. Some, resembling our Illinois-Wisconsin ores, follow certain beds selectively. Others, like the vertical crevices in Illinois and Iowa, were evidently controlled by the occasional fissures found by the solutions, and along these fissures thin seams of ore were laid down or from them outward unimpressive quantities of minerals penetrated for short distances into the country rock. Most striking of all, however, is the mineralogy of such distant bodies: in the district selected as an example the predominant minerals are galena, light green or resin-colored sphalerite low in iron, pyrite, barite, scalenohedral calcite, and quartz.

It is appropriate here to make certain comparisons.<sup>28</sup> We see that the presence of iron sulphide (pyrite at first, later marcasite), sphalerite, galena, scalenohedral calcite, and barite is common to the Illinois-Wisconsin and to the distant facies of the Leadville ores. The relative importance of the scalenohedral form of calcite is especially striking. We find, moreover, in both types of deposits a cryptocrystalline silica. Thus, at the Ruby mine, near Leadville, a limestone breccia horizon is silicified, so that it looks almost like chert. Traces of similar silicification are known from the Illinois-Wisconsin lead-zinc district. In the Tri-State district the dark "jasperoid", as distinct from the white chert, is slightly earlier yet almost contemporaneous in origin with the sphalerite, and thus is strongly suggestive of the silicification mentioned at Leadville. Thus, reasoning by analogy, we are apparently justified in believing, contrary to the opinions of most earlier geologists, that the lead and zinc ores of northwestern Illinois and the adjacent parts of Iowa and Wisconsin were deposited from rising, warm solutions.

One more word on the subject may not be amiss, since it has a practical bearing. If the interpretation of the Illinois-Wisconsin lead and zinc ores as just given is correct, we may ultimately look toward a re-expansion of mining in that region on a moderate scale, due to deeper exploration. Such exploration will be most promising if conducted downward and immediately under the larger ore bodies now known, rather than in outlying parts of the district where only small deposits of lead and zinc minerals have been found close to the surface. At present, mining companies generally drill only to a specific horizon (the base of the Decorah formation). Deeper drilling might be anticipated in the search for ore, especially in the neighborhood of Galena, Illinois, and of Platteville, Wisconsin. The technical difficulties involved, such as

<sup>28</sup> Loughlin, G. F., and Behre, C. H., Jr., Zoning of ore deposits in and adjoining the Leadville district, Colorado: *Econ. Geol.*, vol. 29, pp. 230-244 and p. 247, 1934.

dewatering and hoisting, manifestly loom very large. Whether expansion is to be expected soon or in the more distant future depends upon many factors—upon the prices of the metals themselves and perhaps upon the price of silver (by which lead and zinc production from the mixed-metal mines of the western states is stimulated, with a corresponding glutting of the base-metal market); upon the attitude taken by local land owners in reducing initial and ultimate costs of such operations to the companies willing to take the financial risks involved; and upon the energy and enterprise of the mining corporations themselves.

#### CLOSING REMARKS

When I undertook to present this paper there was no intention to point the way toward any single general conclusion. In the discussion of the three phases of ore deposition which I selected I had hoped merely to contribute to a better understanding of some of the related broader theoretical problems. If I have succeeded in stirring your interest, even though it be adversely critical and combative, in certain specific questions connected with ore deposition, I shall have accomplished my primary purpose.

# History and Forecast of Population of the State of Illinois\*

H. L. Kellogg

*State Planning Engineer, Chicago, Illinois*

**T**HOROUGH UNDERSTANDING of population composition, movement, and characteristics is necessary before any sound program to improve the economic status or the social and physical welfare of that population can be applied. As will be developed later, the Illinois population is made up of about 63 per cent of persons who were born here, about 20 per cent who were born in other states of the Union, and 17 per cent foreign-born population.

The general population drift in the United States has been westward since the formation of the thirteen states (Fig. 1). This westward movement, and the increasingly rapid urbanization of population, are outstanding characteristics of the whole country. To understand this westward migration one has only to trace population growths of each state from its first available census to 1930. Such studies show that the oldest states, with the exception of Maine, Vermont, and Pennsylvania, early lost their high proportionate positions with respect to U. S. population, as territory farther west and south became colonized. New York and the southern and middle-western states reached their peak positions between 1830 and 1870. Then they, in turn, lost ground with further westward migration, but stabilized their trends around 1870. The far western and southwestern states have had steady increases in per cent of total population beginning with their colonization. Numerically, no state has had a decrease in population, but those with large urban centers have had, by and large, the greatest increases.

In 1810, when its first census count was made, Illinois had a population of only 12,282 persons. These were concentrated mostly along the Mississippi bottom lands between Kaskaskia and Cahokia. Kaskaskia, the first capital and commercial center, was founded about 1700. When Illinois was admitted to statehood in 1818 its population had increased to about 40,000, confined almost entirely to strips along the Ohio, Wabash and Mississippi rivers in the southern end of the state.

Although the population of Illinois had reached 851,470 by 1850, the greatest increase came during the era of railroad construction.

---

\* 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." Other papers are to appear in Vol. 28, No. 2.

ILLINOIS STATE PLANNING COMMISSION  
DEC. 1934



EFFECT OF INTERSTATE MIGRATION  
ON ILLINOIS POPULATION  
AN ANALYSIS OF 1930 U.S. CENSUS FIGURES

Fig. 1

From 1850 to 1860 the population more than doubled, and by the end of the century the state's population was 4,821,550. In 1930 the census count showed 7,630,654, a gain, for the 30 years, of 58 per cent.

One of the outstanding characteristics of population movement in Illinois has been the great increase in urban population (Fig. 2). Almost three-fourths of the people live in towns and cities larger than 2,500. Increases in urban population are particularly noticeable in the larger cities (Fig. 3).

In only 13 of the 102 counties in the state did the proportion of the state's population living in the county increase between 1890 and 1930. Five of these counties are in the Chicago region, two in the East St. Louis region, four have been pulled up by major industrial cities and two are coal-producing counties (Fig. 4).

**Population migration.**—Migration of population is another important population characteristic. Analysis of census figures shows that in 1930 there were 1,679,692 persons born in Illinois who were living in other states. On the other hand there were 1,564,121 persons living in Illinois who were born in other states. Thus, the state's population has lost 115,571 persons in interstate migration (Fig. 5). Seventy-five per cent of the increase in Illinois population is due to the natural increase, that is, the births minus deaths, and the net foreign immigration gain is around 25 per cent of the total.

If we further analyze the figures on interstate migration we find that the general flow of population is westward. Only two states east of the Mississippi took more of our native population than they gave Illinois of their native populations. West of the Mississippi the situation is reversed. California takes most of the errant native Illinois people. More than 230,000 native Illinoisans were counted in California's 1930 population (Fig. 1).

Of the native Illinoisans living here, 67 per cent are found to be urban and 33 per cent rural. Oddly enough 67 per cent of those who were born in Illinois but have moved elsewhere are also urban. Of the 1,564,121 persons moving into Illinois from other states 81 per cent are urban and 19 per cent are rural (Fig. 5). Thus we have an infiltration of population which is 27 per cent more urban than the native Illinois population is. This characteristic influences the make-up of our whole population, and were it to continue indefinitely, would make the entire state even more predominantly urban. In fact, studies of the urban and rural population development indicate that the whole state will have become 80 per cent urban by 1960 (Fig. 2). It is estimated that by 1960, 84 per cent of the entire state population will be concentrated in 28 counties that have shown steadily increasing tendencies.

**Changes in age groups.**—A most important change in the composition of our population is the decrease in the proportion in the younger age groups. In only 9 counties in the state—five of which

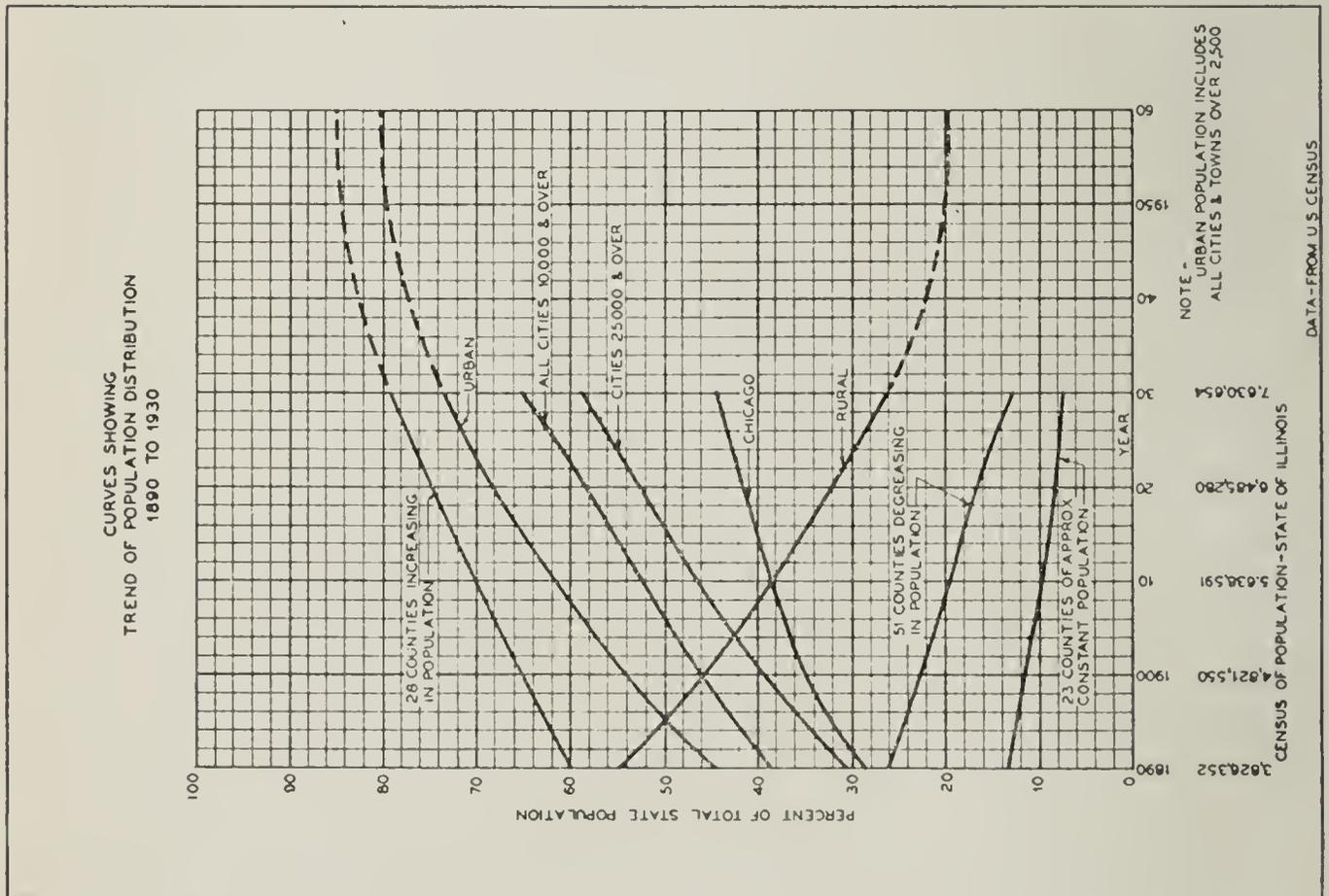
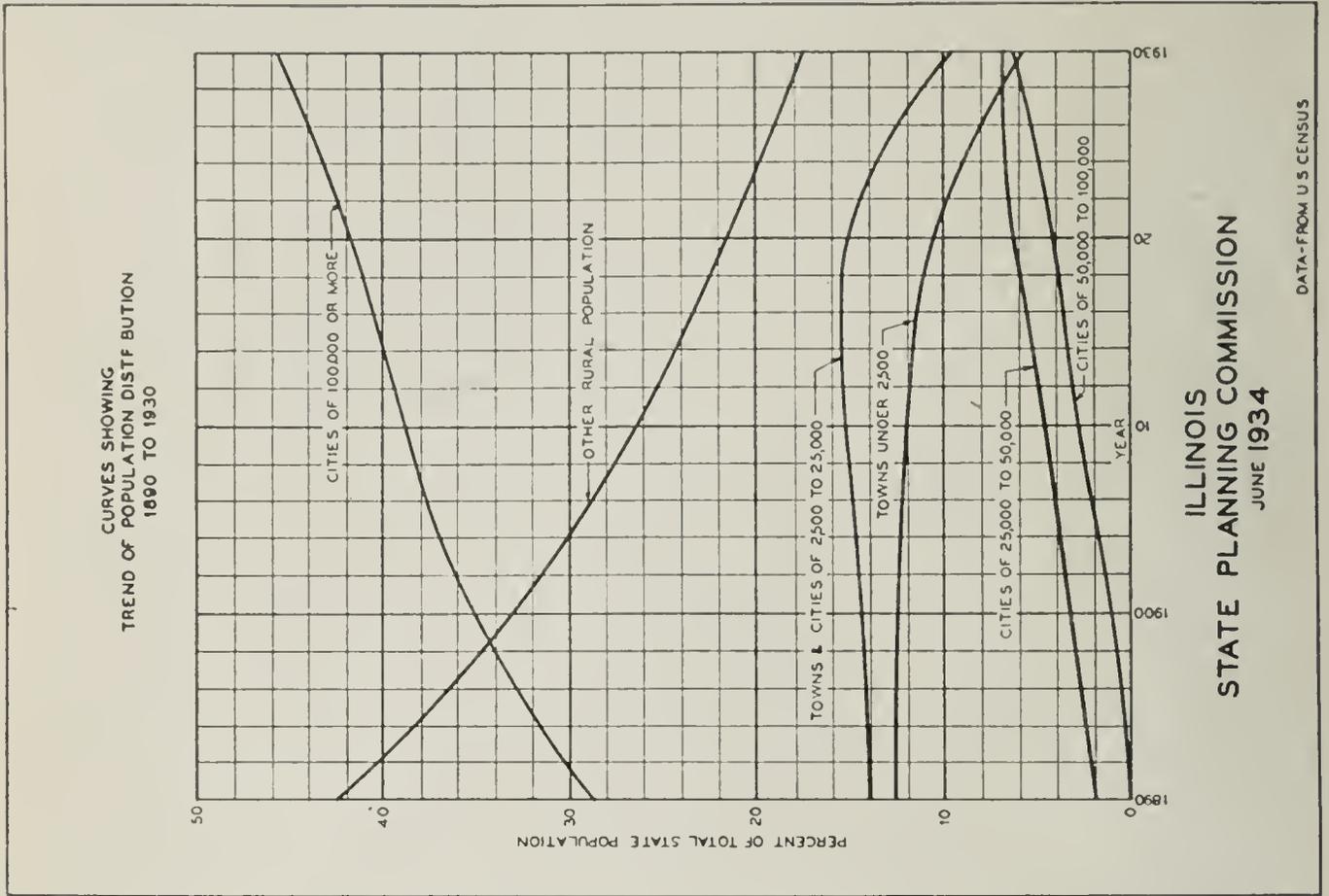


Fig. 2

are urban—was the birth-rate higher for the 1928-1932 five-year average than for the 1923-1927 average (Fig. 6). In 1930, 62.5 per cent of all families in the state had no children under 10 years of age and only 2.5 per cent had four or more children under 10. Even among the farm population 56.5 per cent of the families had no children under 10 and only 4.8 per cent had four or more children, with wide variations being noted as between counties. Contrary to what might be expected Cook County did not have an exceptionally low proportion of small children, but about the average for the state.

For the 16 years between 1916 and 1931 the natural population increase in Illinois averaged 49,000 annually. This is the births minus the deaths. The highest variation above the average was attained in 1921, when the natural increase amounted to 72,685. The lowest net gain was made in 1918, when the natural increase amounted to only 19,996. However, the deaths in 1918 were unusually high, so that year, a war year, cannot be considered as typical. The births recorded in 1931 were the lowest in number for the 16 years.

Improvement in public health facilities and health research have extended the life span to the point where there is an increasingly large number of persons in the old-age brackets. In 1900 there were 3.95 per cent of the whole population of Illinois over 64 years of age. By 1930 this figure had been increased to 5.52 per cent of the population. The state population increased (1900 to 1930) only 58 per cent, whereas persons over 64 years increased in numbers 121 per cent. In other words, the older persons increased in numbers at a rate more than double that of the whole population. The birth rate, on the other hand, has declined. A four-year average of recorded births (1919-1922) reveals a birth-rate per 1,000 population of 21, whereas a four-year average a decade later (1928-1931) was only 17, or a decrease of 19 per cent. Because of the war, these figures may not be entirely comparable, nevertheless they reveal a decrease trend in the birth-rate. The death rate for the two decades are 11.85 and 11.39, respectively.

The decline in the birth-rate is noticeable in the decreasing proportion of the number of persons in the lower age groups. The per cent changes from decade to decade in the various age groups is shown below.

PER CENT OF POPULATION IN VARIOUS AGE GROUPS

Census year	0-9 Years	10-19 Years	20-29 Years	30-39 Years	40-49 Years	50-64 Years	65 and over
1900. ....	22.7	19.8	18.5	15.5	10.4	9.1	4.0
1910. ....	20.3	18.9	19.7	15.3	11.6	9.9	4.3
1920. ....	20.1	17.5	18.0	16.4	12.0	11.3	4.7
1930. ....	17.0	17.9	17.4	16.5	13.5	12.2	5.5

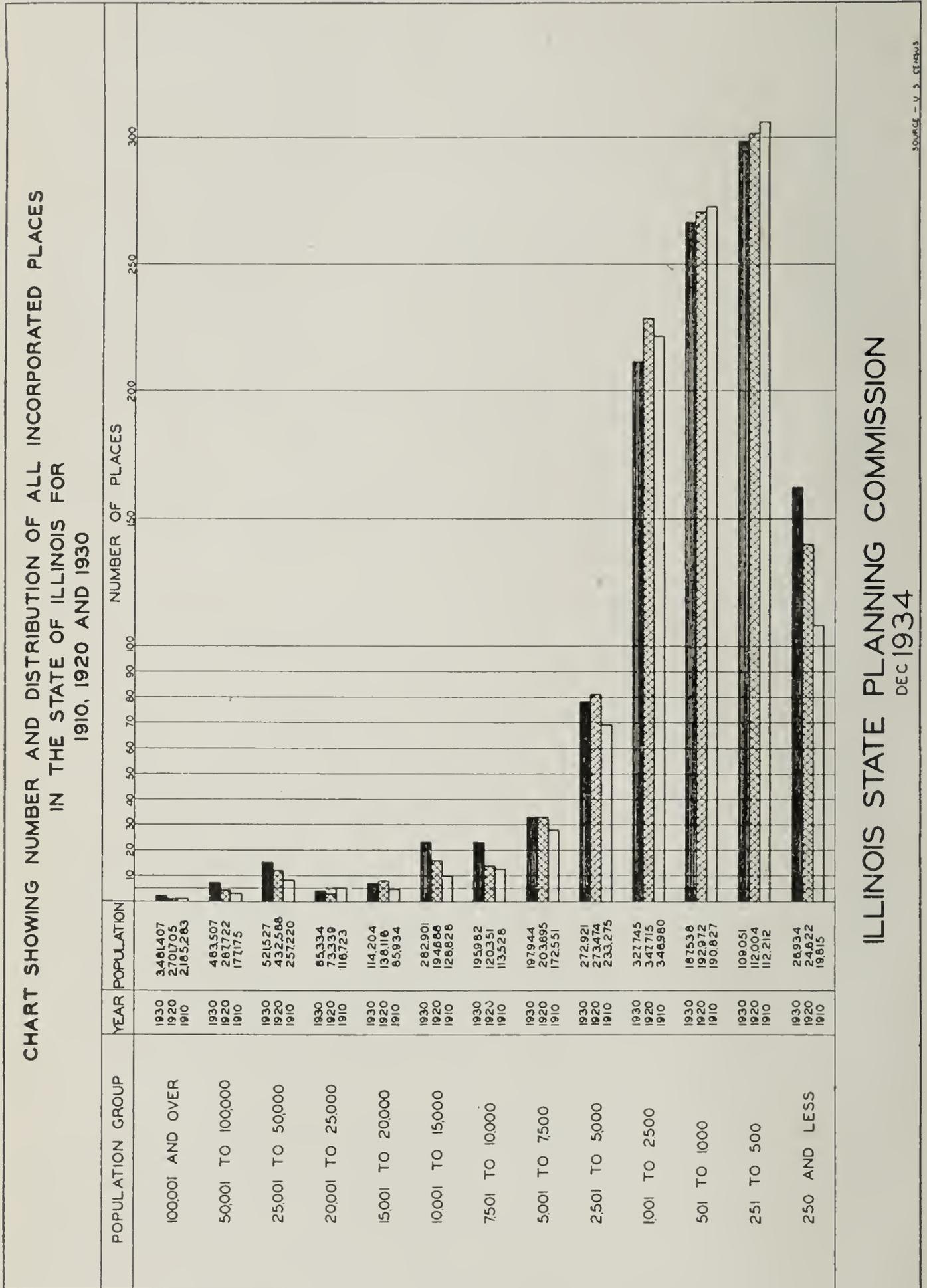


Fig. 3

This 30-year picture of population sheds much light on what the future composition of the state's population will be from the standpoint of age groups. All these considerations, coupled with economic, industrial and agricultural changes lead to a forecast for the state of a popu-

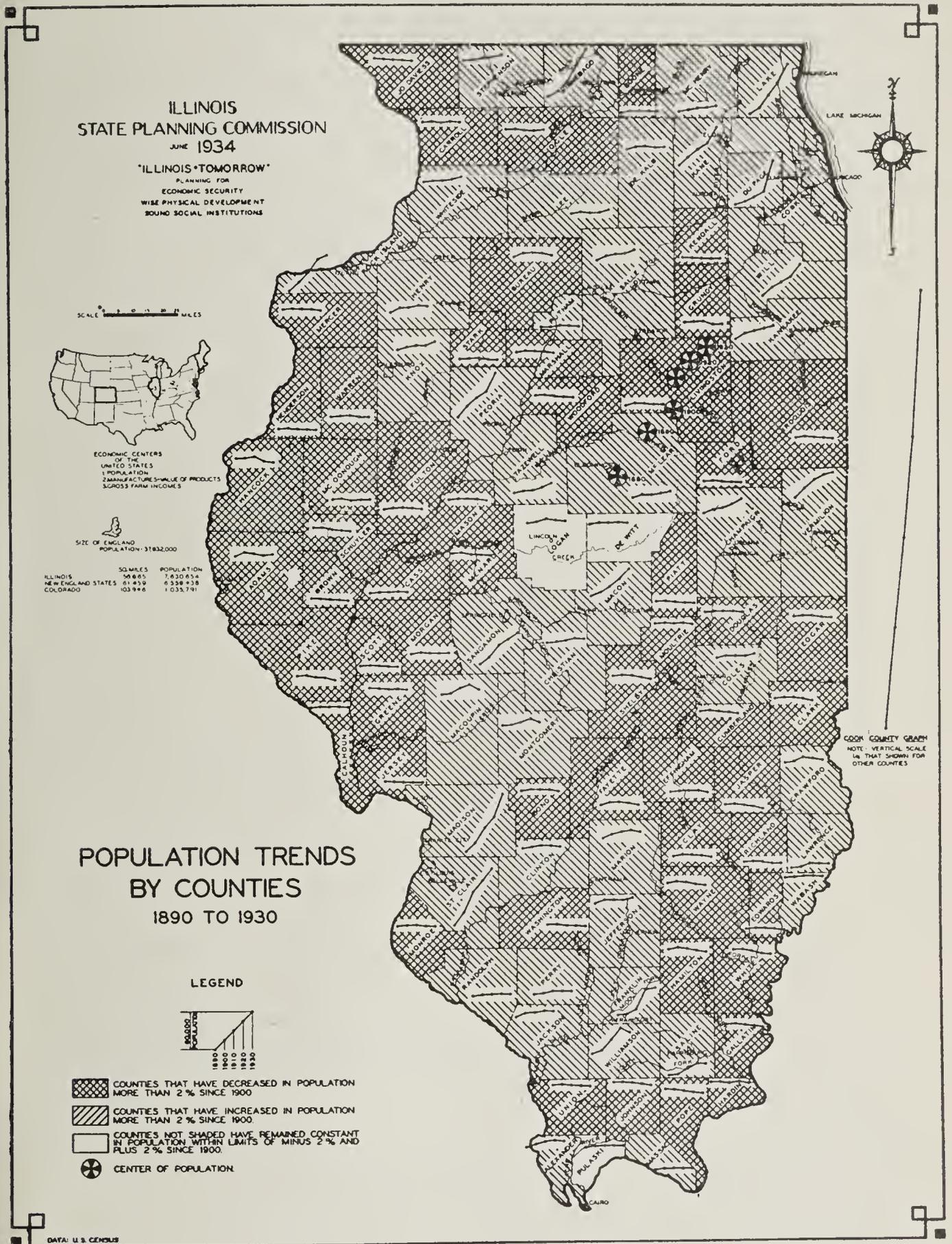


Fig. 4

lation of 9,000,000 by 1960. Of this amount it is believed that at least 7,808,150 will be urban (including all incorporated municipalities). This estimate further cites that the 201 cities and towns expected to be in the group with populations of over 2,500 inhabitants, will contain

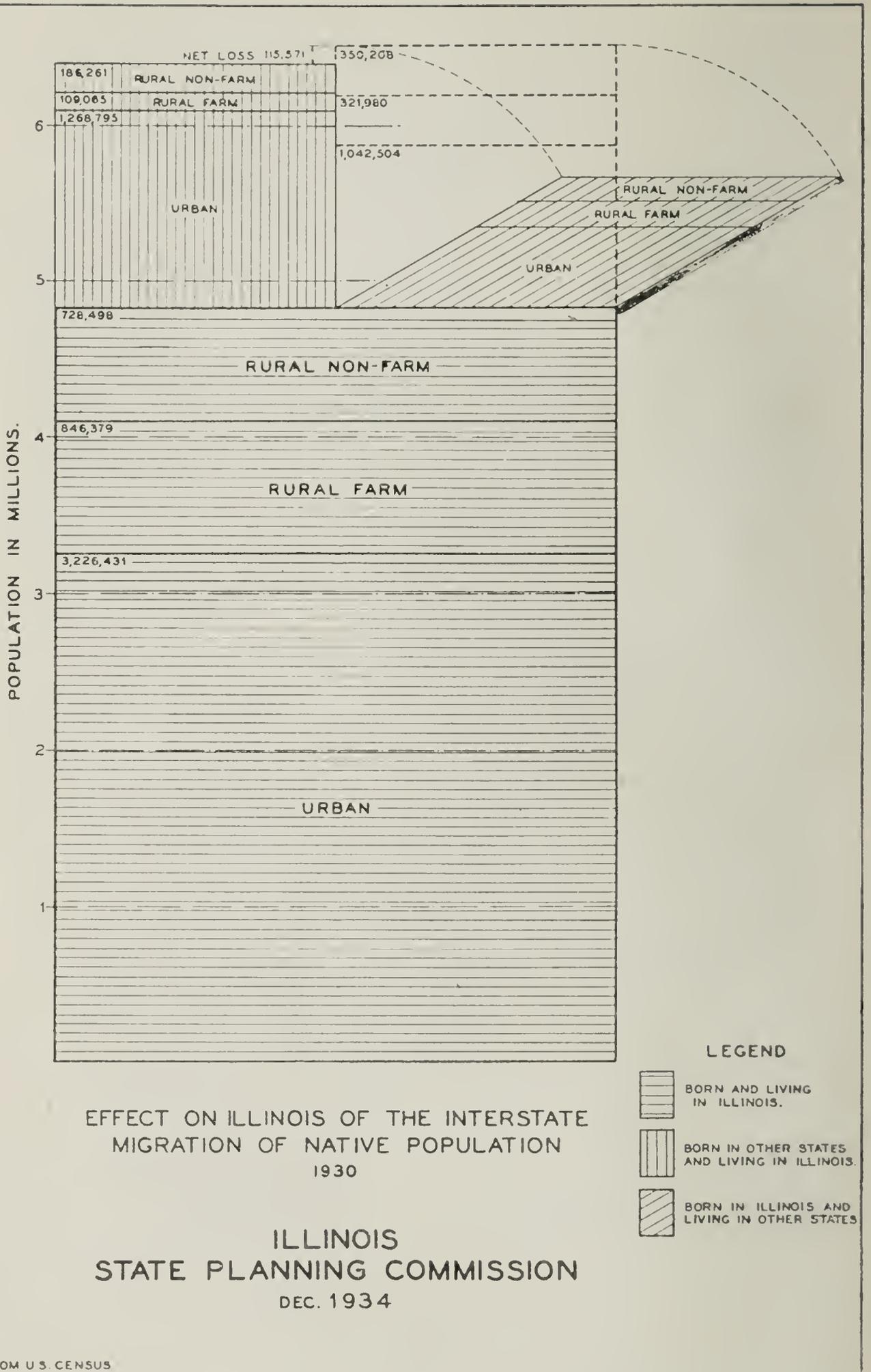


Fig. 5

7,213,400 population and the strictly farm population will be but slightly over 900,000. This forecast includes 1,960 estimates of every incorporated place in the state.

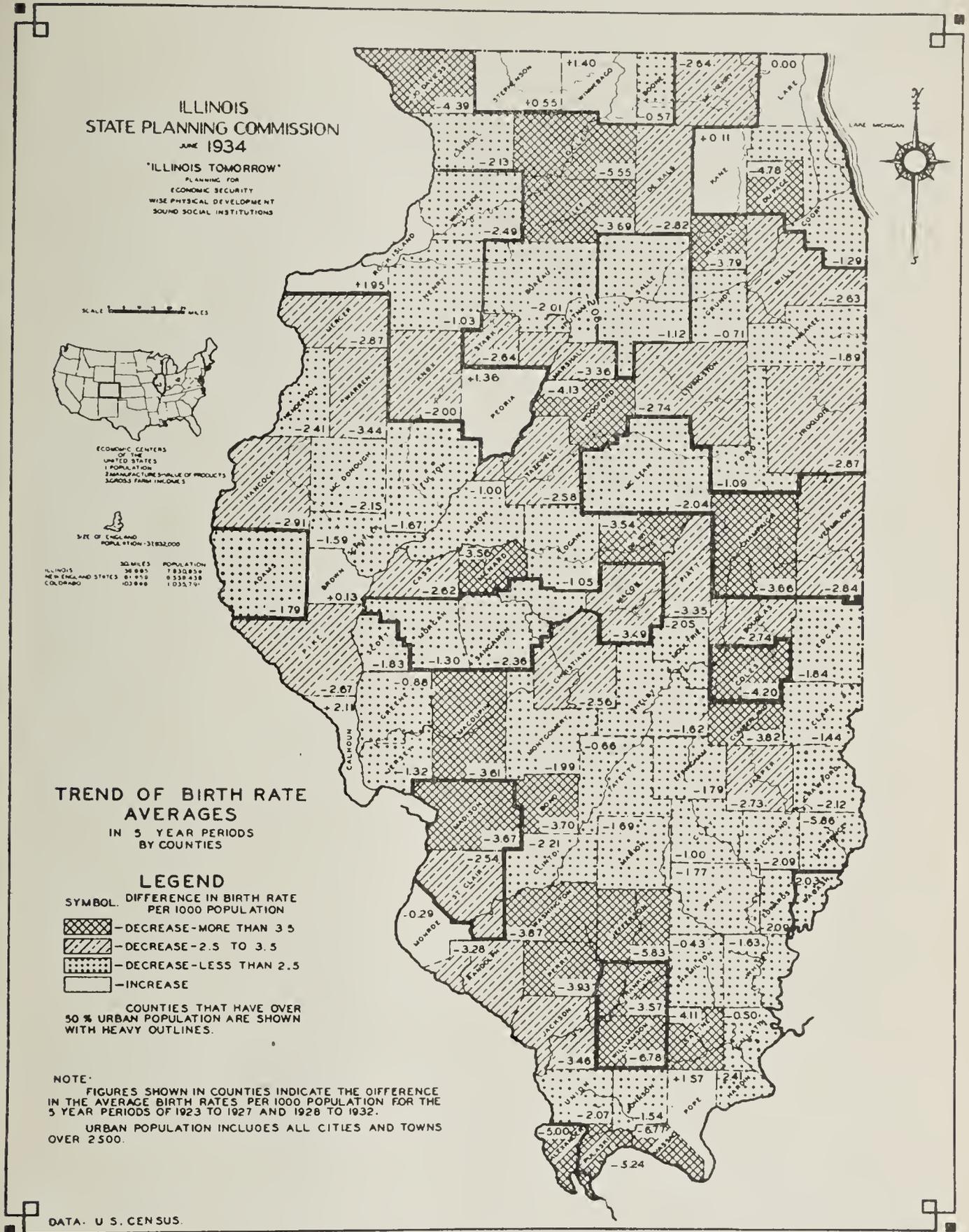
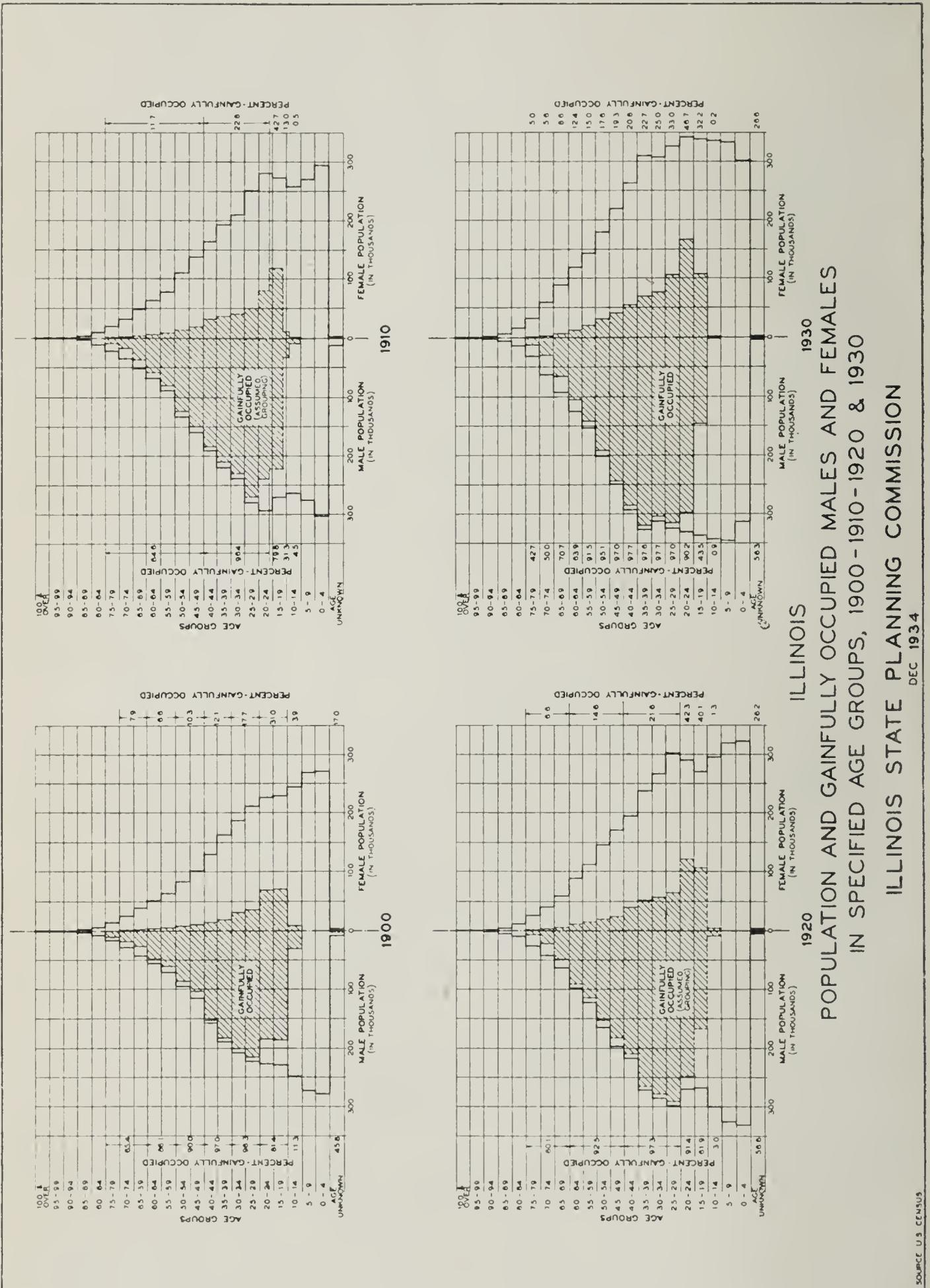


Fig. 6

**Racial characteristics.**—Having determined what the general character and amount of population is to be in the next three decades, let us examine the figures with respect to racial groups. We have seen that our population is becoming more urban all the time and that we are actually losing more native population to other states than we are gaining back. Analyses of these figures on interstate migration



SOURCE: U.S. CENSUS

Fig. 7

show that, as of 1910, Illinois had lost 368,881 more native white persons than it gained; the 1920 census count showed cumulative net loss of 475,807 native whites; and in 1930 the cumulative net loss was 341,961. On the other hand, in 1910, 57,577 more negroes had come into the state than had left it; the number increased to a net gain of 116,476 in 1920; and in 1930 the cumulative net gain was found to be 223,592. Thus the net loss of all native population, due to interstate migration, had decreased from 310,896 as of the 1910 census to 115,571 as of 1930, the influx of negroes being responsible for 76 per cent of that decrease.

When this migration of negro population in and out of Illinois is compared to the United States quite another picture appears. For the whole country only 25 per cent of the negro population lives in states other than where born. On the other hand only 23 per cent of the negroes living in Illinois were born here. The U. S. censuses, for the years indicated, show a 26 per cent increase in total Illinois population from 1890 to 1900, and a 31 per cent increase for the negro population. Between 1900 and 1910 the increases were, for the state, 16.9 per cent, and for the negro, 28.1 per cent. Between 1910 and 1920 the increases were 15 and 67 per cent, respectively, while between 1920 and 1930, these relative increases continued with 17.8 per cent for the state, and 80.5 per cent for the negro.

The percentage changes in the negro population in cities over 25,000 population are even more astonishing. Although Chicago's total population increased 98 per cent between 1900 and 1930, the negro population increased from 30,150 to 233,903, or almost 800 per cent. Peoria increased its population (1900 to 1930) 87 per cent, and its negro population was augmented 117 per cent. East St. Louis gained in total population 151 per cent and in negro population 540 per cent. Evanston, with a population of 19,259 in 1900, had 737 negroes; with a 1930 population of 63,338, it had 4,938 negroes. These percentage gains are 228 and 570 per cent, respectively. However, the demand for unskilled labor, which caused the great influx of negroes between 1910 and 1930, has fallen off since the last general census, so that temporarily this movement has been checked.

Data on foreign population is not so easy to analyze. However, all foreign groups compose about 17 per cent of the total Illinois population. The highest recent net gain in population due to foreign immigration was in 1913 when Illinois' share of immigrants minus emigrants was 82,882. The next largest gain was in 1924, the year the immigration laws based on ethnic groups became effective. That year Illinois gained 42,277 foreigners. In 1930 the number of aliens who came to Illinois to live outnumbered those leaving by only 2,916, and in each of 1932 and 1933 about 2,500 more aliens returned to their native countries than came to Illinois to live.

• **Conclusion.**—It appears obvious that the future growth of population of Illinois will depend on the birthrate and the further influx of negroes. Assuming as a continuing annual increment to the present population the average net of births minus deaths for the 1916-1931 period, and allowing for a continued loss, though slight, of population through interstate migration of native whites, the estimate for 1960 still can be placed at around 9,000,000 people.

---

---

MEMOIRS

---

---



HARRY FOSTER FERGUSON

## HARRY FOSTER FERGUSON

PRESIDENT OF THE ACADEMY, 1932-33

1889-1935

Harry Foster Ferguson was born at Adams, Massachusetts, on March 12, 1889, the son of William Ferguson and Elizabeth (Donaldson) Ferguson. He received his early education in the public schools of his native city, then attended Trinity College, at Hartford, Connecticut, where he was awarded the McKay-Smith Mathematical prize, and, in 1912, was graduated from the Massachusetts Institute of Technology (to which he had been also awarded a scholarship), with the degree of Bachelor of Science in Civil Engineering. He was a member of the Alpha Chi Rho Fraternity. He was always an able and earnest student as evidenced by his awards.

Following graduation and until May 1917 Mr. Ferguson served as an engineer in the State Water Survey at Urbana, following which he enlisted in the United States Army and was a First Lieutenant in the Engineering Corps, having supervision over water supply and sanitary conditions in camps. He returned to his State Water Survey position in March 1919 and in July of that year joined the sanitary engineering staff of the State Health Department as principal assistant engineer. In May 1920 he was appointed Chief Sanitary Engineer and held that position until the time of his death, January 16, 1935.

In this position he was in charge of the investigations, supervision, and analyses of existing and proposed water supplies, including purification works; investigation and supervision of existing and proposed sewerage projects, including sewage treatment works, and engineering, bacterial, chemical, and biological studies of stream pollution (in cooperation with State Sanitary Water Board); supervision of the installation and maintenance of swimming pools; review, issuance of approvals, and permits for plans and specifications for water and sewerage projects, including treatment works and swimming pools; supervision of milk pasteurization plants; advice and assistance in rural sanitation, municipal plumbing ordinances, malaria prevention by mosquito control, school and camp sanitation, and various other items involving sanitary engineering that may have directly or indirectly affected the lives of the people of the State of Illinois.

The Illinois Sanitary Water Board came into existence and functioned effectively largely through the efforts and influence of Mr. Ferguson, who drew up the bill and planned its passage in the 1929 session of the Illinois General Assembly. He was chiefly responsible for the law enacted in 1925 which placed under the State Department of Public Health the supervision of pasteurized milk supplies, and principally upon his initiative and efforts laws were enacted which provided for the establishment of local sanitary districts, local mosquito abate-

ment districts, and the sanitary regulations concerning tourist camps, roadside wells, and food establishments at State Fairs. The bill passed in 1931 giving the State Department of Public Health supervision over swimming pools and bathing places were sponsored by him.

After the enactment of the Sanitary Water Board Law, he served as ex officio Technical Secretary of that Board. He was one of the first Trustees of the newly organized Springfield Sanitary District, to which he was appointed on April 24, 1924. He was re-appointed several times by the various succeeding county judges and served in rotation as President and Secretary of that Board. He was a member of the Board of Trustees at the time of his death.

Needless to say, Mr. Ferguson was nationally known as an authority on sanitary engineering. Few men have contributed as much as he did to progress and improvement in the sanitary conditions of Illinois, particularly in relation to water and milk supplies, to the streams and lakes, and to the disposal of sewage. Endowed alike with administrative talent, clear vision, accurate judgment, and a high sense of integrity, he applied his faculties industriously and effectively. His record is one of faithful service; his death at the very prime of life and in the midst of his fine, humanitarian service, is an inestimable loss. His memory will long be sacred to those who knew him intimately and understood his character, purpose, and achievements.

He passed away January 16, 1935, at the Illinois Research Hospital, Chicago, Illinois, after an illness of several months.

In 1920, Mr. Ferguson was married to Zelda Henson, of Villa Grove, Illinois, and she, with one daughter, Nadine, survives him.

He was a member of the American Public Health Association; American Water Works Association; Illinois Society of Engineers (Past-President); Illinois State Academy of Science (Past-President); Illinois Association of Sanitary Districts (Past-President); Conference of State Sanitary Engineers; Central States Sewage Works Association (Past-President); American Chemical Society; American Association for Promoting Hygiene and Public Baths; Izaak Walton League of America; Associate Professor of the University of Illinois, College of Medicine, in Chicago (in this capacity he lectured on problems in the field at public health and sanitation); and of the American Legion.

He was particularly active in the Illinois State Academy of Science, having served as Chairman of the Public Health Section 1931-32 and as President of the Academy in 1932-33, in addition to various papers he read at annual meetings.

He was the author of many articles on sanitary engineering problems, appearing in current periodicals, among which are the following: American Journal of Public Health, Journal of the American Water Works Association, Illinois State Water Survey Bulletins, Illinois Municipal Review, Illinois Medical Journal, Illinois Health News, etc.

CLARENCE W. KLASSEN

ROBERT EARL RICHARDSON  
1877-1935

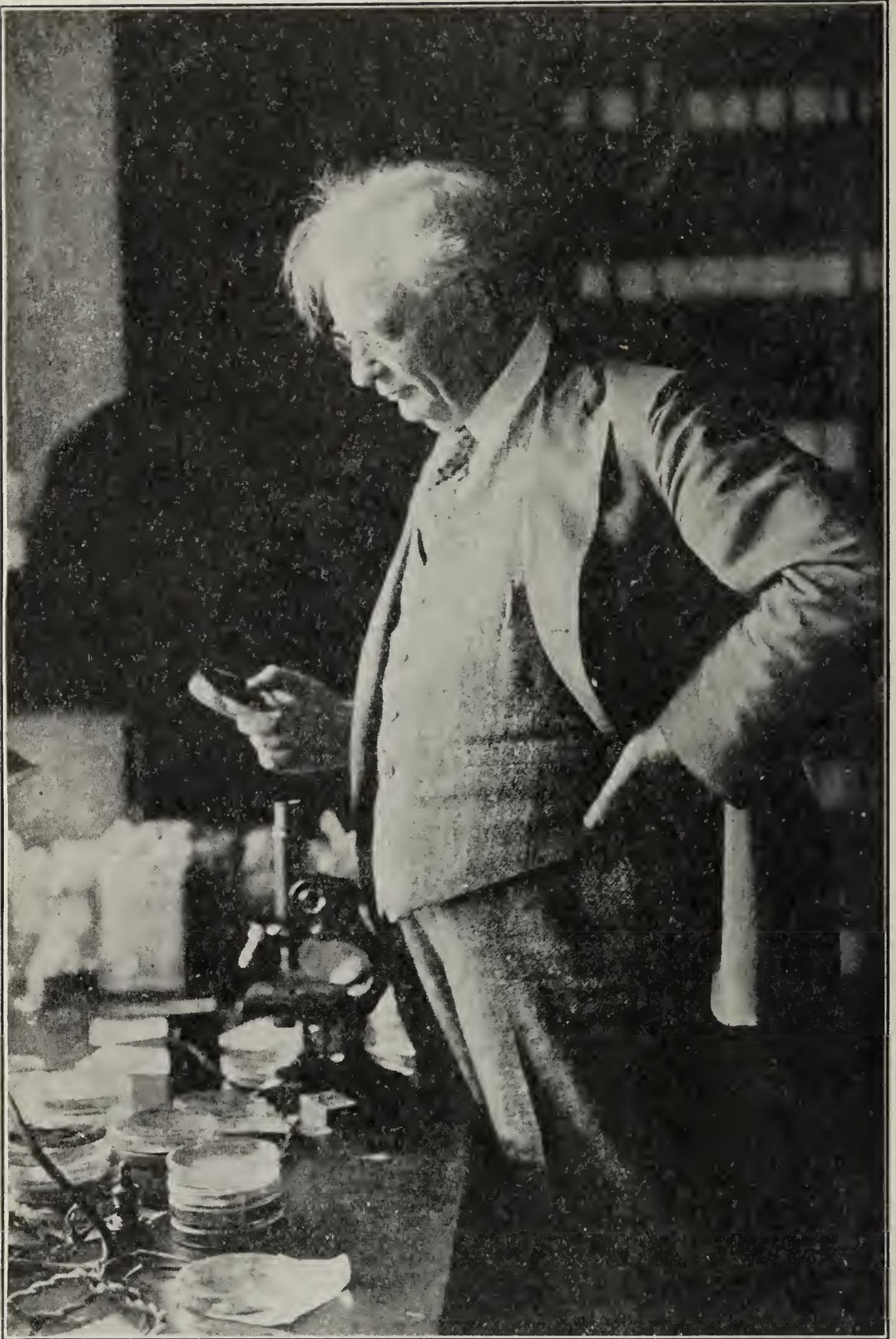
Mr. R. E. Richardson, for thirty years ichthyologist and aquatic biologist for the Illinois Natural History Survey, died on April 14, 1935, following a three-day illness in an Urbana hospital.

He is buried in Brighton, Illinois, the town where he was born on November 28, 1877. His parents were Robert and Emily Dickerson Richardson, who had also been born in Macoupin County. He spent his childhood and boyhood in the vicinity of Alton, attended the De-Pauw preparatory department at Greencastle, Indiana, and received his college work at the University of Illinois where, as a freshman, he was president of his class. After graduation he was elected a fellow in zoology and received the Master of Arts degree in 1903.

Mr. Richardson collaborated with Professor Stephen A. Forbes in the years 1903 to 1906 in the preparation of their classic volume, "The Fishes of Illinois." The years 1906 to 1909 were spent at Leland Stanford University in association with David Starr Jordan with whom he published a series of papers on the fishes of Formosa, Japan, and the Philippines. He returned to Illinois in 1909 to take charge of the field investigations in aquatic biology. Failing health forced him to stop active field work in 1922. He continued his work in the laboratories of the Natural History Survey until 1930 and continued to work mornings until 1933 when rapidly failing health forced him to stop all regular work. During these years he wrote ten of the bulletins of the Natural History Survey, most of which deal with the small bottom animals of the Illinois River. This work was undertaken for the quantitative evaluation of the stocks of food available to fishes, but, with the alarming increase of pollution in the Illinois, he readily adapted these studies to the accurate measurement of the degree of pollution.

Mr. Richardson was not only widely informed in the field of biology but was also well read in the fields of English and Greek literature, biography, history, and finance. Delicate and uncertain health forced him to lead a very secluded and quiet life, but on days when he felt well one could not find a more charming conversationalist or more boyishly genuine enthusiasm.

DAVID H. THOMPSON



FRANK LINCOLN STEVENS

## FRANK LINCOLN STEVENS

1871-1934

The death of Frank Lincoln Stevens, Professor of Plant Pathology in the University of Illinois, August 18, 1934, at Winnetka, Illinois, ended prematurely a life exceptional in service to mankind and great in scientific accomplishment.

The rural environment of Dr. Stevens' boyhood, spent on a farm near Syracuse, New York, fostered a love of nature which became the paramount interest of his life. After graduating from Hobart College, he spent eleven years as student or teacher at Rutgers College (1891-93), Racine College (1893-94), the high school at Columbus and Ohio State University (1894-97), and the University of Chicago, from which he received the Doctor of Philosophy, *magna cum laude*, in 1900 and by which he was granted a traveling fellowship to Bonne, Halle, and Naples for 1900-01.

He became professor of botany and vegetable pathology in the North Carolina State College of Agriculture in 1901 and remained there until 1912, when he became Dean of the College of Agriculture of the University of Porto Rico. Returning to the United States in 1914, he was appointed Professor of Plant Pathology in the University of Illinois, a position which he maintained with honor and distinction until his untimely death.

Early in his career, Dr. Stevens came in contact with three botanists, David G. Fairchild, Byron D. Halsted, and J. J. Davis, each of whom exerted a profound and lasting influence. Fairchild introduced him to the new science of plant pathology; Halsted gave him especially that fastidiously scientific attitude that characterized all his work; Davis imparted the enthusiasm for mycology which, in his last years, was his transcendental interest.

Dr. Stevens' contributions were many and varied. As plant pathologist in North Carolina, he made important studies in plant disease aetiology and was among the first to attack the still vital problems of soil sterilization for disease control and the selection and breeding of disease-resistant crop varieties. He wrote, with J. G. Hall, the first comprehensive handbook of plant diseases printed in America, advocating vigorously the adoption of a distinctive terminology, and collaborated in the preparation of elementary arithmetic, reading, and agricultural textbooks. In Porto Rico, he prepared the manuscript of his best known book, "The Fungi Which Cause Plant Disease."

The twenty years spent by Dr. Stevens in Illinois were notable, as well. Those students who earned degrees under him have borne, in their achievements, unfailing testimony to the excellence of his instruction. Especially important among his many researches are studies of insect and wind transmission of the apple fire blight disease, of the causes of foot- and root-rots of wheat, and of saltation and the effect of irradiation upon fungi. He was largely responsible for the organization of a state plant disease survey and directed much of its early work.

In later years, Dr. Stevens' interest turned to the intensely intellectual problems of taxonomic mycology, which he regarded as fundamental to plant pathology, and he became the outstanding American in this field. He made trips to Trinidad, British Guiana, Panama, Hawaii, and the Phillippines, whence he returned with copious collections. The tropical genus *Meliola* was the subject of two monographs, and he had nearly completed a monographic study of the Microthyriaceae.

The Academy of Science has lost a distinguished member whose teaching brought able workers to the service of science, whose researches have been of large practical worth, and whose far-sighted appreciation of fundamentals had placed him in the forefront of scientific achievement.

L. R. TEHON

## EDWARD DWIGHT WASHBURN

1881-1934

Edward Dwight Washburn came to Illinois to take charge of the division of Physical Chemistry in the Department of Chemistry at the University of Illinois, in 1908. He had only just taken his degree of Ph.D. at the Massachusetts Institute of Technology but was selected for this important position because of his recommendation as a young man of unusual promise by Professor A. A. Noyes.

His thesis for the degree was based on an experimental study of the hydration of ions in which he had used the optical rotation of raffinose as a marker while the ions of an electrolyte were transferred in opposite directions in the solution by electrolytic conduction.

Dr. Washburn soon demonstrated the wisdom of our choice by a series of masterly researches carried out by himself and by his students working in the field of the conductivity of electrolytes.

Since conductivity depends in part on the viscosity of the solution he developed a new and very accurate viscosimeter with which the viscosity of water at different temperatures was determined and also the viscosity of solutions of raffinose.

A very careful theoretical and experimental study of the iodimetric titration of arsenious acid laid the foundation for the development of the iodine coulometer. Before, the only chemical method considered sufficiently accurate for the quantitative measurement of electrical currents was the silver coulometer. Washburn and Bates developed the iodine coulometer to a comparable degree of accuracy and Bates completed the study by a careful comparison of the silver and iodine coulometers at the Bureau of Standards in Washington.

For a number of years the Department of Ceramics at the University of Illinois was without a Head because no one available could be found who combined the training in the art with a fundamental knowledge of physical chemistry. Finally it was decided to ask Dr. Washburn to take charge of the Department. During the six years which followed, in spite of his imperfect knowledge of the art of Ceramics, he made notable additions both to the science and the art of the subject. The effect of this period in his life was still apparent in his work as Chief Chemist of the Bureau of Standards.

Germans are very expert in the laborious collection of data from the literature. They have not been so successful in selecting the best

values available from a mass of confused material. At the organization of the Union of Pure and Applied Chemistry, in London in 1919, it was decided to compile Critical Tables of Numerical Data of Physics, Chemistry and Technology and in 1922 Dr. Washburn was asked to take the position of Editor in Chief for this undertaking. With the aid of a competent Board of Editors and a very large band of experts, the work was carried through. The Critical Tables will long remain a monument to his ability and steady, self-sacrificing devotion to the execution of an extremely difficult task.

In 1926 Dr. Washburn was selected by a group of eminent chemists and physicists as their first choice for appointment as the Chief Chemist of the Bureau of Standards.

Soon after the discovery of the isotope of hydrogen called deuterium by Harold C. Urey, for which Professor Urey received the Nobel prize, Dr. Washburn suggested that "heavy water" might be concentrated by electrolysis. This provided the only successful method thus far used for the separation of deuterium in quantity.

Dr. Washburn married Miss Sophie de Veer of Boston in 1910. She died in 1932, two years before Dr. Washburn. They have left four children, William de Veer, Janet, Roger D. and Barbara.

Further details and a list of Dr. Washburn's published papers will be found in a Biographical Memoir soon to be published by the National Academy of Sciences.

WILLIAM ALBERT NOYES

STATE OF ILLINOIS  
HENRY HORNER, Governor

---

TRANSACTIONS  
OF THE  
ILLINOIS STATE  
ACADEMY OF SCIENCE

---

VOLUME 28      DECEMBER, 1935      NUMBER 2

---

Papers Presented in the Twenty-eighth  
Annual Meeting, Bloomington, Illinois,  
May 3 and 4, 1935



EDITED BY DOROTHY E. ROSE

DEPARTMENT OF REGISTRATION AND EDUCATION  
STATE MUSEUM DIVISION, CENTENNIAL BUILDING  
SPRINGFIELD, ILLINOIS

PRINTED BY AUTHORITY OF THE STATE OF ILLINOIS

---

PUBLISHED QUARTERLY

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

STATE OF ILLINOIS  
HON. HENRY HORNER, *Governor*  
DEPARTMENT OF REGISTRATION AND EDUCATION  
HON. JOHN J. HALLIHAN, *Director*  
STATE MUSEUM DIVISION  
ARTHUR S. COGGESHALL, *Chief*

---

ILLINOIS STATE ACADEMY OF SCIENCE  
AFFILIATED DIVISION OF THE  
STATE MUSEUM

OFFICERS FOR 1935-36

*President*, CHARLES D. SNELLER,  
Peoria, Illinois

*First Vice-President*, C. L. FURROW,  
Knox College, Galesburg, Illinois

*Second Vice-President*, O. D. THURBER,  
Quincy High School, Quincy, Illinois

*Secretary*, WILBUR M. LUCE,  
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 March, 1936



(66068)

## CONTENTS

## PAPERS IN AGRICULTURE

	PAGE
EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN.....	47
HOTTES, C. F.—Physiology of Seed Germination.....	49
BARNES, JOSEPH E.—Canada Thistles in Illinois.....	50
KOEHLER, BENJAMIN—Effect of Seed Coat Injury on Germination, Vigor, and Yield of Corn.....	52
MOORE, L. A.—Purity of Illinois Seed Stocks as Revealed by Seed Analysis Studies .....	55
NEWLIN, WALTER A.—Sweet Clover Seed Production.....	58
BIGGER, J. H.—Insects in Relation to Production of Red Clover Seed.....	60

## PAPERS IN ANTHROPOLOGY

EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN.....	65
THURBUR, O. D.—A New Type of Burial Mound Near Quincy, Illinois....	67
MCCOY, H. V.—A Method of Restoration of Indian Mounds.....	69
JORDAN, R. V.—Our Debt to the Indian.....	71
PEITHMAN, IRVIN—Bannerstones and Related Ceremonial Objects from Southern Illinois .....	73
ANDREWS, VAN—Dental Pathology of Prehistoric Man at the Confluence of the Ohio and Mississippi Rivers.....	75
RUYLE, J. B.—The Dryopithecus Tooth Pattern as a Racial Characteristic of the Mound Builders.....	77
MERWIN, BRUCE W.—Archaeology in Southern Illinois.....	79

## PAPERS IN BOTANY

EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN.....	81
BOEWE, G. H., BARRICK, STELLA H., AND HAGUE, STELLA M.—Mosses from Apple River Canyon, Mississippi Palisades, and White Pine Forest State Parks .....	83
CARSON, MARGERY C.—Germination of the Seed and Development of the Seedling of <i>Calopogon pulchellus</i> (SW.) R. BR.....	85
DAVIS, GLENN E., AND STOVER, E. L.—A Simple Apparatus for the Steam Method of Softening Woods for Microscopic Sections.....	87
EATON, SCOTT V.—Effects of Sulphur Deficiency on the Growth and Meta- bolism of the Soy Bean.....	88
FERNALD, EVELYN I.—A Preliminary Report of a Study of the Plants of Winnebago County, Illinois.....	89
GUMBART, LOUIS F.—Some Thoughts on Popularizing Botany.....	90
HENBEST, ORRIN J.—Size and Ornamentation of Some Modern and Fossil Lycopod Spores .....	91
JENSEN JENS—Wild Life Sanctuaries.....	93
MARKS, ICA, AND STOVER, E. L.—Collection of Fleshy Ascomycetes from East Central Illinois.....	95
MAUNTEL, HARRY W.—Conservation of the Wild Flowers of Illinois.....	97

	PAGE
FULLER, GEORGE D., AND LEADBEATER, MARGARET—Some Effects of Fuel Oil on Plants .....	99
NOÉ, A. C.—Some Paleozoic Gymnosperm Seeds and Their Evolution....	100
PEIRCE, ALAN S.—Types of Pitting in Conifers.....	101
SCHMITKONS, KATHERINE LOUISE—The Origin of Adventitious Roots from Leaf Cuttings of <i>Saintpaulia ionantha</i> Wendl.....	105
SCHOPF, JAMES M.—The Paleobotanical Significance of Plant Structure in Coal .....	106
SHULL, CHARLES A.—Germination Behavior of the Rose Mallows.....	111
STANFIELD, J. FISHER—The Range Indicator Method in pH Determinations of Plant Tissues.....	113
TURNER, LEWIS M.—The Status of the Southern Shortleaf Pine in the Ozark Region .....	115

### PAPERS IN CHEMISTRY

EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN.....	117
ENGLIS, D. T., AND FRIEDMAN, BERNARD S.—The Detection of Fortification or Adulteration of Meat Broth with Monosodium Glutamate.....	119
LONG, A., AND AUDRIETH, L. F.—Reactions in Fused Pyridine Hydrochloride .....	121
LONG, H. J., AND TENNEY, HORACE M.—Some Tests for Metal Ions Making Use of Organic Dyes.....	123
PACINI, AUGUST J.—Some Physiological Responses to Vitamin E Feeding.	125
QUILL, LAURENCE L.—An Inexpensive Ball Mill for General Use.....	127
REED, FRANK H., AND FINGER, G. C.—Illinois Fluorspar as a Chemical Raw Material .....	129
REEDY, J. H.—Micro Methods in Qualitative Analysis.....	131
SCHMIDT, MARVIN T., AND AUDRIETH, L. F.—Onium Salts as Acids—Reactions of Ammonium Chloride at Higher Temperatures.....	133

### PAPERS IN ECONOMICS

EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN.....	135
KELLOGG, H. L.—Occupational Changes in the Gainfully Employed Population of Illinois from 1870 to 1930 with Economic Consequences.....	137
LINDSTRUM, D. E.—The Future Population in the Agricultural Industry in the State of Illinois.....	141
VOSKUIL, W. H.—Population Problems in Illinois Mining Communities..	143
NEWTON, WILLIAM A.—Industrial Opportunities in Illinois for the Absorption of a Growing Wage-Earning Population.....	145

### PAPERS IN GEOGRAPHY

EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN.....	147
BLANCHARD, W. O.—Palestine in Transformation.....	149
CHURCH, PHIL E.—Surface Temperatures of the Gulf Stream and the Waters on its Margins.....	151
ODELL, CLARENCE BURT—A Field Study of Bloomington-Normal.....	153
PLATT, ROBERT S.—A Guatemalan Banana Farm.....	159
POGGI, E. MURIEL—London and Paris: A Comparison of Their Locations.	161
ROBINSON, MARY A.—Industrial Survey of LaSalle-Peru-Oglesby.....	163
ROSE, JOHN KERR—Corn Yield and Climate in Illinois.....	165
CUTSHALL, ALDEN D.—A Gazetteer of the Origin of Illinois Nomenclature.	167

PAPERS IN GEOLOGY

	PAGE
EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN.....	169
NOÉ, A. C.—Some Recent Attempts to Correlate the Later Paleozoic of America and Europe.....	171
SCHOPF, JAMES M.—Spores Characteristic of Illinois Coal No. 6.....	173
MCCABE, W. S.—Results Obtained by Chromic-Sulphuric Acid Etching of Illinois Coals .....	177
FISHER, D. JEROME—Geologic Dating of Time of Coalification.....	179
BALL, CLAYTON G.—Possible Relations of Mineral Matter in Coal to the Time of Coalification.....	181
BELL, ALFRED H.—Status of the Carbon-ratio Theory in Illinois.....	183
THIESSEN, GILBERT—Temperature During Coal Formation.....	184
BENSON, E. T.—Local Calorific Variations in Coal No. 6.....	186
MCCABE, LOUIS C.—Significance of Banded Ingredients in Coal.....	188
WELLER, J. MARVIN—"Grassy Creek" Shale.....	191
POWERS, WILLIAM E.—Geological Setting of the Aurora Mastodon Remains .....	193
SMITH, CLARENCE R.—Mastodon and Other Finds at Aurora.....	195
HOUGH, J. L.—The Bottom Sediments of Southern Lake Michigan.....	197
SHEPHERD, G. FREDERICK—A New Medium for Teaching Geology in the Middle West .....	198

PAPERS IN MEDICINE AND PUBLIC HEALTH

EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN.....	199
BEARD, J. HOWARD—Rickets: Its Cause, Effect, and Prevention.....	201
BRANNON, J. M., AND PRUCHA, M. J.—Studies in Milk Pasteurization....	203
GAULT, ROBERT H.—Implications of Vibro-Tactile Phenomena.....	205
TORREY, J. P., AND GRAHAM, ROBERT—Results of Examining Pasteurized and Unpasteurized Milk for <i>Brucella abortus</i> .....	207

PAPERS IN PHYSICS

EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN.....	209
ANDERSON, SCOTT—A Convenient Chart for Correcting Barometer Readings .....	211
BOYAJIAN, J. A.—On Growing Bismuth Single Crystals.....	213
CARPENTER, BENJAMIN—The Atomic Beam as a Spectroscopic Source....	215
CREW, HENRY—An appraisal of the Definitive System of Units.....	217
BOOMER, S. E.—Ripple Tank Experiments.....	224
CROW, LEONARD—Rotating Magnetic Fields.....	225
CROW, LEONARD—A Polyphase Electric Gun.....	227
FREEMAN, IRA M.—Some Topics in Physiological Mechanics.....	229
GRAY, WILLIAM T.—The Temperature of the Gas in an Interrupted Carbon Arc .....	231
MACHLER, R. C.—A Modified Form of Fabry-Perot Interferometer.....	233
MARSH, CHARLES R.—An Easily Constructed Oxygen Liquifier.....	234
OVERBECK, CLARENCE J.—Design of Some Elementary Physics Laboratory Apparatus .....	235
RAILSBACK, O. L.—Protection of Multiple-Scale Voltmeters in the Laboratory .....	237
VERWIEBE, FRANK—Models of Thermodynamic Surfaces.....	239

## PAPERS IN ZOOLOGY

	PAGE
EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN.....	241
ADAMS, L. A.—Dental Variations of the Dog.....	243
FARRAR, M. D., AND MCGOVAN, E. R.—Rearing Codling Moth Larvae for Testing Insecticides .....	245
BALDUF, W. V.—The Bionomics of the Ladybeetles.....	248
BONNELL, CLARENCE—The Occurrence of the American Eagle Along the Ohio River in Illinois.....	249
ESSENBERG, J. M.—The Effect of X-rays on the Incubation Period, Sexual Development, Egg-laying Capacity and Brooding Tendencies in White and Brown Leghorn Chickens.....	251
FURROW, CLARENCE LEE—Sex Conditions in a Japanese Valvata.....	253
MATTOX, NORMAN T.—Annular Rings in the Long Bones of Turtles and Their Correlation with Size.....	255
MILLER, DOROTHEA S.—Modifications Induced in the Plumage of <i>Passer</i> <i>domesticus</i> (Linnaeus) by Experimental Hyperthyroidism.....	257
PENNINGTON, MARGARET S.—Visual Cells of a Nocturnal Animal.....	259
ROSS, HERBERT H.—An Illinois Marsh Willow Sawfly ( <i>Amauronenatus</i> <i>lineatus</i> ) .....	261
VAN CLEAVE, HARLEY JONES—Some Interesting Pre-Linnean Names.....	263
MIZELLE, JOHN D.—The Destruction of Bird Life by Hail.....	266
• WALTON, A. C.—A New Species of <i>Zanichlophorus</i> from <i>Cryptobranchus</i> <i>alleganiensis</i> .....	267

## PAPERS IN AGRICULTURE

---

### EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN

The program of the Agriculture Section consisted of a symposium of seven papers on the general topic, "Problems of Seed Production in Illinois."

All but the following paper are represented herein.

"Production of Hybrid Seed Corn," by Earl G. Sieveking.

The group expressed a preference for the symposium type of program. Attendance at the meeting averaged about twenty-five.

Dr. James R. Holbert, Senior Agronomist of the United States Department of the Interior, Bloomington, Illinois, was elected chairman of the section for the year 1935-36.

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



# Physiology of Seed Germination

C. F. Hottes

*University of Illinois, Urbana, Illinois*

## ABSTRACT

The subject of seed germination is one of perennial interest to agriculturists and botanists alike. An awakening interest in recent years has added much to our knowledge of the intricacies of the physiologic processes upon which germination depends, and has extended our understanding of seed maturing, injury, storage, and treatment to such an extent that certain principles of practice have become universal. But with all this progress many of the crucial problems of seed storage, seed bed preparation, effect of climatic factors before and after seeding, seed treatment on yield, etc., are still unsolved. The investigations of the future can most appreciably be advanced by a deeper study of the reactions of the living protoplast to external and to internal conditions.

We must recognize the seed as a highly specialized structure whose partially developed plantlet is held dormant by mechanical and biological factors. It is a knowledge of these factors and their effects on germination that has recently added so much of enduring value to applied plant science. A more intimate appreciation of the complex manner in which the living substance, through internal adjustment meets the diverse factors of the environment, is, and must be, our goal. The fact that the same factor acting at different times has a vastly different effect on the germination process, clearly indicates that the physiological phases of the protoplast must receive more consideration.

## Canada Thistles in Illinois

Joseph E. Barnes

*Illinois State Seed Laboratory, Springfield, Illinois*

### ABSTRACT

The United States Chamber of Commerce reports that the combined losses due to insect pests and plant diseases in the field are less than those caused by weeds alone. So, in Illinois seed production is inseparably related to the Canadian thistle problem and this is the season of the year for people to become weed conscious and plan for a more concentrated attack on the worst field weed in our State.

A year's survey, based on reports submitted by thistle commissioners throughout the state, shows there are today in Illinois 100,000 acres of Canadian thistles, the equivalent of four and one-half townships, approximately 156.4 square miles. Laid end to end they would reach from Bloomington to St. Louis.

The thistles are scattered over fifty-six of our best farming counties in patches varying in size from a rod square to 120 acres. The average size of patches in the industrial counties is 15 acres compared to one acre in the rural counties.

Consider some of the reasons for the widespread occurrence of the pest. Illinois people definitely are not weed conscious and have considered this weed a minor problem.

Of the fifty-six counties reporting last year, ten of the largest and most populous contained more than three times the acreage of thistles reported by remaining counties. In these ten counties fifty-five per cent of the land was farmed by the resident owner and forty-five per cent by tenants. The spirit of cooperation was poorer among owners than tenants.

The spread of Canadian thistles in seven of the ten counties has been influenced by the fact that much land there is owned by non-resident groups and, consequently, the system of agriculture is different.

Administration of the thistle problem has been at fault for the local authorities have not complied with the provisions of the law. In fact, fifty-two per cent of the local commissioners did not report on the situation in their communities. The local boards of supervisors failed to appoint commissioners of high calibre.

Administration officers are elective and many fail to enforce the law if their chances for re-election are endangered. So, local authorities defeat any attempt that may be made for an honest, efficient control of their own problems.

Mail order seed is another source of dissemination of Canadian thistles. Farmers who were attracted by price quotations to purchase such seed cause much damage in their community. "Back-fence trading" and buying from "fly by night" truckers hasten the spread of this weed.

In our haste to increase production we have forgotten a tenet of agriculture; namely, that a well-cared for acre yields as much as two that are poorly farmed. Our crops are gently nurtured plants that cannot, as a rule, withstand the savage competition of thistles.

The present methods for control measures are hopelessly inadequate to cope with this existing situation. May I in closing, mention some constructive ideas which if adopted and used persistently, will successfully destroy thistles and reclaim much good farm land that has become of marginal value in the last 25 years.

(1) Develop a long time program for weed control that will be consistently maintained.

(2) Under this program provide educational information free to the public. Establish demonstration plots in each township to be controlled by the township.

(3) Adopt a centralized planting committee manned by energetic, intelligent men to regulate control.

(4) Revision of the law so that the weed control program may be maintained and individual recalcitrants handled so that their weeds are taken care of and charged to their tax bill.

(5) Align the State's Attorney's Association so that they will adopt a definite stand and really support local officers in their control plans.

(6) Appoint weed commissioners for a term of 4 years so that they will be able to know the individual history of each case and really be able to plan adequately to care for each case. Appoint only capable men to this position.

(7) Solicit co-operation of owners of all farms, railroads, airports, sub-divisions, golf courses and resorts to cooperate in the program.

(8) Exercise the section of the law, condemning bringing in seed having noxious weed seed in it from out of State, making it a criminal offense.

(9) Inclusion of a course on weeds and weed control at all State schools and the University, making it a prerequisite.

(10) Provide for research on the ecologic and bionomic importance of weeds.

(11) Adopt the county committee plan as has been done in Boone County wherein the noxious weed committee handles all cases where the Commissioner is unable to secure co-operation.

(12) Maintain a weed council whereby the Farm Bureaus, the University, seedsmen, farmers and the State may convene to attack and solve the weed problems.

## Effect of Seed Coat Injury on Germination, Vigor, and Yield of Corn

Benjamin Koehler

*University of Illinois, Urbana, Illinois*

Within the last twenty years, it has been determined by experiments conducted by a number of investigators that by selecting a corn type somewhat smoother in indentation of kernel and with a higher proportion of horny endosperm than the prevailing types, improvement could be made in field stand and vigor of plants, as well as in yield and quality of grain produced. There seems to be general agreement that a relatively horny endosperm is an important factor in increasing resistance to certain ear rots and checking some important seedling diseases. There remains a question in the minds of many, however, as to whether the type of kernel indentation has anything to do with the matter.

Corn ears that feel rough to the hand have the seed coats of the kernels puckered into sharp ridges at the crowns. These ridges are frail, and in ordinary handling of the ears, the seed coat becomes broken on many kernels. In fully matured smooth types of corn, seed coat injury from reasonable handling does not take place at all.

In an investigation of this subject, data were collected on seed coat injury in the seed planted by a group of 200 Illinois farmers. These samples had been collected at random for another purpose at corn planting time. As an average of all 200 samples, 9.7 per cent of the kernels had the seed coat broken at the crown. The 10 samples with most injury averaged 26.4 per cent breakage, while the 10 best samples averaged only 0.6 per cent.

Previous experiments on the effect of seed coat injury in corn used for seed were few in number, and the results were not all in agreement. Certain experiments were therefore organized by the writer to obtain better information on the effect of seed coat injury in planted seed on the resulting crop.

A considerable number of ears of corn were used in the tests conducted for two years. The kernels were counted so that each ear was represented equally in each plot. Some of the kernels from each ear were injured. Injuries included shaving off the whole crown surface, removing one-fourth of the crown surface, puncturing the seed coat at the crown with a sharp awl, removing a little of the seed coat from the side where only horny endosperm was exposed, and removing the tip cap where the kernel is attached to the cob, thus exposing the dark tissue which covers the germ, but not exposing the germ itself. The remaining kernels from each ear were used as an uninjured check. Forty hills, planted three kernels per hill, constituted a plot, and there were nine replications in each experiment. Growing conditions in both seasons were unusual. In 1933 the soil was exceptionally wet at planting time, but became excessively dry during the summer. In 1934 the soil was barely damp enough for germination at planting time and drought continued until mid-summer. One would expect seed coat injury to be a factor primarily in the seedling stage. Although moisture conditions at planting time were very different in the two years, the results were similar (Table 1).

Seed coat injury at the crown of the kernels caused a significant reduction in yield in each case, even though the seed coat was only punctured. The reduction in yield was brought about by a reduction in stand and also a reduction in the vigor of the growing plants. Where the seed coat was removed from the whole crown, the reduction in stand, resulting from this injury, was 8.6 per cent, the reduction in height of plants when the plants were about waist high was 5.9 per cent, and the average reduction in yield of grain at harvest time was 20.7 per cent.

When the seed coat was removed from a small area on the sides of the kernels where only horny endosperm was exposed, the plants seemed to grow normally. No significant reduction in stand or yield was found. Removal of the tip cap may possibly have had a slight detrimental effect on the crop grown from kernels treated in such manner, but these tests so far have not settled this point, for the reductions found were not statistically significant.

The above results were obtained by planting unsterilized kernels in ordinary dark corn-belt soil in a rotation growing corn twice in every four years. In the same tests some of the seed was disinfected with ethyl mercury phosphate. This is a dry dust that stays on the surface of the kernels and protects the kernels at least to some extent from infection in the soil. Seed with injured seed coats treated with this disinfectant gave results nearly equal to those from uninjured seed (Table 1).

TABLE 1—EFFECT OF SEED COAT INJURY ON THE YIELD OF DENT CORN  
*Illinois Agricultural Experiment Station, Urbana.*

Nature of seed coat injury	1933		1934	
	Acre yield	Reduction in yield from injury	Acre yield	Reduction in yield from injury
<b>Seed Not Disinfected</b>				
	<i>Bushel</i>	<i>Per cent</i>	<i>Bushel</i>	<i>Per cent</i>
None.....	50.8		49.4	
Whole crown removed.....	39.0	23.2*	40.4	18.2*
One-fourth crown removed.....	46.5	8.5*	41.0	17.0*
Crown punctured.....	44.5	12.4*	41.5	16.0*
Tip cap broken off.....	48.8	3.9	48.5	1.8
Cut in side of kernel.....			48.9	1.0
<b>Seed Disinfected With Ethyl Mercury Phosphate</b>				
None.....	50.5	0.6	48.2	2.4
Whole crown removed.....	50.0	1.6	49.2	0.4
One-fourth crown removed.....	47.8	6.0	48.9	1.0

\* Odds of probability greater than 30 to 1 that the reduction is significant.

The soil is inhabited by a great number of microorganisms and the nature of this population is influenced by many factors. Therefore, it would not be surprising if the results obtained from planting crown-injured corn at different times and places might give various results. Fungus isolations were made from the internal tissues of injured kernels several weeks after planting. Various *Penicillia* were especially abundant in these isolations, and frequently *Penicillium oxalicum* was recognized. Inoculations were made on injured seed with pure cultures of a number of fungi just before the seed was planted. These inoculation tests were made in the greenhouse and also in the field. *Penicillium oxalicum* caused very severe stunting and seedling

blight, regardless of whether the inoculated corn kernels were planted in wet, intermediate, or dry soil. Other *Penicillia* investigated so far were nearly harmless. *Aspergillus flavus* and *Aspergillus tamaris* gave a striking effect, except in dry soil, in that they produced virescent plants (plants partly white or cream color). *Gibberella saubinetii*, on the other hand, caused severe stunting and seedling blight only in dry soil. From results so far obtained in these tests, it seems logical to conclude that *Penicillium oxalicum* is an important cause of the harmful effects observed from planting corn with the seed coat injured at the crown, but it is likely that some other organisms may also be of importance.

**Conclusions.**—Rough-eared seed corn is easily injured in handling, and kernels having seed coats injured at the crown, when planted, are much more severely injured by a number of fungi than kernels with sound seed coats. This, no doubt, was one of the important factors involved when in earlier work it was found that the field performance from rough ears was not usually so good as from smoother ears. With the development of good corn-seed disinfectants in recent years, the harmful effects from seed coat injury can largely be eliminated.

# The Purity of Illinois Seed Stocks as Revealed by Seed Analysis Studies

L. A. Moore

*Superintendent, Division of Plant Industry,  
Department of Agriculture, State of Illinois*

The Illinois Law on agricultural seeds applies to the seeds of small seeded legumes, grasses, rape and seed corn. Little attention has been given to seed corn because of the limited facilities of the laboratory. This discussion is limited to the seeds of our common meadow and pasture crops.

Between July 1, 1934 and April 23, 1935, the Illinois Seed Testing Laboratory analyzed 7,828 samples of seeds used in meadows and pastures. Of this number 1,045 samples or 13.2 per cent were unsalable for seeding purposes in Illinois. Section 5 of the Illinois Seed Law states that: "It shall be unlawful to sell, offer or expose for sale for seeding purposes within the State of Illinois any agricultural seeds or mixtures of same containing Canada thistle in greater numbers in the aggregate than one to fifty grams; quack grass, dodder, wild mustard, wild carrot, buckhorn, dock, field sorrel, ox-eye daisy or Johnson grass, in greater numbers in the aggregate than the proportion of 1 to 1,000. Provided, however, that the proportion of field sorrel in alsike, timothy and white clover be not greater than 1 to 500."

To comply with section 2 of the law any container of agricultural seed must have a tag or label showing the approximate number per ounce of each kind of the seeds of the following named noxious weeds, except Canada thistle, which are present singly or collectively, as follows: (1) in excess of one seed in each five grams of red clover, mammoth clover, white clover alsike clover, sweet clover, alfalfa, lespedezas, timothy, blue grasses, brome grass, orchard grass, red top, fescues, oat grass and rye grasses; (2) one in twenty-five grams of rape, sudan grass and millets; (3) one in one hundred grams of vetches. Noxious weed seeds are defined as seeds of buckhorn, field sorrel, Canada thistle, quack grass, docks, ox-eye daisy, dodders, wild mustard, Johnson grass, wild carrot.

If this requirement is met, the law provides a very liberal tolerance. It allows the sale of seed containing nine Canada thistle seeds per pound in any kind of seeds. In this instance the limitation is expressed in weight. Other noxious weeds are tolerated in the ratio of one to one thousand. On this basis, the number of noxious weed seeds per pound varies. Alfalfa may contain 208 noxious weed seeds per pound, blue grass, 2,192, red top 3,372, timothy 1,216, red clover 304, sweet clover 368 and lespedeza 264. It is quite obvious that at the average rate of seeding for these crops from 2,000 to 33,000 weed seeds may be sown per acre and yet be within the law.

A further tolerance in favor of the dealer or seller of seeds is provided in section 2, paragraph d of the seed law; for example Canada thistles may be present in a smaller proportion than 1 to 50 grams or other seeds may contain as many as 96 noxious weed seeds per pound without the information being given on the tag. Seed that complies with the requirements of the Illinois Seed Law is not always pure seed. The law establishes

a maximum amount of weed seeds that may be present in seed to be sold for seeding purposes in Illinois. The analyses of all the samples of the principle crop seeds show a wide range of purity. The following table shows the total samples of each crop analyzed and the percentage unsalable:

	Total	Percentage unsalable
Red Clover .....	4,170	16.1
Sweet Clover .....	1,173	4.4
Alfalfa .....	786	5.3
Alsike .....	259	10.3
Timothy .....	753	15.4
Lespedeza .....	747	18.3
Total .....	7,888	Av. 13.2

The percentage of unsalable samples per year varied from 9.9 per cent to 15 per cent with an average of 11.7 per cent for the last 7 years. Seasonal effects on the quality of the seed and weed growth may account for the variation. With the great improvement in seed cleaning machinery and its distribution throughout the State, an improvement in the quality of seed is anticipated.

There are three sources of seed supply for Illinois purchasers. First, the producer, second the Illinois seed dealer, and third the seed dealer outside of the State of Illinois, chiefly mail order houses. Section 12 of the Illinois Seed Law specifies that only samples of recleaned seed may be submitted to the laboratory for purity analysis. Consequently the analyses made by the laboratory are of samples purported to represent seed which has been cleaned. It is well known that many farmers and some dealers do not take cognizance of the seed law. Many illicit sales have been made. Very frequently such sales are discovered by inspectors who take official samples and submit them to the laboratory for analysis. These are designated as inspector's samples and 35 per cent of them have been unsalable. The total number of sales of this nature is hard to estimate, but we can say that seed from this source is usually of inferior quality due to the presence of weed seeds and inert matter. Recently a sample of alfalfa representing such a sale showed 27 per cent weed seeds and 4 per cent inert matter. It is interesting to note that in this instance there are no noxious weed seeds present. Many other examples may be given to convince one that this source of seed is unreliable.

Since the service of the Illinois Seed Laboratory is furnished free of charge, we feel that a producer or dealer who sells seed without a proper analysis shows lack of responsibility to agriculture and contempt for the seed law, consequently a number of prosecutions have been made during the past season.

Producers especially in Northern and Central Illinois have been making use of the seed testing laboratory in increasing numbers. Of all farmers' samples submitted during the past year, 13.6 per cent were unsalable compared to 6.9 per cent of all samples submitted by recognized wholesalers in Illinois and 2.9 per cent for out of state dealers.

The unfavorable showing of the Illinois dealers when compared to dealers from other states is due to the fact that many Illinois wholesalers submit samples of farm-cleaned seed for analysis before purchasing from the producer. While some dealers from other states have supplied only seed of high quality, the "out of state" dealers are the principle source of low quality seed so far as the records of the laboratory reveal. For example, the supply of one mail order house is represented by 15 mixtures, all containing noxious weed seeds, with seven of them unsalable; 12 samples of alfalfa with 10 containing noxious weed seeds and 2 unsalable. The average germination of the alfalfa was 55 per cent; of sweet clover 48 per cent

with the other crops running from 15 to 30 per cent below standard. The average germination on all seeds from Illinois dealers is 93 per cent and of all Illinois farmers' samples 86 per cent. Of 22 lots of alfalfa taken from Illinois wholesale dealers none were unsalable; 4 showed the presence of noxious weed seeds and the average germination was 80.5 per cent. Of 10 lots of sweet clover, none were unsalable, 3 contained noxious weeds and the average germination was 83 per cent.

To give briefly, an idea of the purity of seed stocks in Illinois the following table is presented—100 salable samples of each crop taken at random are considered:

TABLE 1

	Per cent purity	Percent weed seeds by weight	Per cent inert	No. of samp. containing noxious weeds
Red Clover.....	97.69	.50	1.33	50
Sweet Clover.....	97.4	.56	1.8	24
Alfalfa.....	98.0	.51	.93	21
Timothy.....	98.0	.41	1.12	66
Lespedeza.....	97.58	1.18	1.15	53
Alsike.....	97.01	.25	2.05	40

From the data submitted, it appears that wholesalers equipped with modern seed cleaning machinery are the best source of seed supply. However, farmers who avail themselves of good custom cleaning facilities may supply seed of high quality. Without question the mail order house supplies seed of lowest quality.

The production of high quality seed is largely a matter of weed control and it is important that Illinois become weed conscious.

## Sweet Clover Seed Production

Walter A. Newlin

*Casey Township High School, Casey, Illinois*

The production of sweet clover seed in Clark County began in 1921 by a farmer who harvested 13 acres with a grain binder after it had been pastured rather heavily with cattle. The field made 25 bushels which sold for eight dollars per bushel. The same method tried in fields that had not been pastured with live stock grew so rank that a binder could not handle it. A demand for home grown seed brought a study of other methods of harvesting the seed.

Since the seed shatters easily, forms of beater type machines were developed. The first one, built by a farmer, was a large box on which was attached a reel that was driven by a chain from the drive wheel of the tractor. It was successful but expensive to build and could be operated only with tractors. Another beater made to push ahead of horses proved impractical. In 1924 the vocational agriculture department of the Casey Township High School constructed the binder type beater which can be drawn by horses or tractor. This machine was made on the frame of a discarded 6-foot binder. It beats the seed into a cage and drags the plants down to be plowed under for fertilizer. The cost of construction varies from thirty to fifty dollars.

The time to harvest sweet clover seed with a beater type machine is when the greatest amount of ripe seed is found on the plants. This is hard to determine since the seed does not always ripen evenly. Too early harvesting gives much green seed of poor quality, yet waiting for more to ripen permits some of the earlier plumper seed to be shattered. The seed is beaten onto an enclosed platform and is removed from the harvester at one end of the field through a door at the rear of the machine into a large flat box where it is run through  $\frac{1}{4}$ -inch hardware cloth into a wagon box to remove the coarser trash and leaves. The seed should be spread on a floor to a depth of not more than 6 to 10 inches, depending upon the amount of green material, and should dry for two weeks when it may be bunched or cleaned with a fanning mill and hulled if desired. Very little seed is hulled now except that sold to seed dealers.

Sweet clover seed that is to be hulled and scarified is usually run through a machine which blows the seed against sand paper. Regular threshing machines and Letz feed grinders are sometimes used. One hundred pounds of good clean seed in the hull will make from 70 to 75 pounds of seed when hulled, depending upon the quality.

The yield of seed varies with weather conditions and types of soil. Our largest yield was eight bushels of scarified seed per acre in 1926 from a 5-acre patch. Other yields have varied from nothing to 5 bushels, and the average is about 2 to 4 bushels. We have never determined the amount of seed that is shattered on the ground by harvesting, but when followed by wheat a fine stand of volunteer clover is obtained.

Only the large white blossom biennial is grown in our section where it is true to type and generally free from disease. Other varieties have not given satisfactory results. We need a strain of the large white blossom

biennial which will mature at least a month later than it does at present, providing a pasture period for live stock through the driest part of the season when it is most needed.

The vitality of the seed deteriorates after it is hulled and scarified, depending upon the severity of scarification. Seed three years old has turned a reddish-brown and when sown in the field gives a poor stand. The unhulled seed retains its vitality much longer, as shown by germination tests made on seed that was ten years old when hulled and scarified. When all our seed came from the northwest, only hulled and scarified seed was sown because the seed coat was so hard that moisture could not penetrate and very poor stands resulted from unhulled seed. About 1925 farmers began seeding unhulled seed with winter wheat during the last of February and the first of March at the rate of 15 pounds per acre, obtaining good stands, but hulled and scarified seed sown in wheat at the same time germinated more readily and was frozen. Sowing unhulled seed with oats after all freezing and thawing is over is being practiced by more than half the farmers of our community with good results. It may be that after being grown under our more humid conditions the plant has become acclimated to such an extent that the seed coat is softer than on seed produced in the northwest.

Types of soil and weather conditions play an important part in the production of sweet clover seed. Clover fields which ripen evenly and hold the seed always produce the best yields even if the stands are not so good. Clover with these characteristics is usually found on the poorer type of soil, as gray silt loam. In fields with good brown silt loam soil you will find good stands with ripe seed, green seed, and bloom all on the same plant, so that there is never a time when seed can be harvested. The product is either of poor quality large red seed which is worthless or immature seed which will not grow.

Weather is important. A day of strong wind when a field is ripe may shatter the seed so badly that it is not worth beating off. Rains ten days to two weeks before the seed begins to ripen (on clover grown on gray silt loam), cause the plants to start reblooming and the seed aborts as it ripens. Rainy seasons give the same results.

In conclusion it may be said that sweet clover seed can be produced economically when grown on gray silt loam provided there are no heavy rains ten days before the seed ripens and no strong winds at harvest time. The seed should be harvested with a binder type beater. One of the greatest benefits that can come to a live stock producer is for some one to develop a strain of sweet clover which will mature one month later than our large white blossom biennial matures at the present time.

# Insects in Relation to Production of Red Clover Seed

J. H. Bigger

*Illinois Natural History Survey, Urbana, Illinois*

In preparing the following manuscript the author has in mind that the only consideration to be dealt with is the production of seed of red clover. The factors considered, their effect on the plant, and recommendations offered are based entirely on that premise. The suggestions do not in all cases agree with those that would be made where red clover is used as a hay and fertility-maintenance crop.

Red clover is attacked by insects at various stages of growth and almost continually during its entire life. The production of seed by the plant is affected either directly or indirectly in several ways and several factors influencing the development of a good crop of seed are affected.

## EFFECT OF INSECTS ON STAND

One of the primary requisites for a satisfactory seed crop is, of course, the development of a good stand of plants in the field. This may be affected by insects at two times.

**Leafhoppers.**—First, during the seedling stage and the remainder of its first season of growth red clover is attacked by the Potato Leafhopper, *Empoasca fabae* Harris. The amount of damage done by this insect can and does determine whether or not the crop will survive to produce any growth at all, or whether the growth that does survive will be strong and healthy. The plant is also affected during the second year of growth, soon after the first cutting, at which time the leaves are affected by so-called 'tip-burn' or 'yellows'. The damage may develop to the extent of practical destruction of the plant.

Prior to 1927 this was considered a physiological condition. At that time it was found that this condition was directly caused by the Potato Leafhopper mentioned above. Research demonstrated that foreign clovers were unable to survive the attacks of these insects, but that native strains of red clovers could survive under most field conditions. This work has been previously reported.<sup>1</sup>

The use of native strains of red clover seed will largely prevent serious losses from this cause.

**Clover Leaf Weevil.**—During the fall and winter of its first season and the spring of the second season red clover is attacked by the larvae of the Clover Leaf Weevil, *Hypera punctata* Fab. The adults of this insect deposit their eggs in the mature, hollow stems of the clover plant during September. A portion of the eggs hatch during the fall, while the remainder stay in the stems until the following spring before hatching. Those larvae which have hatched spend the winter in the trash under the plants.

<sup>1</sup>Hollowell, E. A., Monteith, John Jr., and Flint, W. P., Leafhopper injury to clover. *Phytopath.* 17, 6, 399-404, June, 1927.

The losses are caused by the feeding of the larvae on the leaves. The larvae are small, green, footless worms with a white or yellowish stripe down the back. They feed during the nights or on dark, cloudy days. During the day they are usually found curled up in the base of the plant or in the trash under the plant.

During long, cool springs the damage by the insects is frequently so severe as to cause total destruction and death of the plants. In 1927 hundreds of acres of red clover were plowed under because of this condition.

Farmers have found that much of this damage may be prevented by burning over the stubble during the winter. If this is done while the plants are fully dormant they survive this treatment, but if they have started to grow they will be killed by it. Spraying of the plants with an arsenical poison would produce control, but is not economical under present conditions. The insects are frequently controlled by a fungus disease which will develop on them during warm, wet weather. This is the most common check to an outbreak.

Clovers other than red clover do not suffer as badly as this crop, especially in mixtures.

### EFFECT OF INSECTS ON THE NUMBER OF BLOOMS

Another essential to the production of seed is the development of a large number of heads in which the seed may be produced. This depends, of course, on the general condition of the plants and is indirectly affected by the Clover Leaf Weevil as described above. It is also directly affected by the Lesser Clover Leaf Weevil, *Phytonomus nigrirostris* Fab.

**Lesser Clover Leaf Weevil.**—The adults of this insect are small (about  $\frac{1}{8}$  inch long) snout beetles covered with green hairs so that it appears green to casual observation. The adult spends the winter in trash in hedgerows, fence rows and, to a certain extent, in the trash under clover plants in the field.

The eggs of the insect are deposited in the inter-epidermal layer of the stems during mid-April to mid-May and hatch in 2-3 weeks into footless, maggot-like worms, whitish in color, with a black head and a black or brown line across just behind the head. When taken from the plant they lie in a crescent shape in the hand.

Much of the feeding of these insects is done in the axils of the leaves and stems. They burrow into the stem just below where the bloom is forming and either cut off the stem or entirely devour the newly-formed bloom before it develops beyond the leaf-axil.

The importance of the insect may be shown by the results of a single survey trip June 3-4, 1929 in western Illinois where it was found that 17.3 per cent of the stems and 58.2 per cent of the blooms were infested, and 33.6 per cent of the blooms were completely destroyed. Other and similar observations could be quoted from other years, the infestation varying, of course, from season to season.

Much of the damage can be avoided by delaying the development period of the clover by pasturing lightly until about May 1st. Some benefit should be obtained by destroying the adults in the winter by cleaning up the hedges and fence rows and burning the stubble.

### EFFECT OF INSECTS ON CONDITION OF BLOOM

After the clover blooms have developed it is essential that they remain intact if they are going to produce a satisfactory crop of seed. The Clover Head Caterpillar, *Grapholitha interstinctana* Clem., attacks the plant in this stage.

**Clover Head Caterpillar.**—This insect attacks the red clover plants both fall and spring. In the fall they feed in the crowns of the plants, reducing the vitality of the plants so that they are not able to withstand winter as well as they might, and this is important. But the greatest damage as a red clover seed pest is the feeding on the blooms in the spring and summer.

There are three generations of the insect. The fall larvae hibernate and produce moths in the spring which lay eggs at the base of the developing florets. The larvae from these feed in the flowers at the base of the florets and cut them off, thus destroying their ability to produce seed. The adults of these develop in time to attack the normal second crop of red clover heads and damage them, and the third brood of adults appear in time to produce the over-wintering larvae in late blooms in the fall or on tender shoots at the base of the plants.

The importance of this insect is indicated by survey figures. For instance, in 1923 in western Illinois 33 per cent of the first crop blooms were attacked. In 1924 as high as 86 per cent of the heads were infested. In 1926 54-70 per cent showed damage, and 23 per cent were infested in 1928. Certain counts showed that about 7 per cent of the infested heads are completely destroyed.

Certain important records were made in 1927. In that year first crop clover showed 1.5-2.7 per cent of infested heads, but second crop clover developed 17.2-23.6 per cent infested heads on several counts. The damage that year was light but the increase between the first and second crop infestations is rather spectacular.

It is not supposed that all losses caused by this insect can be averted, but they may be reduced by: (1) Destroying the over-wintering generation by fall clipping and removing volunteer crops by plowing clover fields in the fall; (2) delaying the development of blooms in the spring by clipping or pasturing; (3) the use of first crop clover for the seed crop and avoiding the heavy second brood damage.

#### DIRECT EFFECT OF INSECTS ON SEED

Finally, the seed produced must be plump, healthy, mature seed. Two insects may be responsible for the destruction of the seed of red clover after or just as it is being formed, namely, the Clover Seed Chalcid, *Bruchophagus funebris* How., and the Clover Seed Midge, *Dasyneura leguminicola* Lint.

**Clover Seed Chalcid.**—The adult of the Clover Seed Chalcid is a small, black, four-winged fly to be seen about the maturing heads of red clover. There are at least three broods of the insect occurring on the first crop, second crop, and volunteer heads of the fall crop. The generations are not distinct.

The damage is done by a tiny, white, footless maggot which lives inside the seed, causing a total loss of each seed so infested. The seed is very light or broken and only the hull is left. These are blown out by the fan in threshing and constitute a large part of the seeds which go into the straw pile and cause the farmer to think that he is getting 'a poor job of threshing'.

Losses from this insect vary greatly from year to year, but may be very serious. Records show infestation, and consequent loss of 18.8 per cent of the seed in 1925, 12-15 per cent in 1927, and 16.6 per cent in 1928. These are estimated to cause a reduction in yield of approximately a peck an acre, and are for first crop clover. Second crop records are not available, but it is observed to be more severe than the first crop.

These losses cannot be entirely eliminated, but certain practices will be of benefit: (1) The use of the first crop for seed will avoid the heavy second brood damage; (2) clipping or pasturing in the fall to remove the overwintering population will reduce the number present the following spring; (3) destroying the straw stacks into which much of the infested seed is blown will remove that many.

**Clover Seed Midge.**—The Clover Seed Midge is much like the Chalcid except that it attacks the ovules before the seed is entirely formed. Their presence in the field is indicated by flowers that are partly in bloom and partly green where development has been stopped. Infestation at Urbana has been reported by Mr. Flint as high as 25 per cent.

Infestations are more severe in the second crop clover than the first crop. The appearance of the adults coincides with the development of blooms in the clover so that the broods come along with each crop of clover.

The application of remedies for the Clover Seed Chalcid will help reduce damage by the Midge.

### SUMMARY

The grower whose aim is to produce a maximum of red clover seed cannot afford to neglect the importance of insects affecting the crop.

Clover is attacked in all stages by insects that affect the seed production indirectly or directly by influencing (1) the condition of the stand; (2) the production of an abundance of blooms; (3) the development of well-rounded, full blooms; and (4) the production of an abundance of plump, mature seed.

The maximum results in controlling these insects may be expected by following the following practices:

- (1) The use of native strains of seed.
- (2) Fall clipping or pasturing.
- (3) Winter burning when the plant is fully dormant.
- (4) Pasturing lightly in the spring until about May 1st.
- (5) Cleaning up fence rows and volunteer growths in the fall.
- (6) Disposing of old straw stacks.
- (7) The use of the first crop for seed.



## PAPERS IN ANTHROPOLOGY

---

### EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN

The entire program consisting of eight papers was presented before the members and guests of the Anthropology Section.

It was suggested that the Central Section of the American Anthropological Association, of which George R. Fox, Dowagiac, Michigan, is Secretary, be invited to meet with the Anthropology Section of the Illinois State Academy of Science.

Attendance at the meeting averaged twenty-five and maximum attendance was thirty-six.

Dr. J. B. Ruyle, Champaign, Illinois, was elected chairman for 1935-36.

(Signed) BRUCE W. MERWIN, *Chairman*



## A New Type of Burial Mound Near Quincy, Illinois

O. D. Thurber

*Quincy Senior High School, Quincy, Illinois*

There are dozens of early burial mounds in west central Illinois along the Mississippi River. In Quincy, one of the parks has six mounds, and an expedition from the University of Chicago spent the summer of 1928 excavating in and near another park. Mounds are scattered for at least 75 miles along the river north and south of Quincy.

Most of them are the typical mounds of western and southern Illinois, but the type of mound here described is entirely different. The site is eight miles down the river from Quincy in the bottomland immediately adjacent to what is known as the bottom road. The burials are on slightly sloping ground about 200 feet from the foot of the bluff and two miles from the river. The immediate place of burial is approximately 120 feet by 80 feet and roughly rectangular. It is only slightly raised above the surrounding ground.

The first crypt or vault was badly destroyed before its contents were fully discovered. Eight burial vaults were found in the west half of the mound, which is all that has been excavated to date. From five to thirty-five individuals were buried in each crypt. After the discovery of twenty-eight individuals in the second crypt, the University of Chicago was notified and Dr. Newmann arrived to take charge of the work.

The crypts varied in depth, the average being two feet. They were roughly circular and rectangular in shape with an average diameter of about six feet. All of the vaults were built of native limestone slabs laid up in a more or less regular brick masonry formation with the inside wall vertical. The tops of the walls were from two to three feet thick and the bases from four to six feet thick. Each crypt was covered with layers of flat rocks laid regularly to form a rock cover a foot or more thick. One vault near the middle along the west side of the group that was opened had a doorway that faced southwest. A six-foot stairway with laid-up walls led down to the crypt floor. The three steps were formed by flat rocks laid on the dirt.

The earth was removed from the outside of all these crypts before any of the rocks were removed, then the cover rocks were taken off and the material taken from the inside. The contents of these stone vaults are more difficult to describe exactly. Broken pieces of pottery were found everywhere, both inside and outside the crypts, almost all of which were shell-tempered and fire-blackened on the inside. Everything was badly jumbled, yet bones seemed to lie in layers. On the bottom was a layer four to eight inches thick of unburned bones, more or less in their proper relationship to each other, with the bones of several individuals piled together. In some instances a few small flat rocks seemed to separate this layer and the next one. The second layer consisted of charred bones and bone fragments. In only one instance were they completely matted with charcoal and ashes, yet single pieces of charcoal and bone fragments were found scattered

throughout every crypt in all the layers. The third layer was for the most part unburned bones and fragments. The top layer was a mixture of both burned and unburned bones. These are called layers for want of a better term, but they were not separate, distinct, layers, as each seemed to fuse into the next.

In one vault seven skulls were found, fairly free from breakage, piled in one corner. The number of individuals represented in these crypts could be computed only by counting the skulls. In the eight crypts so far uncovered we have found 152 skulls, only one of which, a woman's, was in perfect condition.



Fig. 1.—Vault graves near Quincy, Illinois.

Five pipes were found. One was an unfinished effigy stone pipe, two were shell-tempered pottery pipes, and the other two were stone, one of which was highly polished, of delicate construction, and showed much use. Only four small projectile points were found, four bone needles, three stone knives, one small scraper, and only two pots. One was an ordinary shell-tempered eight-inch pot and the other was a little two-inch pot about three-fourths full of what appeared to be face or body paint. Three beads made from the columella of sea shells were found.

Obviously these burials were a type of bundle burial, possibly extending over a period of many years. It is almost certain that most of the bones were devoid of flesh when they were interred. It is quite likely that part of the cremation was done in the vaults, but most of it was done elsewhere and the charred bone fragments carried in for burial. The bones of men, women, and children were jumbled together as if they had been tossed in from outside the pit.

The age of this site is problematical, yet all indications are that it is several hundred years old. Who were these people? We do not know and can draw definite conclusions only after other similar sites have been discovered and excavated. The writer knows of one other such site near Quincy and hopes to help get more exact information from it.

# A Method of Restoration of Indian Mounds

H. V. McCoy  
Collinsville, Illinois

## ABSTRACT

Mounds may be preserved in their present state or restored to their original contour by calculating the equation of the curve of the mound. This can be done by certain primary excavations made in the most advantageous places. The procedure would be to excavate near the toe of the mound on either side until the top of the original mound is uncovered. This line is usually easy to place as the difference in the soil above and the mottled appearance of the mound itself is very evident. If the point where this top line intersects the original base of the mound is found, so much the better. If this point is not found, however, it will be necessary to calculate it from the slope of the top and the base line as found, or estimated. Readings should then be taken on the top slope of the original mound and tabulated for elevation above the base of the mound and distance, at right angles, from the center line or axis of the mound. Thus 68'/4.5 would mean that 68 feet from the axis the top of the mound was 4.5 feet above the old base.

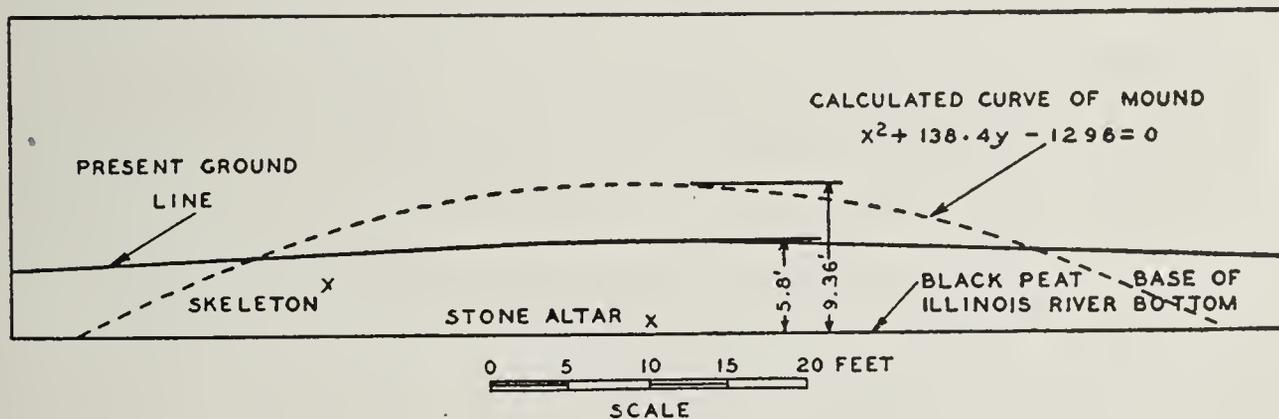


Fig. 1.

The equation of the curve of most mounds will be of the form,  $Ax^2 + By - C = 0$ , where A, B, and C are constants for any particular cross-section of a mound. By taking measurements from the true axis of the mound the value of "A" in the equation will be 1. The value of "C" is easily determined by finding the point where the top slope of the mound intersects the old base. Then y will be zero and "C" will equal  $x^2$ . To determine the value of the constant B several elevations should be taken and referred to the axis, and these values of "x" and "y" substituted in the formula and the average of the value thus found used as the true value of "B".

The procedure may be illustrated by an example: In the excavation of a certain mound, the original toes of the mound were found to be 36 feet either side of the axis. That is x was plus or minus thirty-six when y was zero (see Fig. 1). Substituting 36 and 0 for x and y in the equation we find C is 1296. Then, by elevations taken on the mound, it was found that

28 feet from the center the original mound was 4.4 feet above the old base. Substituting these values of "x" and "y" in the equation we find B is 138.4. Thus the equation for the curve of the mound becomes  $x^2 + 138.4y - 1296 = 0$ . At several places where the top of the old mound could be seen this equation was checked and found to be correct in every instance.

This method is valuable because where time, the elements, and man have partially destroyed a mound it can be restored to its original form by calculating this curve. The mound shown in Fig. 1 had been under cultivation for a number of years and had been almost obliterated. To restore it to its original shape it was only necessary to rebuild to the curve  $x^2 + 138.4y - 1296 = 0$ . The mound was but 5.8 feet high due to cultivation. By letting  $x = 0$  in the equation and solving for y we found the original height of the mound was 9.36 feet. Let it be emphasized that comparatively few elevations are necessary and very little excavation need be done to make sufficient determinations to estimate what the original contour of the mound was, at the time it was built.

## Our Debt to the Indian

R. V. Jordan

*Superintendent of Schools, Centralia, Illinois*

When the first textbook was published on the subject of American history, about the year 1775, a large proportionate amount of space was devoted to the American Indian. As time went on, less and less space was devoted to Indian history until about two decades ago, when we reached a point where this topic had been almost entirely dropped except for incidental mention.

In the latter part of the nineteenth century the authorities on the teaching of American History in the elementary and secondary schools, laid down the principle that in choosing the curriculum for these schools we should admit only such historical material as belonged to the stream of history to which we owe our civilization; namely, that flowing via Northern Africa, Western Asia, Greece, Rome and Western Europe. For the reason that he had not contributed to our lineage or our culture, the American Indian was to be dropped.

But there is coming into being a changing viewpoint as regards the function of the Indian in American history. From being accustomed to regard him as an extinguished enemy, of interest only as a museum specimen, many have come to consider him as an important factor, in the development of our modern culture.

**The problem.**—Suppose that Columbus had found the American continent a land never yet peopled by any race. What difference would that circumstance have made in the exploration and development of the country? What differences would be in our modern culture? Have the inventions, geographical knowledge, agriculture, and woodcraft of the Indian been a positive factor in attaining to our present stage of culture?

**The North American continent.**—The North American Continent is a region of vast distances. In a north and south direction, it stretches from the tropics to the arctics. Great mountain barriers rise close to the eastern coast. The greatest river system and the largest fresh water lakes to be found anywhere upon the face of the earth care for the drainage of the interior. The colonists had to confront the problem of an indigenous food supply. To face the problem of conquering so remote and so vast a continent entirely without intelligent guidance would have been the severest test of the stamina of any people.

**Friend and guide.**—The colonists who sought our shores were not trained in woodcraft, but came from various motives. Some were religious or political radicals who came to escape persecution; some were indentured servants; some were land speculators; some had been prisoners for debt; some were gold seekers. It was not a particularly well chosen group from which to select men to cope with the problems of the pioneer. How rapidly would such people have conquered these natural obstacles without the ready trained skill of the friendly aborigines? We must not forget, that in the majority of cases the success of the exploring expeditions was largely due to Indian guides. Their knowledge of the geography of the continent was acquired by long journeys or spying expeditions and by oral reports of other

tribes. The red man was not exactly a stay-at-home as the wars between the Iroquois and the Illini bear witness. In their century-long quest for a passage to the South Sea, the explorers of the eastern coast were told repeatedly of a great water to the west. From letters which reached England from Virginia in 1648 we learn that Indian rumors had already come to governor Berkeley concerning the land beyond the mountains, of the great river systems and of the Gulf of Mexico.

Indian guides made possible the marvelous chain of discovery by which the French linked the Gulf of St. Lawrence with the Gulf of Mexico. They made possible the discovery by the Virginians of the upper waters of the Ohio Valley and the basing of England's claim on the basis of prior discovery.

In 1687 LaSalle having failed in his effort to colonize Louisiana found himself in his last extremity of suffering and want. Failure to locate the mouth of the Mississippi, mutinies, shipwreck, hunger and disease defeated the great leader but could not break his iron will. With a party of seventeen men, using Indian guides, he set out overland for Quebec. Two months later he was murdered by mutineers from his own party on the banks of the Trinity. Indian guides, scouts and soldiers have fought side by side with the soldiers of the United Colonies and States in every War from the War of the Revolution to the World War.

**Indian money a factor in New England civilization.**—Another way in which the Indians of the coast contributed to the welfare of the colonists was by furnishing them with a currency; this stimulus was Indian wampum.

The unit of value first used among the natives was the cubit. It no doubt originated from the handy scheme of seizing the wampum belt in the knuckle of the little finger, running it down the forearm to the point of the elbow, and there seizing it as a mark. This mark was then lifted to the knuckle and the process repeated at will.

**The debt of language and literature.**—Twenty-four of our States bear Indian names. But it is not for geographical names alone that our language is indebted to the Indian. We use a large number of other words in our English-American speech whose Indian origin we never suspect. Tabulations show that we use about five hundred words of this kind, also many popular phrases and expressions are of Indian origin. Literature has been enriched by Indian legends and stories, such as Longfellow's "Hiawatha" and Alonzo de Ercilla's "La Araucana".

In time of war, officers of the opposing armies are constantly trying to devise cipher codes which will deceive each other. Yet during the World War the German intelligence officers captured many American messages which they could not decipher. After the close of the War the secret was let out. The American messages were written in the Choctaw Indian language—and the Germans did not know that such a language existed.

**The debt of the arts and sciences.**—To the Indians we owe our introduction to a knowledge of gums and resins, valuable timbers and many useful inventions.

Indian doctors taught the colonists the use of many valuable medicinal herbs and other members of the forest pharmacopeia.

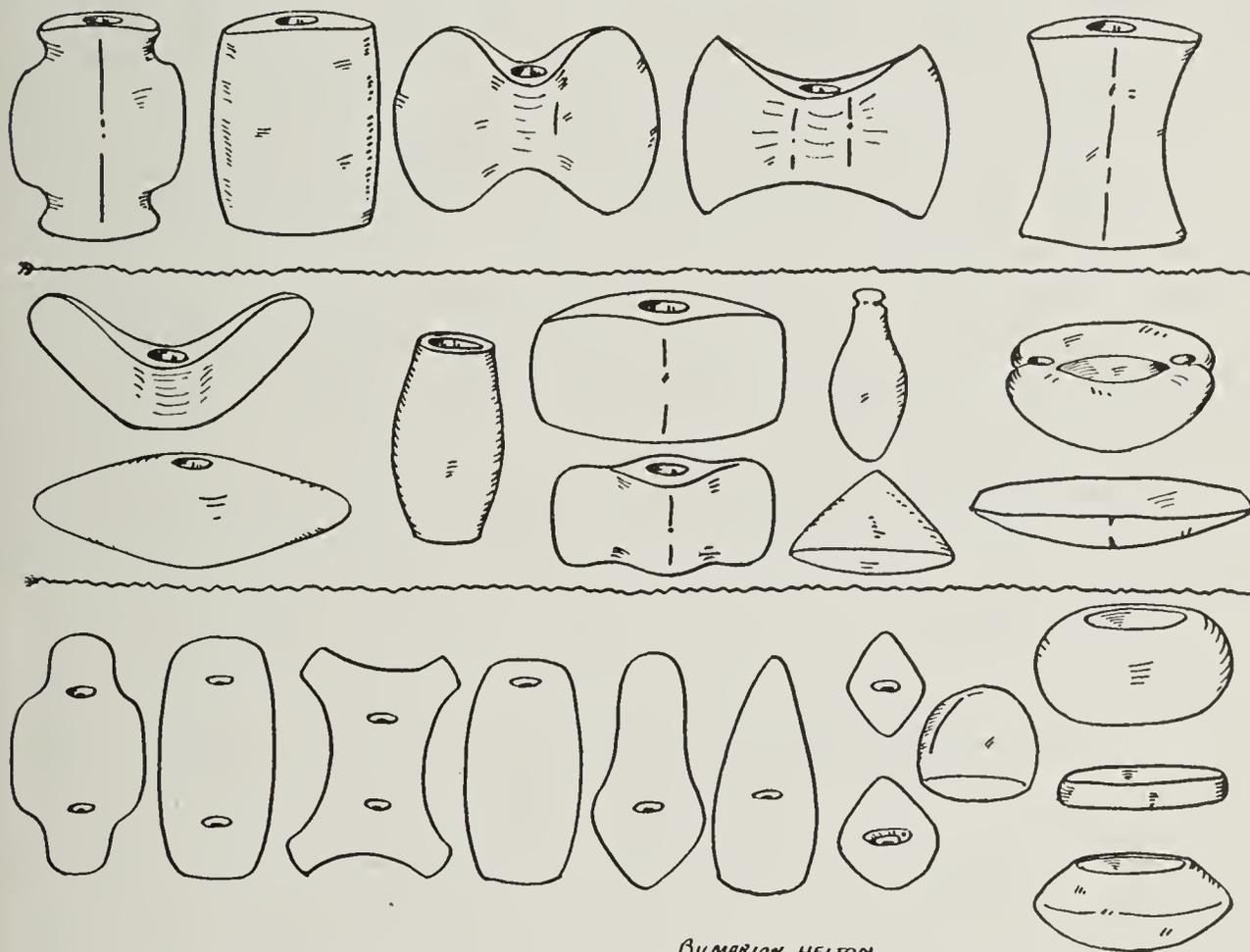
**The debt for a nation's food.**—Before the coming of the white man the Indian had developed corn or maize into practically its present form. The effect corn had on colonial development, the westward movement, the live stock industry, the building of cities and railroads, in winning the Civil and World wars are topics too large to discuss in a paper of this length.

The conclusion as to the enormity of our debt to the Indian for friendly guidance, for pioneer currency, for useful inventions, our vocabulary, our knowledge of the arts and sciences, and for the nation's food supply is so obvious as to need no further proof.

## Bannerstones and Related Ceremonial Objects From Southern Illinois

Irvin Peithman

The bannerstones and related ceremonial objects from southern Illinois here described are grouped according to four regions: first, the lower half of the Kaskaskia River; second, all of the Big Muddy River and its tributaries; third, the Mississippi Bottoms south of the mouth of Big Muddy; and fourth, Cypress Creek in Johnson and Union counties. The statements are based on trips made over the various village sites that are located on the above mentioned streams and on a study of collections of relics.



By MARION HELTON

Fig. 1.—Artifacts from Big Muddy River and tributaries.

On the lower half of Kaskaskia River the predominating problematical forms that have been found on the village sites are the discoidal and plummet. These two types are well made and are above the average in size and symmetry. The bannerstone, gorget, and pendant are very scarce here and only several have been found in late years. In only rare instances have broken ceremonial objects been found in the debris of the various village sites.

Slightly to the southeast of Kaskaskia River lies Big Muddy River and its tributaries; Beaucoup Creek, little Muddy River, and Crab Orchard Creek. In ancient times these streams were more thickly populated as evidenced by the numerous large and small village sites. Along Beaucoup

Creek one finds a converging of all the problematical forms in larger numbers than in any other given area in southern Illinois.

All of the known types of ceremonial objects common to southern Illinois have been found on the Big Muddy River village sites. Here one finds many broken ones of which quite a few show that they have been reworked and some have repair holes drilled through them. The bannerstones are very interesting in that they show finish and symmetry of the very highest degree. The general type is somewhat tube-like with short wings and very closely resembles the types that are found in Kentucky and Tennessee. They have a slightly curved under side while the top has a very pronounced ridge extending the length of them. Quite a few unfinished ones have been found here. These are very interesting for they show in the unfinished hole a core made by a reed drill. The favorite material from which the various forms were manufactured was basalt, slate, quartzite, and hematite. The discoidals and plummets from the village sites on this stream are the same general type as those found in the Kaskaskia River area. The gorgets and pendants are found in more shapes here than in any other locality in southern Illinois. A few boatstones and cones have been found on different sites here but they are not common over the whole of southern Illinois.

The village sites along Mississippi River south of the mouth of Big Muddy River are fewer in number but much larger in size, the various problematical forms that have been found on the Big Muddy River sites are almost entirely absent with the exception of the discoidal and it has changed from the large thick type found on Kaskaskia and Big Muddy sites to a small, thin, almost straight-sided disc, many of which have been perforated in the center. There have been found here various forms of human-effigy pipes made from stone.

The problematical forms that have been found on Cypress Creek are very similar to the ones from the Big Muddy River area. The bannerstone predominates over the other forms, the plummets and cones are absent, and the discoidal is the same general type as those found on the Mississippi River village sites.

Over the whole of southern Illinois all finds of bannerstones and ceremonial objects have been made on the village sites, both large and small. Finds in mounds or burials have been confined to pottery, effigy pipes, copper and flint implements.

## Dental Pathology of Prehistoric Man at the Confluence of the Ohio and Mississippi Rivers

Dr. Van Andrews  
*Cairo, Illinois*

Material for the investigation here summarized was obtained from Mr. Fain King, who owns the Ancient Buried City in Kentucky, from the Thomas Beckwith collection in southeast Missouri, and from the writer's own collection from southern Illinois.

The burials found in southeast Missouri and in west Kentucky are very similar in that they generally occur in small conical mounds. However, the writer knows of a large village site covering approximately fifteen acres with burials scattered throughout the entire site, buried with the usual camp debris.

In southern Illinois, we have what is known as the slab-burial or stone graves. The grave is usually lined on all sides with limestone or flint slabs standing edgewise against each other. One large slab or several small ones may be used as a covering. It is not at all unusual to find the side or end of one grave forming a side or end of another. We find no special arrangement as to the direction in which they are buried. Very few artifacts are found with these burials.

We know that geographical and cultural environment play an important part upon the lives of the human race. Naturally then, the mode of living, the preparation of the food and the kind of food would, we believe, have a decided influence upon the health of the people. The particular kind of food as well as its preparation would have affected the organs of mastication then, as it does today.

The investigation was done as thoroughly and as accurately as possible. Not all specimens examined were in a good state of preservation, and due to this fact it was necessary to examine all available material. At times we had only a maxilla or a portion of a mandible containing only a few teeth. Some of the teeth examined were found loose with the burial without any osseous structure, so instead of recording the result of the examination according to an individual mouth, it is recorded regarding each individual tooth with or without the osseous structure.

This report gives the result of the investigation on individuals with fully matured mouths. Attrition is classified into four degrees;

- (1) Enamel beginning to wear.
- (2) Exposure of the dentine at any point.
- (3) Cusps of the teeth worn away.
- (4) Attrition approaching or exposing the pulp.

The teeth were also examined for caries, but the number of carious teeth only is noted, although in the examination, the location was also recorded, and the majority of cavities were found to be occlusal or mesial or distal occlusal.

	No. of teeth
Showing 1st. degree attrition.....	1,028
Showing 2nd. degree attrition.....	2,168
Showing 3rd. degree attrition.....	1,525
Showing 4th. degree attrition.....	690
Showing caries .....	421
Showing alveolar abscesses.....	71
	<hr/>
Total examined .....	5,390

It is noted in the examination of the skulls that the maxilla and mandibles are large and well formed with the articulation of the teeth unusually good. We find broad well-shaped arches, seldom finding a narrow contracting one. The teeth are large, although not exceptionally so, are well formed with strong roots and thick enamel. Caries is present, especially in specimens showing third and fourth degree attrition. Occasionally one or more teeth may be found in malocclusion, which is usually linguo or bucco-version. Impactions, especially of the lower third molars are occasionally noted, also evidence of alveolar abscesses and periodontiaclasia, although the latter is rather difficult to diagnose with any degree of accuracy, due to the destruction of the osseous structures supporting the teeth. Evidence of osteomyelitis is seen occasionally.

Prehistoric man at the confluence of the Ohio and Mississippi rivers subsisted on both animal and vegetable foods, as well as on grain and nuts. Agriculture was carried on, corn being a very important food. The coarseness of the foods and the amount of grit in them, due to the preparation in stone mortars, were attributing factors to a large percentage of the teeth being found in third and fourth degree attrition. This was responsible also for a large amount of the carious teeth and for the greater percentage of alveolar abscesses. Third degree attrition was the rule in the vast majority of individuals who had reached middle age. Ante-mortem loss of teeth is noted in many instances, as well as a few edentulous cases. The result of foecal infection is manifested in some of the joints and in the vertebrae.

This single study is too incomplete to be conclusive or to be of any great value, however, it is believed that, if it were possible to make a similar survey of the skeletal material throughout the United States, and these accumulated data carefully recorded and studied, it would be beneficial and interesting to archaeologists and anthropologists.

## The Dryopithecus Tooth Pattern as a Racial Characteristic of the Mound Builders

J. B. Ruyle, D. D. S.

*University of Illinois, Urbana, Illinois*

In order to properly understand the significance of the articulation patterns, as shown by the lower molar teeth of the aboriginal Mound Builders, it is necessary to take into account and trace the evolution of tooth structures. Passing over the long period of time which saw the gradual evolution of some primitive invertebrate form into a type which exhibited the first differentiation of the body into head and tail portions, and considering briefly the Ostracoderms of the upper Silurian period, we note that these latter gave rise to the abundant though primitive and toothless fishes of the Devonian period. First of the vertebrates to develop a masticatory apparatus were the Devonian sharks, in which the body scales surrounding the mouth were gradually drawn into the tough skin of the jaws and enlarged to form rudimentary grinding surfaces. They were arranged in rows and succeeded each other in series, as is still the case, recapitulating the relationship of the teeth to the body scales.



Fig. 1.—Left side of mandible of *Dryopithecus frickae* of the Miocene of India, showing the earliest manifestation of the "Dryopithecus pattern" on the crown surface of the molars.

The lung fishes developed a more advanced type of tooth with a recognisable base for attachment to the jaw, a double-folded structure and a thick alveolar wall. This type of tooth was carried over into the amphibians. Branching off from the amphibians, we find that the reptiles rapidly developed incisors, cuspids, premolars and molars, as well as initiating the deciduous and permanent tooth stages. Their teeth were cylindrical in cross-section.

Later the first mammals appeared, with their teeth exhibiting a triangular cross-section. At the bases of these triangular teeth on both the upper and lower jaws, there were evolved spurs on the insides. These spurs engaged each other when the teeth were in occlusion. As the anthropoid

mammals came in and progressed anatomically, their dentition was reduced. More clearly expressed—there was a progressive reduction in the number of teeth from the canines back, thus accommodating the enlargement of the brain case and the shortening of the snout and face. The lingual posterior angles of the upper molar teeth were increased, accompanied by the formation of corresponding crushing basins on the lower molars. In the teeth of the giant anthropoid apes that roamed the hills of the Mediterranean and south Asian regions in mid-Miocene time (some 14 million years ago), we find the same pattern on the lower molars that we see on those of the chimpanzee, gorilla, and man.

These teeth possess three cusps on the outside and two on the inside, against the tongue, resulting in a pattern having the appearance of a five-pointed star. All three lower molars of the giant apes show this *Dryopithecus* pattern, which though inherited by the teeth of modern man, varies in amount of expression with different races and individuals.

In an examination of the lower jaws of 75 Illinois Mound Builders, this pattern was found on every first molar tooth. It characterized the second molars of fifteen individuals; but was not present on any of the third molars studied. It is probable that the percentage of occurrences as applied to the second molars was in reality somewhat higher, since teeth were missing in some cases, and in others showed so much wear, due to the chewing of gritty foods, that the surface was worn flat and any original pattern obliterated. Even so, when we consider that the human race has shown a tendency towards abandonment of the *Dryopithecus* type molar, and having before us evidence that the teeth of the Mound Builders show a much closer relationship to the parent stock of mankind, than do those of modern races, we can safely assume that as a race they date far back into antiquity and truly represent a distinct branch of the human family tree. Contemporaneous as they probably were with the white race, they were undoubtedly more primitive in type, probably mentally, and certainly from a skeletal standpoint—their teeth supplying the evidence for such an hypothesis.

## Archaeology in Southern Illinois

Bruce W. Merwin

*Southern Illinois State Normal University, Carbondale, Illinois*

In previous meetings of the Illinois Academy of Science, the writer has discussed various prehistoric remains in southern Illinois and pointed out possibilities for archaeological research. The present paper makes a suggestion for a possible means of coordinating the various men and agencies interested in the field of archaeology so that the entire field can be more thoroughly covered and made available for scientific study.

There is a large number of persons in southern Illinois actively engaged in making collections of Indian artifacts. Many of these men have in turn a considerable following of farmers, schoolboys, hard-road workers, etc., who keep them informed on specimens that may have been found and on sites that have been visited or discovered. Of course the collector has to pay small amounts for this service, but it seems worth while. Some of these men are thus enabled to have such a wide acquaintance that they are kept in very close touch with archaeological discoveries.

The question comes up as to whether it would not be desirable for some organization such as the State Historical Society, the Forestry Service, State Parks, or the Department of Archaeology at the University of Chicago, to organize a clearing house in which permanent records of the findings of these men in the field could be assembled.

There are, to be sure, many objections to overcome in a plan of this sort. In the first place the collectors themselves will object. Many of them feel that the professional scientists have not been especially scientific in their work nor friendly in their attitude, and so hesitate to divulge the location of promising sites. For instance it is claimed the scientist does not remain in touch with areas studied after he has completed his field-work and hence sometimes fails to note some of the most interesting and valuable finds.

On the other hand the scientific organizations have a contempt for the research ability of the layman and feel that they should not work with the "Pot-Hunters". Still, since the local collectors will continue to excavate, explore, and collect, even if the work is done merely to secure specimens, an interview will frequently give much information regarding the occurrence of various artifacts. Again, many of the local collectors have had good training. For instance one man worked for some time with Dr. Moorhead, while others have collected in the local area and have really become specialists in the local field. In fact some of these men have been able to draw interesting, tentative conclusions and, from their reading and actual finds, produce considerable supporting evidence.

Another objection is the cost of clerk hire, postage, traveling expenses, etc., but here also the cost would be less than that of maintaining a few students in the field. Federal funds might even be secured to carry on this work as a part of the Forestry Preserve movement, or in connection with some other form of public work.

All of these obstacles would serve to hinder the successful carrying through of this scheme for cooperative research; and yet it would seem that

the State Historical Society or other central agency could recognize in some way the work of these private collectors through a journal such as that of the Academy of Science if not through money. A small sum expended for travel, photographs, and carefully written records would result in a vast amount of information, from which the research men could generalize and draw conclusions supplementing and verifying the interpretation of actual scientific exploration.

The larger and more interesting sites might be secured by the state for public parks and excavated like the sites at Wyckliff, Kentucky, and Lewistown, Illinois. These new parks would possess a far greater drawing power than that of the Forest Preserves and State Parks whose main attraction is their unusual scenery.

While there may be other means for securing the cooperation and support of the local collectors, the writer feels keenly the need for some integrating agency that will in a mutually helpful and friendly manner unify the work of the scientific specialist, and the local collector. After that is accomplished the joint results should be made available to the general public.

## PAPERS IN BOTANY

---

### EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN

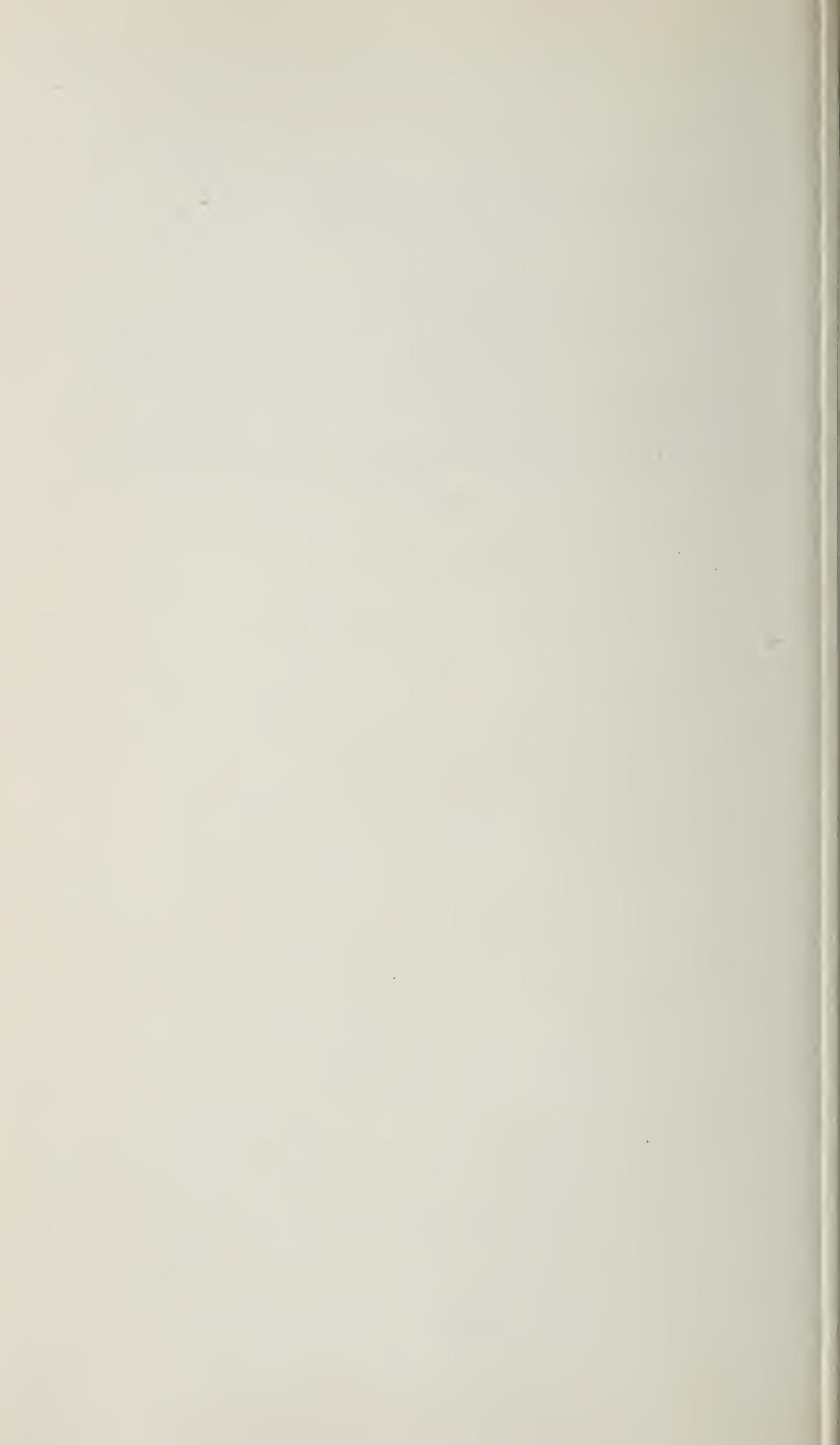
The program of the Botany Section consisted of twenty-two papers, eighteen of which are here represented. Not presented for publication were:

"The Problem of the Frost Flower," by Willard N. Clute, Butler University, Indianapolis, Indiana.

"The Genus *Senecio* in Illinois," by J. M. Greenman, Missouri Botanical Gardens, St. Louis, Missouri.

Harry W. Givens, Joliet, Illinois, was elected chairman of the section for 1935-36.

(Signed) W. M. BAILEY, *Chairman*



# Mosses From Apple River Canyon, Mississippi Palisades and White Pines Forest State Parks

G. H. Boewe, Stella Holmes Barrick, and Stella M. Hague

*University of Illinois, Urbana, Illinois*

The mosses reported in this paper were collected in the fall of 1934 by G. H. Boewe and Stella Holmes Barrick.

In conformity with previous reports of Illinois mosses the names and arrangement are those given in "Mosses with a Handlens and Microscope," by Dr. A. J. Grout, and "Moss Flora of North America," Vol. 2, Part 1, and Vol. 3, Parts 1, 2, 3, and 4.

The following abbreviations are used to designate the parks where the specimens were collected: A.—Apple River Canyon; M.—Mississippi Palisades; P.—White Pines Forest

## POLYTRICHACEAE

Catharinea undulata (L.) W. & M.....	A. M. P.
Polytrichum Pilifera Schreb.....	P.

## FISSIDENTACEAE

Fissidens incurvus var. minutulus Austin.....	M. P.
adiantoides (L.) Hedw.....	A.
cristata Wils. ....	M.

## DICRANACEAE

Ditrichum pallidum (Schreb.) Hampe.....	A. P.
Ceratodon purpureus (L.) Brid.....	M.
Dicranella heteromalla (L.) Schimp.....	A. P.
rufescens (Dicks.) Schimp.....	A. M. P.
varia (Hedw.) Schimp.....	M. P.

## GRIMMIACEAE

Grimmia apocarpa (L.) Hedw.....	A. M.
---------------------------------	-------

## TORTULACEAE

Weisia viridula (L.) Hedw.....	A.
Barbula unguiculata (Huds.) Hedw.....	A. M.
fallax Hedw. ....	A. M.
Tortella caespitosa (Schwaegr.) Limpr.....	M.
Tortula sp. ....	A.

## ORTHOTRICHACEAE

Orthotrichum Schimperii Hamm.....	A.
-----------------------------------	----

## FUNARIACEAE

Physcomitrium turbinatum (Mx.) Brid.....	M.
Funaria hygrometrica (L.) Sibth.....	A. M. P.

## TIMMIACEAE

*Timmia megapolitana* Hedw..... A.

## BARTRAMIACEAE

*Bartramia pomiformis* (L.) Hedw..... A.

## BRYACEAE

*Rhodobryum roseum* (Weis.) Limpr..... P.

*Mnium cuspidatum* (L.) Leyss..... A. M. P.

*rostratum*, Schrad. .... P.

*Drummondii* B. & S..... M.

*spinulosum* B. & S..... A.

*punctatum* L. .... A. M.

*stellare* Reich. .... M.

## LESKEACEAE

*Thuidium delicatulum* (L.) Mitt..... A. M. P.

*recognitum* (Hedw.) Lindb..... A. P.

*Virginianum* (Brid.) Lindb. .... A.

*pygmaeum* B. & S..... M.

*Leskea polycarpa* Ehrh. .... A. M. P.

*denticulata* Sull. .... M.

*Austinii* Sull. .... A. M.

*Anomodon minor* (P. Beauv.) Fuern..... A. M. P.

*apiculatus* B. & S..... P.

*attenuatus* (Schreb.) Hueben..... A. M.

*rostratus* (Hedw.) Schimp..... A. M. P.

*Thelia hirtella* (Hedw.) Sull..... M.

*asprella* (Schimp.) Sull..... A.

## HYPNACEAE

*Brachythecium salebrosum* (Hoffm.) B. & S..... A. M.

*oxycladon* (Brid.) J. & S..... M. P.

*acutum* (Mitt.) Sull..... M.

*Eurhynchium hians* (Hedw.) J. & S..... A. P.

*strigosum* (Hoffm.) B. & S..... M. P.

*serrulatum* (Hedw.) Kindb..... A. M.

*Climacium Americanum* Brid..... A.

*Drepanocladus aduncus* (var?) (Hedw.) Warnst..... A.

*Campylium hispidulum* (Brid.) Mitt..... M.

*Amblystegium serpens* (L.) B. & S..... A. M.

*Juratzkanum* Schimp. .... A.

*varium* (Hedw.) Lindb..... A. M. P.

*irriguum* (Wils.) B. & S..... A.

(*Hygroamblystegium irriguum* (Wils.) Loeske)

*Plagiothecium micans* (Sw.) Paris..... A.

*denticulatum* (L.) B. & S..... A. M.

*Amblystegiella subtilis* (Hedw.) Loeske..... A. M.

*Entodon seductrix* (Hedw.) C. M..... P.

*cladorrhizans* (Hedw.) C. M..... A. M.

*Platygyrium repens* (Brid.) B. & S..... A. M. P.

*Pylaisia Schimperii* R. & C..... P.

## LEUCODONTACEAE

*Leucodon sciuroides* (L.) Schwaegr..... P.

# The Germination of the Seed and Development of the Seedling of *Calopogon pulchellus* (SW.)

## R. BR.

Margery C. Carlson

*Northwestern University, Evanston, Illinois*

Since Knudsen's (1, 2) success in germinating seeds of *Cattleya* spp. on a sterilized nutrient medium, and in growing plants to maturity without the presence of a mycorrhizal fungus, the writer has been interested in trying to grow native members of the Orchidaceae in like manner.

Seeds of a number of species of several genera were planted on Knudsen's nutrient medium. Only those of *Calopogon pulchellus* (grass pink) grew. Further germination and viability tests will be made when next summer's seeds are available, but in the meantime the development of *Calopogon* plants has been studied.

The seed consists of an ellipsoidal embryo, composed of a mass of parenchymatous cells, and is enclosed in a loose-fitting membranous seed coat made up of a single layer of elongated, thick-walled cells (Fig. 1).

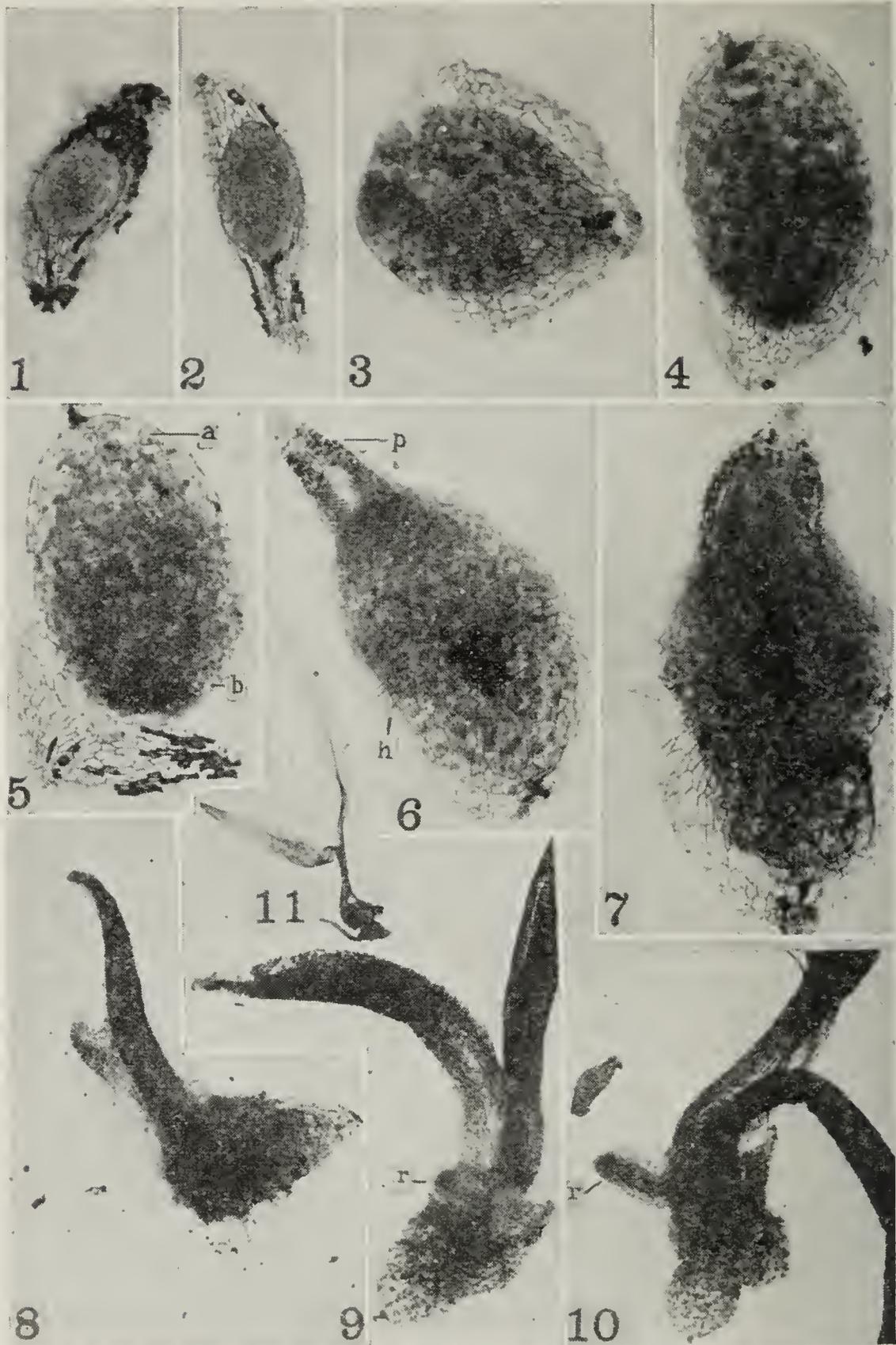
The embryo enlarges, still retaining its oval form (Fig. 2), and soon ruptures the seed coat (Figs. 3 and 4). The cells in the posterior half of the embryo continue to enlarge and become vacuolated (Fig. 5, a). The cells in the anterior region divide actively and form a stem-meristem (Fig. 5, b). A ridge, a leaf primordium, arises forming a ring around the meristematic tip. This primordium elongates and becomes the first leaf (Fig. 6, p). Certain cells, and often groups of adjacent cells, of the surface layer begin to elongate and produce absorbing hairs (Fig. 6, h) which resemble root hairs.

Chloroplasts appear in the outer layers of cells and the embryo becomes green very early. Later, starch grains accumulate in the basal half.

A greater increase in diameter occurs in the upper half of the seedling than in the lower part (Fig. 7). A second circular leaf primordium is formed within the first (Fig. 7). These primordia elongate and differentiate into leaves which are tubular at the base but open out into sheathing blades toward the tip. Figure 8 shows a seedling, about two months old, in which the second leaf has grown beyond the first and has not yet opened out into its flattened tip. The third leaf is seen just pushing up into the sheath of the second. The seed coat, the original basal part of the embryo, the enlarged upper part ("tuber") of the seedling, and the elongated absorbing hairs are also visible in this figure.

A root now forms (Fig. 9, r) in the outer part of the stem just above the attachment of the first leaf. The root digests its way through the base of the leaf and emerges. The elongating root is seen in figures 10, r and 11. The third leaf (curved downward) has emerged from the sheath of the second in figure 10, and in figure 11 the third and the fourth, or final, leaf of the first season's growth are visible.

Finally, the internodes of the stem elongate and enlarge in diameter, forming a new "tuber" which is larger than the former one (Fig. 11). A bud, or stem tip, differentiates at some point on the surface. Then the leaves die down and their bases become scale-like coverings of the new "tuber." After a period of dormancy this "tuber" develops much as did the smaller embryo of the year before.



Photomicrographs of seeds and young plants of *Calopogon pulchellus* (Sw.) R. Br. taken with Leica camera.

1. Seed, with oval embryo and membranous seed coat.
2. Germination seed.
3. Enlarging embryo has burst seed coat.
- 4, 5. Seedlings differentiating into posterior (a) and anterior (b) ends; emerging from seed coat.
6. First tubular leaf (p) and absorbing hairs (h) developing.
7. Second leaf forming inside first; upper half of seedling enlarging.
8. Plant about two months old, showing two leaves and beginning of third.
9. Older plant, root (r) just emerging.
10. Still older plant with three leaves and elongating root (r); new "tuber" forming; a seed at left shows relative sizes.
11. Plant about 6 months old; third and fourth leaves mature; root elongated; new "tuber" with bud at right, surrounded by tubular bases of leaves.

1. KNUDSON, L., Physiological study of the symbiotic germination of orchid seeds. *Bot. Gaz.* 79:345-379. 1925.
2. ———— Flower production by orchid grown non-symbiotically. *Bot. Gaz.* 89:192-199. 1930.

# A Simple Apparatus for the Steam Method of Softening Woods for Microscopic Sections

Glenn E. Davis and E. L. Stover

*Eastern Illinois State Teachers College, Charleston, Illinois*

The original apparatus for softening wood by steam was introduced by Joseph Kisser, Vienna, Austria. The idea was brought to Mr. Stover by D. A. Anderson, who was studying in Vienna with Kisser. Mr. Stover developed the apparatus here described.

This apparatus has been in use in our laboratory for the past eight or nine years. It is simple to assemble and easy to operate. Live steam is simply played upon the wood while it is being cut. Water is heated in a hypsometer or steam boiler, having a capacity of about one quart. These boilers have a water gauge, an outlet for steam, and an opening for refilling. To the outlet for steam is attached a rubber tube in the end of which is inserted a glass tube drawn out in the shape of a pipette. The tube is fitted in an adjustable clamp so that it can be held out of the way.

The heating element we have used and recommend is an electric hot plate of durable construction with solid metal top, which gives an even temperature for a constant steam jet.

By using this method and a sliding microtome we have successfully cut all of the native wood, both green and old, with the exception of old wood of *Toxylon pomiferum*, which proved to be too hard to soften with steam.

It is especially noteworthy that we have been able to cut woody stems one and three years old. The steam is much easier to use than hydrofluoric acid or boiling the wood in water, which did not eliminate torn cambium cells and sections that split and cracked while being stained and mounted.

The time required to soften young stems may vary, but usually the best results were obtained by steaming for about five minutes before cutting.<sup>1</sup> Sections 10 to 15 microns thick showed no tearing of the cambium or pith cells. The sections did not crack and split when mounted in balsam as is common when other methods are used.

Staining is a matter of personal choice with most microtechnicians, however I wish to make mention of the fact that we have stained these sections quite satisfactorily with Delafield's Haematoxylin and safranin. Safranin is applied first and destained until only the bast and woody fibres remain a brilliant red. Delafield's Haematoxylin is applied by the dip method using ammoniated water as an intensifier and a fixer. Mature wood sections were best stained by the "quick method" of using iron alum-haematoxylin.

<sup>1</sup> With this apparatus it is not necessary to remove the steam while cutting.

## REFERENCES

- KISSER, J., Der hentige Stand botanisch-mikrotechnischer Schneidemetoden. *Biologia Gen.* Band IV. L. ½ Leipzig, 1928.  
 CHAMBERLAIN, C. J., *Methods in Plant Histology*, 5th Ed., 1934.

## Effects of Sulphur Deficiency on the Growth and Metabolism of the Soy Bean

Scott V. Eaton

*University of Chicago, Chicago, Illinois*

Soy bean plants were grown in washed quartz sand in the greenhouse in the springs of 1933 and 1934. Half of the plants were given a complete nutrient solution and half a solution in which magnesium chloride was substituted for magnesium sulphate. In order to keep the plants from blooming before marked symptoms of sulphur deficiency developed, the natural day length was increased to about 16 hours by the use of electric lights.

The main symptoms of sulphur deficiency in the soy bean were: the yellow-green color of the leaves, the smaller leaves, and the thinner stems. The tops were stunted more than the roots. The upper leaves became yellow first. These symptoms are similar to those of the deficiency of other elements, for example, nitrogen, phosphorus, and calcium. This is perhaps to be expected, especially as regards the effect on color, since the deficiency of sulphur and the above elements except nitrogen causes a low reductase content of the plants, and so nitrates cannot be used, although they are present in the nutrient solution. Under these conditions the plant is naturally chlorotic, since nitrogen is necessary for the synthesis of chlorophyll. Also, sulphur may have an effect on the color of the plant due to the fact that it is a constituent of the proteins of the chloroplast, though it is not found in chlorophyll itself. It needs to be kept in mind too that calcium interferes with the absorption of nitrates. The stems of the minus-sulphur plants elongated remarkably and were almost as tall as the stems of the plus-sulphur plants. The main effects of sulphur deficiency on the chemical composition of the plant were that carbohydrates, nitrates, and soluble organic nitrogen accumulated in the minus-sulphur plants. However, this was not true of all forms of carbohydrates. Starch was higher in the sulphur-deficient plants, but the plus-sulphur plants had a higher content of sugar. Carbohydrates and nitrates no doubt accumulated in the minus-sulphur plants, because the synthesis of amino acids and other organic nitrogenous material was restricted by the low reductase content of the plants. The higher percentage of the soluble organic nitrogenous material in the sulphur-deficient plants was probably due mainly to proteolysis, the hydrolysis of the proteins. As a rule, in a plant which is poorly vegetative because of the deficiency of an essential element, the proteins are not broken down unless the plant is put in continuous darkness. The minus-sulphur plants were able to carry on this process in the light, and it was their ability to do this that accounts for the stem elongation of these plants, which was mentioned above.

Summarizing, the main symptoms of sulphur deficiency in the soy bean are: the yellow-green color of the leaves, the smaller leaflets, and the thinner stems. The tops are stunted more than the roots. The upper leaves become yellow first. These symptoms are probably due both to the lack of sulphur and to poor nitrate assimilation, which results from the low reductase content of the minus-sulphur plants. Because of poor nitrate assimilation, starch and nitrates pile up in the sulphur-deficient plants and the accumulation of starch is correlated with harder stems. The minus-sulphur plants are high in the soluble forms of organic nitrogen. This is due mainly to proteolysis and is important in the stem elongation of these plants.

# A Preliminary Report of a Study of the Plants of Winnebago County, Illinois

Evelyn I. Fernald

*Rockford College, Rockford, Illinois*

Since 1859 plants have been collected in the vicinity of Rockford in Winnebago County. In that period of 76 years there have been quite a few individuals who have made a study of the local plants. One of the earliest of these, and in many ways the most interesting, was Michael S. Bebb (1833-1895). There were so many sheets with his name on them in the Herbarium of Rockford College that the author's curiosity was aroused. As a result of questionings in various quarters, information regarding this unique individual appeared from the most unexpected places. So much material has come to light that a more extensive report on him will be given at a later date. An excellent biographical account of Mr. Bebb was written by Mr. Walter Deane of Cambridge, Massachusetts, and in 1896 was published in Volume 21 of the *Botanical Gazette*. In the bibliography given at the end of this article, the following items should be recorded here:

- (1) "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. Agric. Soc.* 3: 586-587, 1859.
- (2) "Recently introduced plants in and about Rockford, Ill." *Bot. Gaz.* 1: 68-70, 1882.

In addition to being a well known authority on willows, Mr. Bebb made a careful study of several other groups of plants. Most of his large herbarium, originally of 50,000 sheets, is now in the Herbarium at the Field Museum in Chicago. His plants may also be found in other herbaria in the United States, since he was well known by many of the botanists who were his contemporaries, and exchanged plants with them.

So important are his collections that no list of plants of Rockford and vicinity can be considered complete until the material from his herbarium has been examined carefully and compared with that of the more recent collections. For example, on some of his sheets, he has left the notation that the plant may have been uncommon, or may have been found only recently; while the later collectors may record it as very common. Unfortunately, some of the common and beautiful plants of his day may be at present rare, or even extinct! That other changes may have occurred since those early pioneer days makes this study very engrossing.

The work initiated by Bebb has been carried on at different periods by many others—a few of these are as follows: Miss Mary Norton, Miss Frances T. Sheldon, Miss Agnes Brown, Dr. Ruth Marshall, Miss Lena Henderson, Miss Zaida Fisher (Mrs. Victor Buys), Miss Mabel Thomas (Mrs. Mathew Whelan), and Miss Mildred Willoughby. The plants collected are in the herbarium of Rockford College. The Nature Study Society of Rockford has been actively interested in local plants and has already published these two booklets: *The Trees of Rockford and Vicinity* (July, 1914) and *The Shrubs and Woody Vines of Rockford and Vicinity* (July, 1916). At present this organization, in cooperation with the author of this note, is working on the list of the herbaceous plants of this region, and expects to have it ready for publication in the near future.

## Some Thoughts on Popularizing Botany

Louis F. Gumbart

*Macomb, Illinois*

We have been in an era of "Nature Study" for some thirty years, but there are few high school students asking for botany. Fifty years ago the influence of Asa Gray on American thought was still potent and many high school students constructed and cherished "Herbariums." Why the change? We have studied biology and with a microscope and we have failed to create a desire to know more of plant structure as we can see it every day with our own eyes. Not in the least belittling the study of biology, why not work out a small well illustrated book of supplementary reading for seventh and eighth grades that will help stimulate a desire for plant study with a manual, by high-school time?

Such a book could start with outlines of leaves, green perhaps, showing the leaves of some of our commonest trees and shrubs, with special attention to the sharp points on black oak and round lobes on white oak types, and the freak forms of sassafras and mulberry. Second, with root forms, bulb, corm, rizome, turnip, potato and trees, with peanuts as the freak.

Third, with seeds, corn and wheat as endogen examples; then beans, peanuts, other nuts and apple and orange seeds for exogens, not illustrated, but with the suggestion that the reader put some dirt in a small box, plant the seeds, marking the places, water well and set in sunny window and keep moist—then watch them grow, noting particularly the way the two types of seed come up. Calling attention to the fact that this difference makes the fundamental division in plant life.

We are now ready for some family studies, and, to be attractive and thought and question provoking, each should have its characteristic illustration. Some of the flowers should be shown with parts separated and with the office of bees, butterflies and moths mentioned.

The Lily family with flowers in threes, onion and lily side by side.

The Rose family, flowers in fives, single and double, to show man's possibilities—there may be another Burbank among the readers. By all means stress the value of this family in food economy as well as beauty, berries, apples, peaches, pears, etc. The Mustard family, with flowers in fours like a cross, radishes, turnips, cabbage as well as some well-known flowers. The Pulse family, with flowers like a butterfly, includes beans, peas, peanuts, the clovers, etc. The Convolvulus family, flower a twisted bud opening into a trumpet, morning glory, sweet potato, dodder and bindweed.

Solanum, the true potato family, flower a five pointed star, some very bad members of which are close relatives of our good friends the so-called Irish potato, the tomato and egg plant; belladonna, henbane, nightshade and jimson (Jamestown weed), not forgetting tobacco and cayenne pepper.

Then the Mint family, with its square stems, opposite leaves and tubular flowers. A great many so-called weeds are in it, but peppermint, spearmint, catnip, horehound and sage are all well-known to most of us as quite useful. The Composite family, with dandelions, daisies and sunflowers.

For the benefit of city children a page or two illustrating ears of corn and heads of wheat, oats, rye, barley, rice and sugar cane should be quite interesting as well as instructive. Particularly so when their relationship to the common grasses is shown.

Such a book would be quite a help toward pleasant auxiliary work for both teachers and pupils, and who knows what the stimulus might be, for some backward or bright boy or girl, toward a lot of clean fun and possible improvement in fruit, flower and forest.

## Size and Ornamentation of Some Modern and Fossil Lycopod Spores

Orrin J. Henbest

Department of Geology, University of Chicago, Chicago, Illinois

This brief summary of the external features of the spores of a few representative genera of lycopods, both fossil and recent, is only an introduction to the problem involved in the determination of spores found isolated in shale and coal.

The genera dealt with in this paper include the extinct forms *Lepidostrobus* (the cone of *Lepidodendron*) and *Sigillariostrobus* (the cone of *Sigillaria*), and the modern forms *Lycopodium*, *Isoetes*, and *Selaginella*.

The megaspores of *Isoetes* vary in size from 250 to 900 microns. The exospore is siliceous and the color gray to white, except in *I. melanospora* where the spores are black. All of the megaspores have triradiate ridges which terminate at an equatorial ridge dividing the spore into four faces—the three upper faces and a lower or basal face. The sculpturing consists of spines, small tubercles, or reticulations, and may be similar on all faces or different on the basal face. These characters are constant in a given species, and serve as the best means of their classification. The slightly elongate microspores vary in length from 20 to 40 microns. They are smoothish, or are marked by papillae or small spines, and rarely have a winged crest. The color is usually ashy, fawn, or cinnamon-brown.

*Selaginella* also is heterosporous. The megaspores (Figs. 4, 5) have annular wings, while *Isoetes* megaspores (Figs. 6, 7) are wingless. The spore-body varies in diameter from 240 to 460 microns, with wings 30 to 90 microns wide. *Selaginella apus* megaspores are ornamented by reticulate ridges, while those of *S. caulescens* bear a few spines. *S. apus* microspores are 21-35 microns in diameter, are slightly rough, and have a triradiate slit.

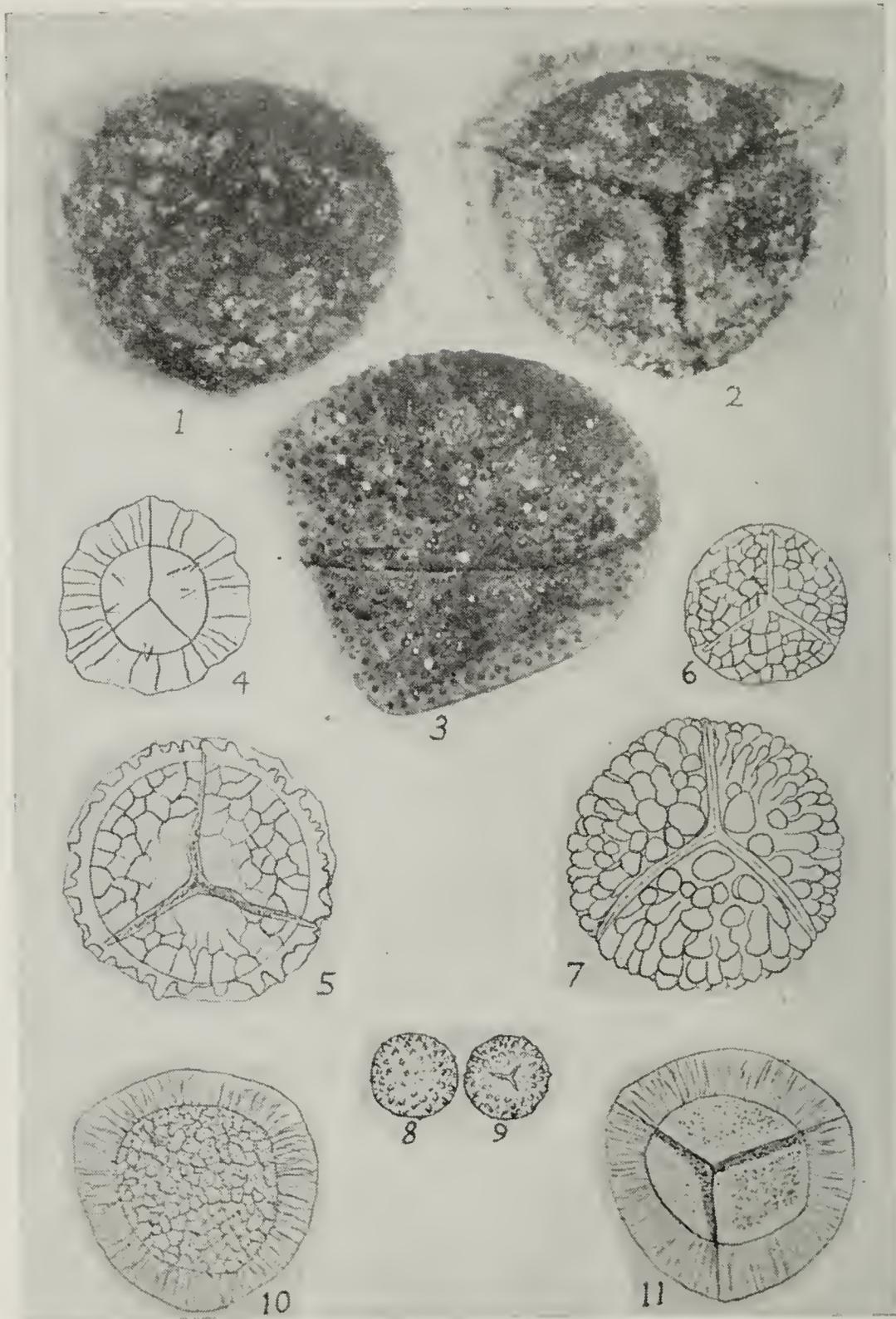
With the exception of the little known *Phylloglossum*, *Lycopodium* is the only homosporous lycopod. The spores compare in size with the microspores of *Isoetes* and *Selaginella*, but show distinctly the triradiate ridge and equator as in the megaspores of these two genera. The color is sulphur-yellow, and they measure 26-34 microns in diameter. The surface is usually reticulate, or occasionally ornamented with tubercles.

The megaspores of modern lycopods seldom reach a diameter of 900 microns, while those of *Sigillariostrobus* are 1,000 to 2,250 microns in diameter. The author has found in the No. 6 coal of Illinois, megaspores measuring as much as 3,100 microns in diameter, which are most likely lycopodiaceous.

The megaspore of *Sigillariostrobus ciliatus* (Figs. 8-9) compares favorably with the large megaspore shown in Fig. 3. Several similarities may be seen between the spore of Figs. 1-2 and that of *Selaginella apus* (Fig. 5). This same spore (Figs. 1-2) compares favorably with *Triletes triangulatus* type II of Zerndt (Figs. 10-11), and compares even more closely with Scott's description of the megaspore of *Selaginellites suissei*.

A close analogy may be seen between the spores of *Isoetes* and those of *Lepidostrobus*. The megaspores of *L. Veltheimianus* are 800 microns in

diameter and are covered by long stout spines. The microspores of this species and of *L. oldhamius* are often found in tetrads and are 20 microns in diameter, slightly smaller than the average *Isoetes* microspores.



Figs. 1-2, Winged megaspore x 54, with reticulate markings on basal face; 3, Megaspore x 18, covered with short spines; 4, *Selaginella caulescens* megaspore x 43; 5, *Selaginella apus* megaspore x 58; 6, *Isoetes englemanni* megaspore x 32; 7, *Isoetes malinverniana* megaspore x 36; 8-9, *Sigillariostrobus ciliatus*, echinulate megaspore x 5; 10-11, *Triletes triangulatus II* megaspore x 36.

1-2, 3, by L. C. McCabe, from No. 6 coal of Illinois; 4, after Bennie and Kidston; 6, 7, after Motelay and Vendryes; 8-9, after Scott; and 10-11, after Zerndt.

## Wild Life Sanctuaries

Jens Jensen

*Ravinia, Illinois*

It was my good fortune to make a discovery last summer. Just outside the city limits of Chicago, the prehistoric Glenwood beach, a reminder of the early history of Lake Michigan, rises quite conspicuously over the prairies. Very little is left of its original tree cover in the way of oaks and maples and other plants usually found on sandy or gravelly lands in this region. Much of this growth was noted by early botanists, but one grove near the city of Niles Center apparently escaped their attention. Here last summer a colony of pepperage (*Nyssa multiflora*) was found. Some of the trees measured about eighteen inches in diameter. There must be a dozen good sized trees, quite a few smaller ones, and hundreds of saplings. The undergrowth consists of blueberries, choke berries, and other plants usually associated with these trees. On investigation to the west of the old beach quite a depression was found which years ago must have been a swamp that supplied the trees with moisture. The swamp has been drained by real estate speculators, but on its margin grew remnants of several varieties of dogwood, meadow sweet, sedges, and other swamp plants. This grove, or what is left of it, represents a bit of landscape strange to this region. The pepperage and some of the other plants are pioneers that have marched westward from their original home, and as far as the writer knows, with the exception of a few scattered plants in south Evanston which are dying, and a group reported by Dr. Pepon in Rogers Park, destroyed long ago, there is no other record of these trees anywhere else in this region. In other words, they are on the western rim of their natural habitat.

The few remaining tamarack bogs in the Fox Lake area were also explored last summer. One of them was found to contain several groups of yellow birch (*Betula lutea*) so rare in Illinois, but still more surprising was a section of this bog with mountain ash in all stages of growth. The older trees were suffering from scarcity of moisture. Perhaps too their vitality is poorer in this southern home. These two varieties, yellow birch and mountain ash, as far as the writer knows, are on the southern rim of their natural habitat. The undergrowth consists largely of grey dogwood, *Ilex verticillata*, *Vaccinium arborium*, and numerous ferns. This bog is located a few miles east of Antioch.

Of the other bogs, one especially has become familiar to botanists and teachers because of its unusual character and its northern flora. The pitcher plant (*Sarracenia purpurea*) is quite numerous, also several varieties of the orchid family and other plants rare in Illinois. There were a few scattered yellow birch saplings and one was puzzled to know where they had come from. Poison sumac (*Rhus vernix*) is also plentiful. Years ago this bog had quite a pool of water in the center; an old boat hidden in the rushes told the story of its former depth. Last season it was a mud flat with a few turtles plowing through it in search of water. This open center is surrounded by rushes, cattails, and other bog plants, followed by tamarack and plants associated with them. It is the most complete tamarack bog the writer has seen.

The problem of chief interest is what is to become of these plant sanctuaries which teach us the natural migration of plants, the struggle for the survival of the fittest, and give us an understanding and knowledge not to be found anywhere else and therefore most essential to our intellectual growth. Their destruction, and this is on the way, is due to our failure to understand that all life is part of the same creation, linked together into a wholesome growth in the evolution of things.

My suggestion is that such sanctuaries, wherever found, should be preserved and become part of our educational system rather than our political system. They should be accessible, to a degree consistent with their preservation, to all centers of learning. They might come under the supervision and belong to more than one school district in the vicinity of which they are found, so that the expense of guarding them from exploitation would not fall on one district alone. The State should also share in the purchase of these tracts and in their upkeep.

## Collection of Fleshy Ascomycetes From East Central Illinois

Ica Marks and E. L. Stover

*Eastern Illinois State Teachers College, Charleston, Illinois*

This collection of fleshy ascomycetes was made rather causally over the last ten years; however more species were found last fall than in any one preceding year. The collection was made by Mr. Stover, other members of Botany Department staff, and students. All species were collected in Coles, Clark, and Edgar Counties. The names are those used by Seaver in "North American Cup Fungi"<sup>2</sup> except *Leotia* and *Geoglossum*, forms not described by Seaver.

This collection consists of forty-one representatives; nine genera of *Pezizaceae*, two genera of *Elvelaceae*, two species of *Leotia*, and *Geoglossum glabrum*.

### PEZIZACEAE

<i>Bulgaria rufa</i> Schw.....	May
<i>Humarina araneosa</i> (Peck) Seaver.....	Sept.
<i>Humarina</i> spp. ....	Sept. Oct.
<i>Patella albida</i> (Schaeff.) Seaver.....	Oct.
<i>Patella scutellata</i> (L.) Morgan.....	Oct.
<i>Paxina corium</i> (Weberb.) Seaver.....	summer
<i>Paxina hispida</i> (Schaeff.) Seaver.....	summer
<i>Paxina olivaceae</i> (Clements) Seaver.....	Sept. Oct.
<i>Paxina platypodia</i> (Boud.) Seaver.....	Sept. Oct.
<i>Paxina semitosta</i> (Berk. and Curt.) Seaver.....	Sept. Oct.
<i>Paxina subclavipes</i> (Phill. and Ellis) Seaver.....	Sept. Oct.
<i>Peziza badia</i> Pers.....	Sept. Oct.
<i>Peziza brunneoatra</i> Desm. ....	Sept. Oct.
<i>Peziza griseorosea</i> Ger. ....	Sept. Oct.
<i>Peziza repanda</i> Pers. ....	Sept. Oct.
<i>Peziza succosa</i> Berk.....	Sept. Oct.
<i>Peziza sylvestris</i> (Boud.) Sacc. and Trott.....	Sept. Oct.
<i>Peziza violacea</i> Pers.....	Sept. Oct.
<i>Plectania floccosa</i> (Schw.) Seaver.....	spring
<i>Plectania occidentalis</i> (Schw.) Seaver.....	spring
<i>Scodellina leporina</i> (Batsch) S. F. Gray.....	Sept. Oct.
<i>Sphaerospora brunnea</i> (Alb. and Schw.) Masee....	Sept. Oct.
<i>Sphaerospora hinnulea</i> (Berk and Br.) Masee....	Sept. Oct.
<i>Urnula craterium</i> (Schw.) Fries.....	spring, summer, fall

### ELVELACEAE

<i>Elvela albipes</i> Fuckel.....	Sept. Oct.
<i>Elvela atra</i> (Pers.) Boud.....	Sept. Oct.
<i>Elvela brevissima</i> Peck.....	Sept. Oct.
<i>Elvela caroliniana</i> (Bosc.) Nees.....	April
<i>Elvela crispa</i> (Scop.) Fries.....	Sept. Oct.

Elvela elastica Bull. Herb. Fr.....	Sept.	Oct.
Elvela Klotzchiana Strum.....	Sept.	Oct.
Elvela underwoodii Seaver.....	April	
Morchella angusticeps Peck.....	April	May
Morchella conica Pers.....	April	May
Morchella crassipes (Vent.) Pers.....	April	May
Morchella deliciosa Fries.....	April	May
Morchella esculenta (L.) Pers.....	April	May
Morchella hybrida (Sow.) Pers.....	April	May
Leotia lubrica Pers.....	Aug.	Sept.
Leotia chlorocephala Schw.....	Aug.	Sept.
Geoglossum glabrum Pers.....	Oct.	

The general opinion seems to be that fleshy ascomycetes are vernal. Most of this collection was made in the fall. The species of *Morchella*, large forms of *Elvela* (*E. caroliniana*, *E. underwoodii*), and six species of Pezizaceae were the only forms collected in spring. V. O. Graham,<sup>1</sup> Chicago reported *Peziza badia*, *P. sylvestris*, *P. repanda* and *P. violacea* as appearing in spring in the Chicago region. These species of *Peziza* were collected in September and October in Eastern Illinois. *Patella scutellata* also reported as a spring form by Graham was collected here in the fall. *Urnula craterium* was found in spring, summer, and fall. It was more abundant in fall.

These specimens may be found in the herbarium at Eastern Illinois State Teachers College.

#### REFERENCES

- (1) GRAHAM, V. O., Ecology of Ascomycetes of the Chicago Region, Trans. Ill. State Acad. Sci. Vol. 25, 1933.
- (2) MASSEE, GEORGE, British Fungus-Flora, Vol. 4, 1895.
- (3) SEAVER, F. J., The North American Cup-fungi (Operculates), 1928.

## Conservation of the Wild Flowers of Illinois

Harry W. Mauntel

*Mendota Township High School, Mendota, Illinois*

Nature's garden has been ruined and in many cases destroyed by man who stands bewildered as he realizes the true situation, wondering how to repair the damage. Many meetings are planned, lectures given, and even Legislative interests are aroused, but little actual work is done about replenishing and remaking the despoiled woodlands. We in America must take a cue from our friends across the Atlantic and restore the beauties of nature in the form of natural forests (not artificial parks), wild open prairies, and in fact in every nook which can not be classed as productive agricultural land. This unproductive land could again be made to give to future generations some of its original glories.

We should start in the home, school, and community to educate the people to the beauties of nature and the healthful outdoor life. True it is today as in years gone by, many individuals lack understanding and interest in the fast disappearing native wild flowers. Nevertheless much interest has been aroused and a movement is on foot for the reforestation of many acres of waste and unproductive land, so why not incorporate in this plan a program of wild flower conservation.

Each year in Illinois, as in other states, when spring arrives the roads are crowded with the traveling public on their way to the scattered woodlands and groves to make a wholesale raid on the few remaining patches of wild flowers. The hepatica *Hepatica triloba*, trillium *Trillium grandiflorum*, lady slipper *Cypripedium parviflorum*, bloodroot *Sanguinaria canadensis*, bluebell *Martensia virginica*, white adders tongue *Ophioglossum vulgatum*, dutchman's breeches *Bicuculla cucullaria*, as well as the common violet will soon suffer extermination if this thoughtless destruction of wild flowers continues. Most of the wild flowers are so delicate that within a few hours they are wilted and withered and as a result are consigned to the roadside or ash heap, the beauty of the woodland faded. The same is true of our native trees and shrubs such as the red bud *Cercis canadensis*, dogwood *Cornus florida*, and wild crab *Prunus serotina*, which being defaced, soon die.

If we must have these native wild flowers in our yard or garden, let us make a careful study of the habitat of each flower and then select with a scientific plan the desirable environment for each particular plant in the new surroundings. For example, we know that the heavy tuberous roots of the bloodroot *Sanguinaria canadensis* can be readily transplanted into a shady nook in the wild flower garden. This is also true of the trillium *Trillium grandiflorum* and *T. sessile* and the jack-in-the-pulpit *Arisaema triphyllum*.

Illinois has passed some legislation protecting a few of the wild flowers that are becoming rare in some localities. This act, approved June 21, 1923, protects the bloodroot *Sanguinaria canadensis*, lady slipper *Cypripedium parviflorum* and *C. hirsutum*, columbine *Aquilegia canadensis*, trillium *Trillium grandiflorum* and *T. sessile*, lotus *Nelumbo lutea*, and *Gentiana crinita* and *G. andrewsii*. With the passage of this act, Illinois became the second state in the Union to pass a law protecting her plant resources.

Through the splendid organization, The Wild Flower Preservation Society (Illinois Chapter) much valuable work has been accomplished in

getting the people of our State acquainted with the native wild flowers, what flowers to protect, and how to protect the rare wild flowers.<sup>1</sup> Much interest could be aroused regarding the conservation of native flowers if there could be organized a definite program of conservation. Various societies or organizations (Woman's club, Kiwanis, American Legion) could carry on this work through posters, interesting lectures, exhibits, and community gatherings as has been done in other states. In the District of Columbia a campaign was made to save the dogwood.<sup>2</sup> Posters and pleas were disseminated through the following agencies: Theater owners, street cars, florists, merchants, Boy Scouts, Girl Scouts, and newspapers. The results were excellent and the dogwood, so common and natural to that section of America, was saved for future generations because the public was aroused, and therein lies our strength.

Following are certain rules regarding the picking of wild flowers which could be used on posters or in leaflets for the education of the public: In picking flowers let us remember (1) That what we have picked and carried away can no longer be enjoyed by anyone else in the place which they made beautiful; (2) that although it is tempting to pick a place clean of every wild flower, most of them will probably be withered before we reach home; (3) that, most important, there will not be enough flowers left in the place to go to seed and make it beautiful again next year.<sup>3</sup>

Other educational information may be used on posters; the following has been used in Illinois to educate its citizens:

#### HELP US SAVE THE WILD FLOWERS<sup>4</sup>

The trillium, lady's slipper, gentian, bloodroot, columbine, lotus, and many of our loveliest wild flowers are fast disappearing from Illinois. Do not pick them—picking flowers destroys their seed. Leave them to beautify the earth. Be a lover, be an enjoyer, be a protector of wild flowers.

We must enlist the aid of the schools of our State in conservation, creating an interest among the teachers and students in Nature's gifts so that this movement will be carried into the future. Interesting lectures, posters, and visual education will implant in the receptive minds of students the proper respect, admiration, and knowledge pertaining to Nature and her ways. The student should be brought into actual contact with nature through field trips conducted by experienced teachers or nature lovers who demonstrate conservation by being satisfied with a few plant specimens and do not molest the rare specimens at all. They should be taught to study the plants in their natural environments rather than to pull them up or pick and take them back to the laboratory. If these suggestions were carried out in our schools and communities there would be little danger of some wild flowers becoming extinct and others so rare, and our new forest sanctuaries and few remaining prairies would again blossom forth in the glories of nature as in the past.

<sup>1</sup> A list, with rules for picking of the wild flowers in Illinois, has been prepared by the Wild Flower Preservation Society of Illinois for distribution to the citizens of this State.

<sup>2</sup> Nature Magazine, April, 1925, p. 249.

<sup>3</sup> Society for the protection of Native Plants, Suggestions about Wild Flowers. Leaflet No. 29, 1918.

<sup>4</sup> Wild Flower Preservation Society, Illinois Chapter, Chicago, Ill.

## Some Effects of Fuel Oil on Plants

George D. Fuller and Margaret R. Leadbeater

*University of Chicago, Chicago, Illinois*

### ABSTRACT

Experiments were carried on with the tomato, the peach, the apple, and with *Ageratum houstonianum*. These exhibited marked variation in their reaction to oil applied to the soil in which they were growing. Where the oil actually entered the tissues a slow death followed. In other cases rather sudden death occurred with no traces of oil within the plant tissues. The experiments lead to the conclusion that commercial fuel oil has a harmful effect when brought into contact with the roots of plants and that the effect is fatal when the quantity is raised above the critical point for the species.

This article has been published in full in *Plant Physiology* 10: 817-820. 1935.

## Some Paleozoic Gymnosperm Seeds and Their Evolution

A. C. Noé

*University of Chicago, Illinois State Geological Survey*

Early in my collecting of fossil plants in Illinois, I was struck by the abundance of Gymnosperm seeds throughout the entire range of Pennsylvanian strata. The seeds belonged primarily to the orders of Cycadofilicales, and, in some instances, of Cordaitales. Both groups were assumed to have disappeared at the end of Permian time. In September, 1934, I had a chance to examine the type material of G. R. Wieland's Bulletin 31 of the Instituto Geologico de Mexico, in which he describes the Flora Liasica de la Mixteca Alta from the state of Oaxaca, and also of the Bulletin 34 by E. D. Lozano on the Liassic plants of Huauchinango, in the state of Veracruz. These so-called Liassic floras contain an abundance of typical Cordaites leaves and Trigonocarpus seeds. The Cordaites go mostly under the name of Noeggerathopsis, but are typical Eu-Cordaites. The Trigonocarpus and Rhabdocarpus were allowed to keep their genuine names. I found also a number of seeds which seemed to me to be typical Cordaites seeds, but which were called Cycadospermum. I called upon Dr. Carl Burckhardt, retired Geologist of the Mexican Survey, who had published a most complete treatise on the Mesozoic of Mexico. He assured me that the floras of Mixteca Alta and Huauchinango were not Liassic but Dogger. These identifications prove that the Cycadofilicales and Cordaitales can be traced to the Middle of the Jurassic. It would be extremely interesting to follow this clue and to try to establish the connection between these Cycadofilicales and the Cycadophytes which latter form the bulk of the fossil floras of Mixteca Alta and Huauchinango.

A good impression of Codonospermum from coal No. 2 at Spring Valley near LaSalle in Illinois, was published in my Bulletin 52 of the Illinois State Geological Survey, and a beautiful Trigonocarpus seed was found protruding from a coal ball collected near Booneville, Indiana, in the coal seam No. 5 of Illinois-Indiana. It has not yet been cut, but a similar Trigonocarpus seed from another coal ball which had been cut showed practically no structure, but had a little Pecopteris leaf under its sclerotesta. A great many seeds found in coal balls have been sectioned and we are able to see, in many of them, the megaspore membrane, the pollen chamber, the tapetal layer of the nucellus, also the pollen in the pollen chamber, but no embryo has yet been found, although we sincerely hope that that may happen some day.

# Types of Pitting in Conifers

Alan S. Peirce

*University of Illinois, Urbana, Illinois*

This survey is an exposition of those types of pitting which, by virtue of their predominant occurrence in certain taxonomic groups, are regarded as typical. The work is largely compiled from existing literature so organized as to be useful in the diagnosis of coniferous woods. The terms are largely those encountered in the literature, supplemented by certain tentative terms. To select and test those types worthy of recognition, approximately 140 specimens of 95 species, embracing 35 genera, have been examined and have furnished the illustrations. The inexperienced wood diagnostician is cautioned to use these type-characters only in combination with others, owing to the great variability in the anatomy of individual specimens. The classification of Pilger<sup>1</sup> and the anatomical terminology approved by the International Association of Wood Anatomists<sup>2</sup> are employed throughout.

## SURVEY OF TYPES\*

### TRACHEIDS

**Abietinean.**—This is a condition featured by opposite pitting on the radial walls of the deep<sup>3</sup> tracheids of early wood, passing to uniseriate arrangement in the remainder of the growth ring (Fig. 1). The pit borders of opposite pit-pairs are isodiametric and often somewhat compressed at the contiguous edges. Low magnifications suggest vertical crassulae (bars of Sanio) at these lines of juncture, which are shown to be illusions when a higher magnification is employed (Fig. 2). The pit borders of uniseriate pit-pairs present a wider face view and approximately the same height as do those of opposite pitting. Abietinean pitting occurs typically in the Pinaceae, with slight modification in most of the remaining conifers. The exceptions will be noted below as distinctly different types.

**Araucarian.**—The Araucariaceae are distinguished from all other conifers in two important features of tracheid pitting. These are briefly enumerated as, (1) absence of crassulae, and its corollary, (2) various arrangement of pit-pairs (Fig. 3). Pit-pairs are often crowded in such fashion as to present pentagonal or hexagonal margins of the pit borders. Often they are arranged in horizontal rows, but alternate vertically; quite as often they may be in vertical rows, horizontally alternate. Or they may have a two-dimensional symmetry or none whatever. Within the family, the preponderant number of vertical rows per tracheid may be used as a distinction.

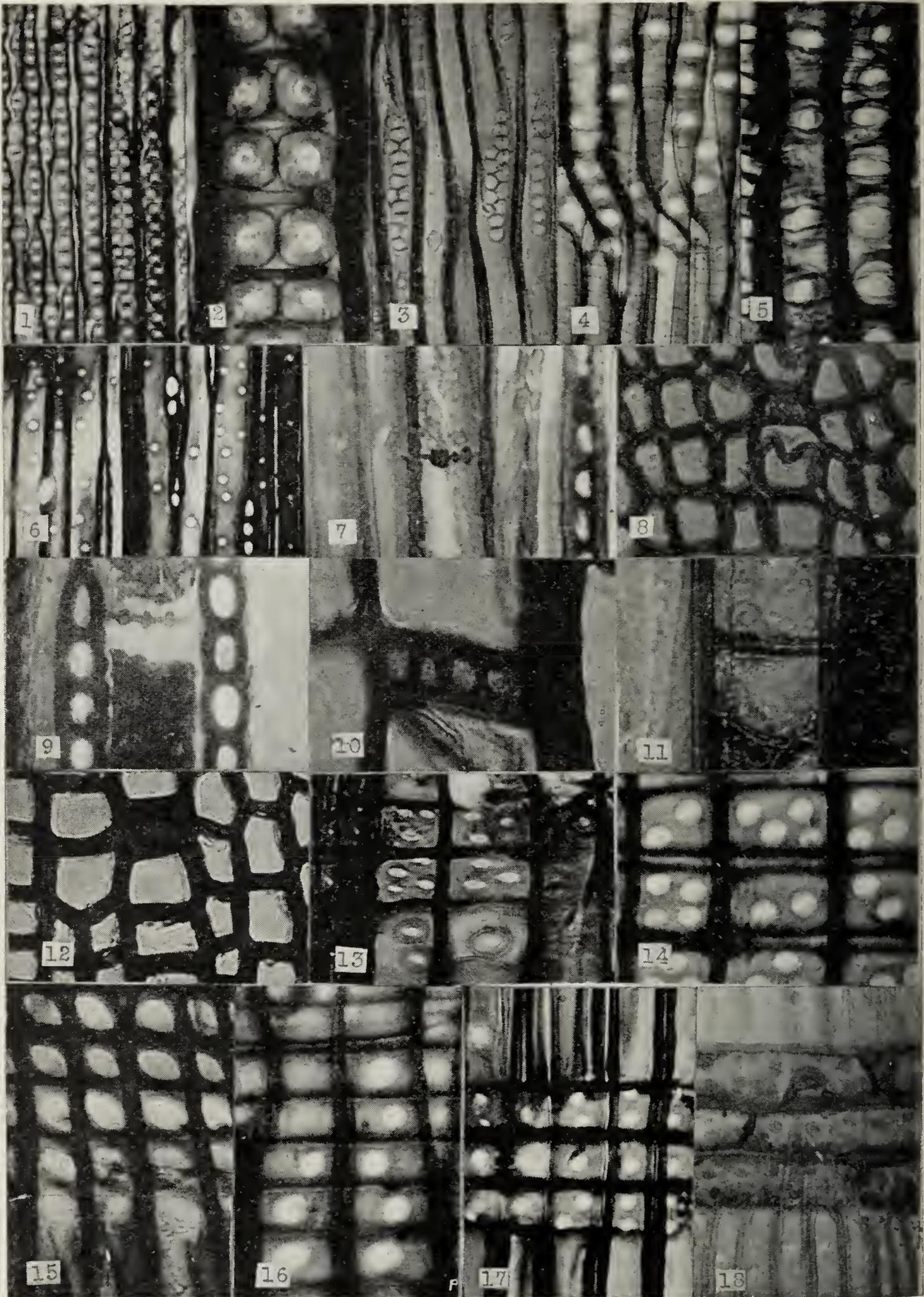
**Taxinean.**—This type is characterized throughout by the occurrence of slender spiral bands of secondary thickening in the tracheid walls (Fig. 4). Bordered pit-pairs are uncrowded and almost without exception uniseriate; the spirals often traverse the borders of the pit-pairs above and below the pit aperture. This type of tracheid sculpture occurs in the Taxaceae and

\* Thanks are due Dr. John T. Buchholz for valuable criticism, the Yale School of Forestry for the greater portion of the materials, and the Field Museum of Chicago for the remaining specimens.

<sup>1</sup> Engler and Prantl. 1926. *Die Natürlichen Pflanzenfamilien*, Band 13.

<sup>2</sup> Committee on Nomenclature, International Association of Wood Anatomists. 1933. Glossary of terms used in describing woods. *Tropical Woods* 36:1-12.

<sup>3</sup> The radial dimension of tracheids is referred to as "depth", to distinguish from the tangential "width".



1. *Pseudolarix kaempferi* (Lind.) Gord. Radial, x100.
2. The same. Radial, x500.
3. *Araucaria excelsa* (Lamb.) R. Br. Radial, x125.
4. *Taxus brevifolia* Nutt. Radial, x250.
5. *Callitris glauca* R. Br. Radial, x400.
6. *Fokienia maclurei* Merrill. Tangential, x150.
7. *Juniperus virginiana* L. Tangential, x450.

Cephalotaxaceae, where it may be used diagnostically on the basis of thickness and frequency of spirals. Similar spirals occur in *Pseudotsuga* and in some species of *Picea*.

**Callitris.**—The tracheids of most species of *Callitris* possess peculiar secondary thickenings which are superposed upon the upper and lower portions of the pit border. These thickenings are slender bands resembling the spirals of *Taxus* in structure. However, they are isolated bands and often lend the appearance of shielding the pit border, since they do not traverse the pit aperture but are convergent at the outer margins (Fig. 5). Distinctions within the genus may readily be made on the basis of this character.

**Tangential.**—In every observed specimen the tangential walls of late wood tracheids have been found to possess bordered pit-pairs (Fig. 6). These are usually smaller than the radial pit-pairs of earlier wood and are isodiametric. The pit aperture is quite small, elliptic, and its long diameter is inclined slightly from the vertical. In section the border exhibits the bluntness characteristic of all bordered pit-pairs formed in thickened tracheid walls of late wood.

#### WOOD PARENCHYMA TRANSVERSE WALLS

**Juniperus.**—The transverse walls of wood parenchyma cells show three distinct variations in the matter of pitting. One of these is found in some species of *Juniperus* and consists of a rather thin wall with delicate knobs of secondary thickening (Fig. 7). The transverse view shows distinctly the communicatory nature of these simple pit-pairs (Fig. 8). This character is intrageneric in the Cupressaceae.

**Taxodium.**—In this type the transverse walls of wood parenchyma cells are considerably thicker and possess correspondingly coarser thickenings (Fig. 9). The transverse view is somewhat similar to that of the *Juniperus* type, although the characteristic coarseness may still be noted (Fig. 10). A considerable degree of constancy renders this character of diagnostic value among the genera of the Taxodiaceae.

**Cupressus.**—This type is featured by absence of pitting rather than by any peculiarity in pit-pairs (Fig. 11). The transverse walls are moderately thick and devoid of the knob-like structures described above. This conclusion is borne out by observation of transverse (Fig. 12) and radial sections as well. This is also a useful character, since it may be used generically as well as within certain genera of the Cupressaceae.

#### XYLEM RAY CROSSFIELD<sup>4</sup>

**Taxodinean.**—This type is characteristic of the Taxodiaceae, with few exceptions. The relatively deep tracheids produce a wide crossfield, with the result that generally from two to four pits are formed abreast. In usually high ray cells, therefore, there may be eight pits in a crossfield. The pit aperture is large and elliptic, ranging from horizontal to

<sup>4</sup> That area of a tracheid wall delimited by the walls of a crossing ray cell.

8. The same. Transverse, x400.
9. *Taxodium distichum* (L.) Rich. Tangential, x350.
10. The same. Transverse, x500.
11. *Fitzroya cupressoides* (Molina) Johnston. Tangential, x550.
12. The same. Transverse, x325.
13. *Sequoia gigantea* (Lindl.) Dec. Radial, x325.
14. *Glyptostrobus pensilis* Koch. Radial, x325.
15. *Rodocarpus nagi* (Thunb.) Zoll et Moritz, Radial, x325.
16. *Sciadopitys verticillata* Sieb. et Zucc. Radial, x350.
17. *Juniperus ashei* Buchholz. Radial, x450.
18. *Cupressus macnabiana* Murr. Radial, x300.

slightly inclined; the pit border is regularly circular (Fig. 13). The width of the border above and below the center of the aperture approximately equals the short diameter of the aperture.

**Glyptostroboid.**—This is a modification of the *Taxodinean* type in that the aperture is larger and the border correspondingly narrower (Fig. 14). The border occasionally appears as an extremely thin “halo,” and in the earliest wood purely simple pits are found. This type is characteristic of *Glyptostrobus* and may be found sparingly among other genera of the Taxodiaceae.

**Podocarpoid.**—In the podocarps the prevalent type of crossfield pitting consists of irregular pits, simple in early wood and elliptically bordered in late wood with a distinct gradient occurring through the year's growth. The predominant form is ovoid, very seldom occurring in excess of two in a crossfield (Fig. 16). They resemble greatly the simple pits of the *Glyptostroboid* type, and occur as most typical in early wood.

**Sciadopityoid.**—The pits occurring on the crossfields of *Sciadopitys* are the logical choice for discussion at this point. The crossfield of early wood bears one large simple egg-shaped pit-pair (Fig. 15). The gradient in this type shows a decrease in border size accompanied by a greater decrease in aperture size. The late wood pits possess a long narrow aperture approaching the vertical, and a still rather broad elliptic to circular border. The form of the early wood pits have no parallel among conifers, the closest approximation being the ray parenchyma pits found in white pines.

**Cupressinean.**—The last of the distinct crossfield pitting types to be discussed here is that found in general among the Cupressaceae. This is perhaps a less definite type than those preceding. Those pits considered as typical are small, occurring from one to two (occasionally four) in a crossfield (Fig. 17). The pit borders are usually circular throughout the year's growth and the apertures are characteristically slit-like, ranging from oblique to vertical, even in the early wood.

#### XYLEM RAY TANGENTIAL WALLS

**Juniperoid.**—The pitting on tangential walls of ray cells falls into two general types. The first of these is termed “*Juniperoid*” and is of frequent occurrence in the Cupressaceae, where it may be employed generically as well as within certain genera. The walls exhibiting this type of structure range from very delicate to moderately thick, and are equipped with knob-like thickenings similar to those described for the transverse walls of wood parenchyma (Fig. 17). No attempt is made here to separate this feature into two types according to coarseness.

**Cupressoid.**—The second general type of tangential ray cell wall is smooth and entire (Fig. 18). The walls showing this condition may vary considerably in thickness in different species, while remaining moderately constant within species, illustrating the diagnostic possibilities of this character.

#### SUMMARY

Illustrated descriptions are given of various moderately constant “types” of conifer pitting. Among these are four conditions occurring on radial walls of tracheids, three occurring on transverse walls of wood parenchyma, five on crossfields, and two on the tangential walls of ray cells. The descriptions are accompanied by the general distribution and potential diagnostic value of the types. Care should be taken to use these characters only in combination with others, because of great variations in wood anatomy.

# The Origin of Adventitious Roots From Leaf Cuttings of *Saintpaulia ionantha* Wendl.

Katherine Louise Schmitkons  
Northwestern University, Evanston, Illinois

## ABSTRACT

Leaf cuttings of *Saintpaulia*, which is commonly known as the African violet, were found to root readily from the cut surface of their petioles within 18 to 20 days after planting in moist sand boxes. The purpose of this investigation was to study the origin and development of adventitious roots thus formed.

Microscopic sections of the basal portions of petioles, which had been planted from 4 to 18 days, were studied and compared with vertical and transverse sections through petioles of various ages, which had not been planted.

The first noticeable change from the normal structure of the petiole is the formation of a zone of meristematic activity in a region immediately surrounding the vascular bundles (Fig. 2, a). This activity appears to be correlated with a basal enlargement of the petiole.

A circular trough is formed by the disintegration of parenchyma cells in a region immediately outside the zone of increased activity. This disintegration of cells and the failure to produce callus tissue are attributed to the succulent nature of the petiole.

Root primordia are initiated within the zone of increased activity by the division of small groups of parenchyma cells in: (a) the undifferentiated central region in one side of the vascular bundle; (b) a region in line with the undifferentiated central region of neighboring bundles; (c) the parenchymatous zone adjacent to the xylem or phloem of a vascular bundle.

The formation of a root primordium involves the change of several parenchyma cells from an inactive to a meristematic condition, and subsequent radial and tangential divisions of these cells.

Growth of the primordium is by: (a) the division of initial cells, (b) enlargement of newly formed cells, (c) initiation of divisions in adjacent parenchyma cells and their incorporation into the root complex.

Differentiation of root tissues begins soon after the organization of the root apex.

A young root grows at right angles to the axis of the petiole, but turns down before reaching the epidermis. Roots begin to emerge through the cut surface of the petiole 18 days after planting, and within 8 to 10 days after their initiation (Fig. 1).

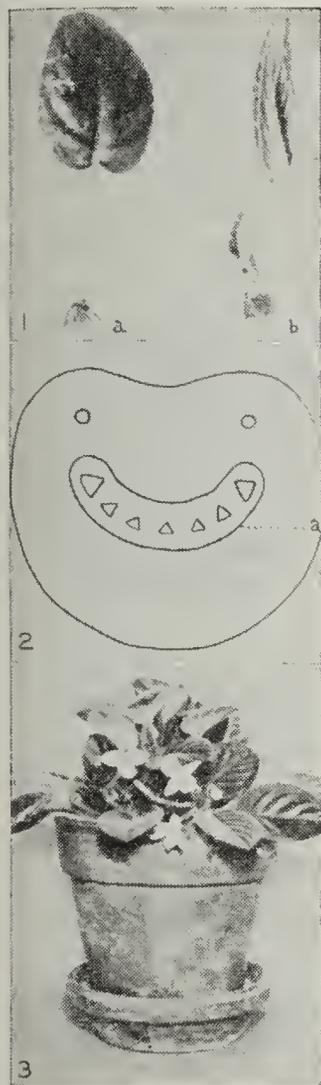


Fig. 1a. Petiole 3 weeks after planting. 1b. Petiole with adventitious shoot. 2. Cross-section of mature petiole. 2a. Crescent of vascular bundles surrounded by parenchyma cells in which divisions in localized groups of cells are initiated. 3. *Saintpaulia ionantha* Wendl.

## The Paleobotanical Significance of Plant Structure in Coal\*<sup>o</sup>

James M. Schopf

*Illinois State Geological Survey, Urbana, Illinois*

Some remarkable plant structures may be obtained from bituminous coal by the various techniques now available. The methods generally practiced are: (1) Thin section technique, whereby the sections are ground until they become translucent; (2) relief polishing and etching procedure; and (3) maceration, in which all the humified material is removed, leaving the chemically resistant parts free of the matrix.

In thin sections of coal, cuticles and spores are clearly shown in cross section and have been abundantly figured in the literature of coal microscopy.<sup>1</sup> Recent results of etching procedure are discussed by W. S. McCabe in this same volume.<sup>2</sup> Maceration technique as applied to Illinois coals has been reported by L. C. McCabe<sup>3</sup> who presented the first general proof of the applicability of the maceration procedure to Illinois coals. Other techniques are given by Zerndt<sup>4</sup> and Jurasky.<sup>5</sup>

The material presented here has been obtained through study of thin sections and macerated residues of Illinois coals No. 5 and 6 at the Illinois Geological Survey. Spores and cuticles, because they are resistant to chemical oxidation, are well adapted to study by maceration.

Some of the microsporangial spore groups from coal No. 5, Williamson County, are shown in Plate I, Figs. 1-4. The narrow elliptical grouping indicates fructifications of synangial nature, roughly comparable with those figured and described by Halle<sup>6</sup> in a recent paper. Since the spores were embedded while still in their sporangia and are relatively small, they probably represent immature organs that had not attained full growth. Additional studies of this coal using maceration and etching methods will reveal more about these organs.

The salient external characteristics of the genus *Triletes* Reinsch<sup>7</sup> are illustrated in the diagrammatic drawings (Pl. I, Figs. A, B, and C). This is the name applied to some of the large trisymmetric lycopod megaspores so

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

<sup>o</sup> Acknowledgement is given for materials, facilities, and cooperation rendered the author while employed as research assistant to Dr. G. H. Cady under a cooperative agreement with the National Research Council, at the Illinois State Geological Survey.

<sup>1</sup> Thiessen, R., U. S. Bureau of Mines Bul. 117, 1920; et seq.; also others cited here.

<sup>2</sup> Page 177.

<sup>3</sup> McCabe, L. C., Some Plant Structures of Coal: Trans. Illinois State Acad. Sci. 24:321-6, 1931.

<sup>4</sup> Zerndt, Jan, Les Megaspores du Bassin Houiller Polonais. Academie Polonaise Des Sci. et Lettres, Comite Des Publications Silesiennes—Travaux Geologiques No. 1, l'ere partie, Krakow, 1934, p. 3.

<sup>5</sup> Jurasky, K. A., Die Macerationsmethoden in Palaobotanik. Handb. biol. Arbeitsmethoden, Abt. XI, teil 4, 331, 1931.

<sup>6</sup> Halle, T. G., The Structure of Certain Fossil Spore-Bearing Fructifications Believed to Belong to Pteridosperms. Kungl. Svensk. Vetensk. Handlingar, Tredje series, B. 12, No. 6:1-103, 1933.

<sup>7</sup> Reinsch, P. F., Micro-PalaeoPhytologia Formationis Carboniferae. Theo. Krusche, Erlangen: Bernard Quaritch, London: 1884 (Reviewed by Bartlett, H. H., The Genus *Triletes*, Reinsch. Mich. Acad. Sci. Arts and Letters, 9;29-30:1928).

common in coal and in some carboniferous shales. The descriptive terminology has been in part rendered from the German and French and in part from current botanical usage. A few additional designations are here introduced where an appropriate term seemed to be lacking. It is hoped by the presentation of this fairly complete terminology to encourage the use of more adequate descriptions in new species subsequently described.

### TRILETES Reinsch

#### *Triletes cf. giganteus* Zerndt

(Pl. I, Fig. 5)

This is an enormous megaspore of the division *Laevigati* which has been described by Zerndt.<sup>8</sup> It reaches a maximum length of over 6 mm. Although not common in any Illinois coal thus far examined, it is present in No. 6 coal at several localities. This specimen consists of only the proximal portion, to which abortive sister spores are attached, a fairly characteristic condition. This is the first record of occurrence in this country. European localities are given by Zerndt<sup>9</sup> and by Wicher<sup>10</sup> in the Polish coal basin and the Ruhr respectively.

#### *Triletes triangulatus* Zerndt

(Pl. I, Fig. 6, *a* distal surface, *b* proximal surface)

This type of spore is assigned to the division *Zonales*, due to the well developed equatorial flange. In size and form this spore is not dissimilar to those of some present day species of *Isoetes* or *Selaginella*. The distal surface of the body of this spore (Fig. 6 *a*) shows a definite coarse reticulation. The surfaces of the pyramic areas ordinarily have a dull-textured even surface. Maximum diameter of the individual shown, measuring diagonally from one radial extremity, is 732 mu. The body of the spore is 532 mu in diameter.

The species is apparently also found in the Polish and in the German Carboniferous coals, although later work may differentiate within the group that is given here as a single species.

### MONOLETES Ibrahim 1933

*Monoletes* was proposed by Ibrahim<sup>11</sup> as a provisional name for spores having one "dehiscence" mark and bilateral symmetry, a designation coordinate with the Reinsch genus *Triletes*. It is used here in this sense and is regarded as a useful addition to spore nomenclature. As more information accumulates, it may be desirable to restrict the genus to spores of the general character seen in those mentioned below, although it would be premature to do so now.

<sup>8</sup> Zerndt, Jan, *Triletes giganteus*, n.sp., eine riesige Megaspore aus dem Karbon. Bull. International De l' Academie Polonais d. Sci. et Lettres, Ser. B. vol. 1(7) ;71-79; 1930.

<sup>9</sup> Zerndt, *ibid.* 1930; also 1934.

<sup>10</sup> Wicher, C. A. Sporenformen der Flammkohle des Ruhrgebietes. Arbeiten aus dem Institut für Paläobotanik und Petrog. der Brennstoffe Band 4, (IV), p. 172, 1934.

<sup>11</sup> Ibrahim, A. C. Sporenformen des Aegirhorizonts des Ruhr Rievers. Dissertation, Berlin, (1932), published 1933.

A form considered as new, which occurs in great abundance in Illinois No. 6 coal agrees with this generic diagnosis and shows general similarity with one of the species included in *Monoletes* by Ibrahim.<sup>12 13</sup> Unfortunately Ibrahim relied almost entirely on descriptive formulae in the works cited. These do not permit the flexibility so necessary for precise description nor is his accompanying figure sufficiently detailed to establish the precise characteristics of the spore resembling the new species of *Monoletes* here described. As far as may be ascertained, however, the Illinois form is quite distinct from Ibrahim's species which we will refer to as *Monoletes ellipsoides*.

In the previously mentioned paper by Halle, the spores of Whittleseya and Goldenbergia are illustrated and both agree fairly well with the new *Monoletes*. In general the latter is larger than those of Halle but the resemblance is so close that the plants may have been identical. Spores of *Codonothea caduca* described and figured by Sellards<sup>14</sup> are also smaller and may be readily distinguished by other features; however, if found separated from the fruiting structures, the spores of *Codonothea* would also be assigned to *Monoletes*. The *Dolerophyllum* prepollen described by Renault<sup>15</sup> likewise is similar in general appearance. It would seem more in keeping with the known facts to class isolated spores of this type also with *Monoletes* rather than assigning them, perhaps erroneously, with *Dolerophyllum* as Zerndt<sup>16</sup> does.

*Monoletes ovatus* sp. nov.\* is the name proposed for this spore, as shown in Pl. I, Fig. 7, found in its characteristic occurrence, separate from identifiable remains of the mother plant. Holotype, designated "Monoletes ovatus", slide collection of the Illinois State Geological Survey, Belleville column (No. 3), Bench 3, Section 30, from Illinois coal No. 6 at Belleville, Illinois.

The dimensions of the spore body average about 450 mu in length and 340 mu in breadth. The haptotypic<sup>17</sup> structures (i. e. "due to contact and other relations with their neighbors during growth"), show that this spore was probably the result of succedanic mother cell division.<sup>18</sup> The faces of juxtaposition in tetrad (corresponding to the pyramic areas of trisymmetric spores) are of varying width, usually about one-half the short radius of the spore or about 85 mu near the center. The marginal lines of these two faces

<sup>12</sup> Described as: *Sporonites ellipsoides*, Potonie, Ibrahim & Loose Sporenformen aus den Flozen Agir und Bismark des Ruhrgebeites. Neues Jahrbuch fur Min. Geol. u. Paleont., Beilage Bd. 67, Abt. B. 449, 1932. Also as: *Laevigato-sporites ellipsoides*, Ibrahim, Ibid, p. 40, 1933. There would seem to be good reasons for rejecting the generic terms as used in these instances and this topic will be discussed more fully in a forthcoming publication.

<sup>13</sup> The other monolete species of Ibrahim show considerable difference from the form mentioned, chiefly in size, sufficient to suggest that different orders of plants may be grouped together under the original usage. It is hoped that this may be adjusted more satisfactorily in the course of later work.

<sup>14</sup> Sellards, E. H., *Codonothea*, a New Type of Spore-Bearing Organ from the Coal Measures. American Journ. Sci. 4th series, Vol. 16; 87-95, 1903.

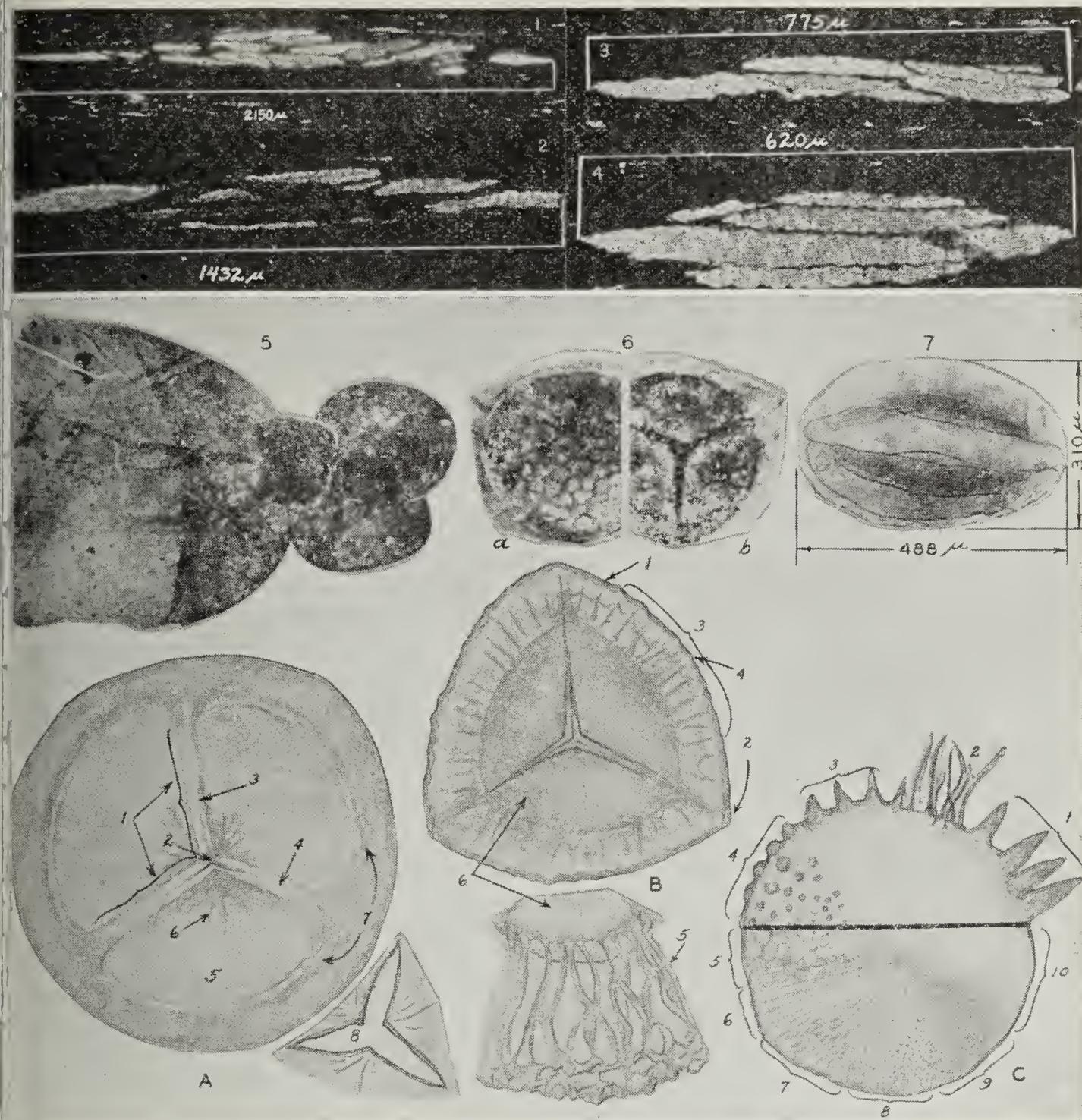
<sup>15</sup> Renault, B. Bassin houiller et permien d'Autun et d'Epinaç. Paris, 1896.

<sup>16</sup> Zerndt, Jan, Megasporen aus einem Floz in Libiaz (Stephanien). Bull. Int. de l'Acad. Polon. des Sci. et Lett., Ser. B., (1); p. 55, 1930.

\* Sporae ovaes longitudinae ca. 450 mu, latitudinae ca. 340 mu, superficibus glabris sed non radiantibus. Proximae superficies tres ostendunt strias longitudinales, quarum duae laterales curvatae, media magis quam ceterae striata. Omnes autem in fine sporae coniunctae sunt. Murus sporae crassitudinae ca. 12 mu.

<sup>17</sup> Wodehouse, R. P., The origin of symmetry patterns of pollen grains. Bull. Torr. Bot. Club 56 (7); p. 340, 1929.

<sup>18</sup> Tammes, P.M.L., On the origin of number and arrangement of the places of exit on the surface of pollen grains. Recueil des Travaux Bot. Neerlandais 27; p. 4, 5 et Seq., 1930.



Figs. 1-4, Synangial groups of microsporangia containing spores.  
 Fig. 5, *Triletes* cf. *giganteus* Zerndt. ca. 18 x. Fig. 6, a and b, *Triletes triangulatus* Zerndt.  
 Fig. 7, *Monoletes ovatus* sp. nov., photograph of Holotype.

Figs. A-C, ASSEMBLED MORPHOLOGIC FEATURES OF TRILETES Reinsch.

Haptotypic Characters\*

- Fig. A, (all Divisions)  
 TRILETE MARKING
1. RADII
  2. APEX
  3. LIP
  4. SUTURE
  5. PYRAMIC AREAS
  6. PYRAMIC PLI-CATIONS
  7. ARCUATE RIDGES
  8. TRILETE APER-TURE

- Fig. B, Division *Zonales*
1. EQUATORIAL RIM or FLANGE (produced by super-development of the arcuate-ridges)
  2. RADIAL EXTREM-ITY
  3. INTER-RADIAL AREA
  4. FLANGE STRIATION
  5. ROTATE APPEND-AGE (notched rim attached by narrow anastomosing pro-cesses)
  6. BODY OF SPORE\*\*

Emphytic Characters\*

- Fig. C, *Apiculati* & *Laevigati*
- Division *Apiculati*
1. CLAVUSATE (spiked)
  2. HIRSUTE or SETOSE
  3. SPINOSE
  4. VERRUCOSE
- Division *Laevigati*
5. RETICULATE or BIRETICULATE
  6. CANALICULATE or STRIATE
  7. RUGOSE
  8. PUNCTATE
  9. GRANULOSE
  10. LEVIGATE
    - (1) dull
    - (2) metallic luster

\* Wodehouse, *ibid* 1929.

\*\* In the division *Zonales*, markings of the spore body may vary as in the divisions *Laevigati* and *Apiculati*.

are often obscured by folds occasioned by crushing, however it is generally possible to distinguish them when observed by means of transmitted light. The central longitudinal striation, in most cases, is clearly made out. The spore wall is quite thin (about 12  $\mu$ ) and translucent, having characteristically a light yellow to brownish color. The surface is essentially levigate (the folds present being induced in preservation,) with a tendency toward a dull texture although this is not pronounced. When placed in an aqueous medium these spores often swell, seemingly by osmosis, the flattened sides are distended giving the appearance of an inflated football.

When sporangial masses of this *Monoletes* are found in the maceration residues they show an impressed linear striation indicating a sporangial structure similar to, but with a little narrower locule than that possessed by the *Whittleseya fertilis* of Halle.

Undoubtedly, judging from the numbers of individuals of this type seen in residues from this one coal seam in Illinois, this spore represents a vegetation unit of the original flora which was often dominant or co-dominant in the ancient coal swamp.

It has been the object of this paper to show some of the well preserved plant structures which may be obtained from Illinois coals and to indicate a method of scientific treatment from the botanical viewpoint. Paleobotanic treatment of coals is a field which has long been overlooked and which offers an enormous amount of valuable information that bears directly on problems of coal deposition and paleobotany. It is hoped that more investigators will interest themselves in this type of study since the interpretations to be gained can only be well founded when based on a sufficient body of facts.

## Germination Behavior of the Rose Mallows

Charles A. Shull

*University of Chicago, Chicago, Illinois*

The genus *Hibiscus* is a wide ranging genus, represented in tropical and temperate floras by almost 200 species including herbaceous annuals, perennial shrubs, and even trees. In North America there are over 20 species, seven of which are found in the region covered by such manuals as Britton and Brown, and Gray. Some of the species, because of their hardiness and large showy flowers, have found favor in cultivation. They are commonly referred to as the Rose Mallows.

The family to which the Rose Mallows belong, the Malvaceae, is listed among those whose species may have macrobiotic seeds, that is, they may remain viable for relatively very long periods in dry storage, or buried in the earth. Such seeds usually have a seed coat which resists penetration by water, and are commonly called "hard" seeds. Other families, including the Nymphaeaceae, Leguminosae, Cannaceae, etc., also possess seeds that do not swell readily on contact with free water.

Various species of the Malvaceae are known to be hard seeded. Thus *Sphaeralcea remota*, formerly known in the United States only from an island in the Kankakee River but now known to have a wider distribution, possesses seeds that will resist entry of water for weeks. Ewart (2) lists 15 species of the Malvaceae as macrobiotic, and it is fairly certain that all of these species are more or less hard seeded.

The most common laboratory treatment used to overcome the hard seeded condition of small seeds is the use of concentrated sulphuric acid (sp. gr. 1.84) for a period long enough to carbonize the cuticular waxes which make the seeds impermeable to water. There is much variation in the length of time that seeds can be treated without being injured. In the case of *Gossypium* whose seeds are not really hard but which germinate more readily if the lint is removed, Miss Brown (1) found that 5 minutes is the optimum treatment period for some commonly cultivated varieties. Delinted cotton seeds absorb water more rapidly than undelinted seeds, mainly because the lint holds air and prevents close contact of the seed coat with water. If the treatment is prolonged to 15 or 20 minutes, cotton seeds show some injury which is reflected in slower germination and growth. Raspberry seeds (Rosaceae) can be germinated following sulphuric acid softening of the seed coats, but some varieties will not stand more than 25 minutes, while others require 40 to 45 minutes, or even an hour of treatment to make them permeable to water. If treated too long, all of them are injured.

Miss Jean White (3) tested the seeds of four species of *Hibiscus*, and found that the minimum time of immersion in  $H_2SO_4$  to bring about swelling in water was one hour for *H. heterophylla* and *H. lampas*; 25 minutes for *H. tiliaceus*; and 30 minutes for *H. trionum*.

The Rose Mallows were brought to my attention some years ago by a gardener who had found difficulty in germinating the seeds. Knowing the characteristics of the family, the sulphuric acid treatment was employed to induce swelling. Only 79 seeds were available for the first tests, and the varietal name was unknown. The seeds were first placed in germinative

conditions for a few days to determine whether any of the seeds would absorb water. During this period seventeen seeds swelled. When germination ceased, the remaining hard seeds were dried superficially, an operation requiring only a few minutes since the seeds were unswollen, and then submerged in pure sulphuric acid for 5 minutes. The sulphuric acid was then quickly washed off in cold water to prevent heating the seeds which were carefully neutralized and returned to germinative conditions. Eleven more seeds were caused to swell following this single treatment. This procedure was continued until every seed had germinated. At the close of the test, the hardest seed in the lot had been given eleven 5-minute treatments with sulphuric acid before its structures would admit water enough for germination. The results for the entire series of treatments are shown in table 1.

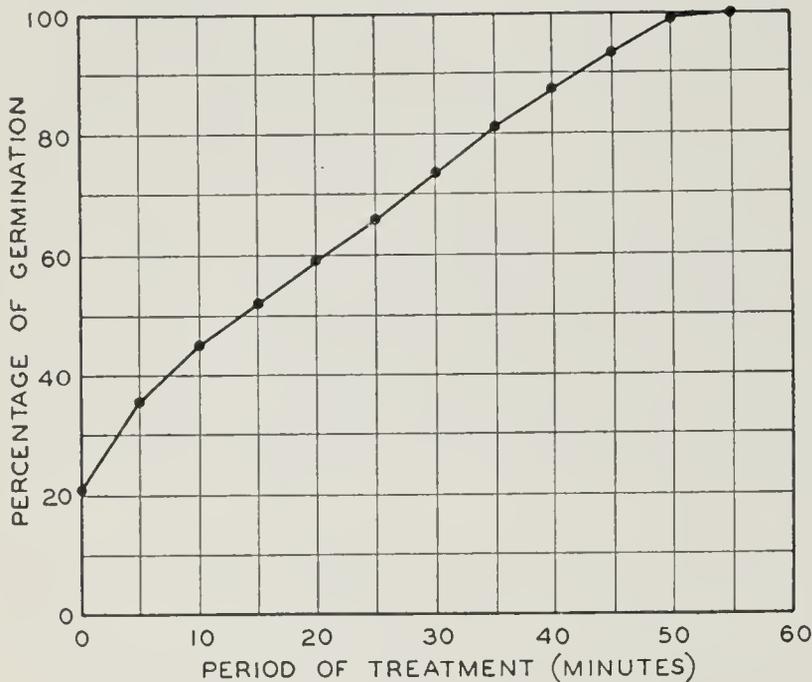


TABLE 1—GERMINATION OF ROSE MALLOW SEEDS FOLLOWING TREATMENT WITH  $H^2SO^4$

Minutes treated	Number germinated	Percentage
0	17	21.5
5	28	35.4
10	35	44.3
15	41	51.9
20	46	58.4
25	52	65.8
30	58	73.5
35	64	81.0
40	69	87.3
45	74	93.7
50	78	98.7
55	79	100

The significance of these results is more readily seen from the graph (Fig. 1) which shows that in a general way the total germination of this lot of hard seeds is a straight-line function of the length of treatment of the seeds in sulphuric acid.\*

Since the first experiment, many tests have been run on various strains of Rose Mallows. They are all more or less hard-seeded except *H. africanus*, which gave 100 per cent swelling without treatment. The variety Golden Bowl usually shows a rather small percentage of hard seeds, although this seems to vary with the conditions under which the seeds ripened and from year to year. In some tests of Golden Bowl as many as 75 per cent were not hard. In Moscheutos Rose, 90 per cent of the seeds required treatment. In one lot of Crimson Eye only about 1 per cent of the seeds swelled without treatment; the other 99 per cent were so impervious that selected groups of them could be kept immersed in water for weeks without any gain in weight.

The efficacy of the sulphuric acid treatment on these exceptionally hard-seeded forms is indicated by the fact that Moscheutos Rose and Crimson Eye germinated to 98 and 99 per cent, with treatments of 45 and 55 minutes respectively in pure sulphuric acid.

#### LITERATURE CITED

- BROWN, AUVAL H., Effects of sulphuric-acid delinting on cotton seeds. Bot. Gaz. 94: 755-770. 1933.
- EWART, A. J., On the longevity of seeds. Roy Soc. Victoria Proc. 21: 1-203. 1908.
- WHITE, JEAN., The occurrence of an impermiabile cuticle on the exterior of certain seeds. Roy Soc. Victoria Prac. 21: 203-210. 1908.

\* More recent experiments show much irregularity in behavior. The data presented here show a condition not commonly found in large scale experiments.

# The Range Indicator Method in pH Determinations of Plant Tissues\*

J. Fisher Stanfield

*Knox College, Galesburg, Illinois*

In studying the pH of certain plants, the necessity arose for the determination of the hydrogen ion concentration of specific tissues within the plant. The variation of the pH from tissue to tissue makes it possible that a mixed liquid expressed from a heterogenous mass of tissues might be misleading in any interpretation of the physiological aspects of the tissues in question. Thus some experiments were conducted with the range indicator method to determine if this method was applicable to the problem at hand and to determine its practicability and objectivity in the hands of the casual worker. Some few results will be given to illustrate the efficiency of the tests.

The methods as given by Small (1) were used with minor variations. Table 1 lists the indicators used with their range as determined by means of the potentiometer with well buffered solutions. In each case the pH listed represents the definite appearance in a very thin layer of solution of the color which is indicative of the pH in question. Variation from the standard ranges is due to the use of this thin layer instead of the ordinary test tube method. Solutions of indicators used were .02-.04 per cent in 5 per cent alcohol. Freehand sections of fresh tissues were used and checked with control sections for natural coloration. Examinations were made with artificial light. A Corning glass globe with a clear, blue Mazda lamp of 75 watts was used as a source of light.

Since this method of pH determination seeks to determine the approximate range, only certain definite colors were recorded and used. These colors were the end points as determined on the potentiometer and the ranges were computed accordingly. No arbitrary ranges were set. It was found possible to distinguish the ranges of pH as shown in Table 2. Other plants were used and many variations were noted.

Difficulty was experienced in determining with exactness the presence of some yellows due to the masking influence of chlorophyll and the tendency of yellow to appear colorless when diluted. There is a variation in the quality of yellow obtained with the different indicators. Blues offered the same difficulties. In general, it is necessary to develop a subjective evaluation of the colors involved which is gained through experience. Although it was found possible to determine differences of pH provided they were of considerable magnitude, no satisfactory determinations of small differences in pH were possible. Results cannot always be checked accurately but certain definite variations in the pH of the various tissues within the plant can be clearly noted. The efficacy of the method is doubtful in the hands of an untrained observer. It can however be used easily in the determination of the pH of liquids such as water, and series of indicators can be arranged to suit the needs of the investigator for such determinations.

\* Contributions from the Biological Laboratories of Knox College No. 47.

1) SMALL, JAMES. Hydrogen-ion Concentration in Plant Cells and Tissues. *Protoplasma Monographien II*. Berlin, 1929.

TABLE 1—RANGES OF INDICATORS USED IN DETERMINATION OF THE pH

Indicator	Alkaline color	pH	Acid color	pH
Brom-phenol blue.....	Blue	> 3.6	Yellow	< 3.2
Brom-cresol green.....	Blue	> 4.7	Yellow	< 3.8
Benzene-azo-a-naphthylamine.....	Yellow	> 4.8	Red	< 4.2
Alizarin red.....	Purple	> 5.0	Yellow	< 4.9
Brom-cresol purple.....	Purple	> 6.2	Yellow	< 5.2
Methyl red.....	Yellow	> 5.8	Red	< 5.2
Di-ethyl red.....	Yellow	> 6.1	Red	< 5.4
Brom-thymol blue*.....			Yellow	< 6.0

\* No ranges higher than 6.0 in this series of tests.

TABLE 2—RANGE OF pH IN TISSUES OF LYCHNIS DIOICA L

Tissues	pH Range	Tissues	pH Range
<i>Ovary</i>		<i>Stem</i>	
Placenta.....	4.1-4.8	Epidermis.....	App. 3.8
Vascular strands.....	4.8-5.2	Cortex.....	3.8-4.8
Ovules.....	4.8-5.2	Sclerenchyma.....	3.7-4.1
Exocarp.....	App. 4.8	Pericycle.....	5.2-5.9
Mesocarp.....	App. 4.8	Phloem.....	5.8-6.2
Endocarp.....	4.8-5.2	Xylem.....	3.7-4.1
		Pith.....	3.8-4.8

## The Status of the Southern Shortleaf Pine in the Northwestern Ozark Region

Lewis M. Turner

*University of Arkansas, Fayetteville, Arkansas*

The presence of the southern shortleaf pine, *Pinus echinata* Miller, in the southwestern part of the central hardwoods region provokes a number of questions. Is it a component of a mixed forest of the region? Is its status established, or is it encroaching upon or being supplanted by, the deciduous species? If it is now encroaching, is it destined to become an important or dominant tree? If it is being supplanted, was it in remote times a dominant species? What was the nature of its initial invasion; as a member of a small group of pioneers, or as a single-species migration?

**Present distribution.**—The southern shortleaf pine occurs from the south Atlantic states to eastern Texas, northward through eastern Oklahoma, northeastward across Missouri to southwestern Illinois, through southern Kentucky, West Virginia, to Staten Island (Sargent, 1922). In the southern part of its range it is a common tree, occurring in pure stands, which are usually "old fields" or "hurricane forest" (Turner, 1935), or as a part of various hardwood complexes. From the Arkansas River northward its occurrence is progressively erratic, with the exception of one area of essentially continuous distribution in north central Arkansas. West and north of there it is found in small, isolated areas separated by thirty to fifty miles of upland deciduous forest and agricultural land (Palmer, 1921). Typifying this condition are the small stands in Union and Randolph counties in Illinois which are also the northernmost extension of the range of the species in this immediate longitude.

In the northern Ozarks it commonly occurs on the south slopes of mountains whose north slopes are occupied solely by deciduous trees. On these south slopes it is usually associated with *Quercus stellata*, *Q. marilandica*, *Q. velutina missouriensis*, *Ulmus alata*, *Juniperus virginiana*, *Bumelia lanuginosa*, *Hicoria buckleyi arkansasa* and *H. villosa*. Less commonly it occurs on east and west but rarely on north slopes. Pure stands are rare and are probably in most cases "old field" or stands established after clearing, heavy lumbering, or tornado.

**Success of reproduction.**—For the most part natural reproduction occurs only in openings, clearings, abandoned fields or pastures that are not heavily grazed. It seems unable to invade even relatively undisturbed forest, whether deciduous, pine, or mixed. However, pine reproduction of all ages has been observed in openings and clearings where sprout and weed competition are not severe. Deciduous tree reproduction is fairly common in older pine stands.

Artificial plantings of one or two-year-old seedlings in the Ozark and Ouachita National Forests and at the University of Arkansas Experiment Station have met with only fair success, for they have high mortality rates unless weed and sprout competition is reduced and grazing animals are excluded. This means that the plantations must be recently abandoned pastures or fields, and that they must be fenced. Even under such conditions about fifty per cent survival is the best that has been attained to date.

**Rate of growth, size, and length of life.**—This species probably has a more rapid rate of height growth than associated species. It usually grows

taller than the scrub oaks and winged elm and as tall as the red, black, and white oaks and others. The age of some pine trees in this region has been determined to be from 150 to 200 years. In general, the life span of the shortleaf pine compares rather favorably with but is probably somewhat less than that of some of the deciduous species.

**Adaptability.**—Data on this pine's adaptability are meager. Apparently, however, it is not much more or less successful than scrub oaks, winged elm, or red cedar in occupying steep, exposed, rocky or otherwise severe sites. In this pioneering capacity, like the deciduous species mentioned, it is, of course, better adapted than the red and white oaks, red maple, shell bark hickory, and others. Although the pine seems to better hold its own on the south slopes, there is not much evidence that it could remain a dominant tree there, except on rocky, very steep situations.

**Winter injury to seedlings.**—In two of the previous three years severe injury to and considerable mortality of shortleaf pine seedlings was recorded at the University of Arkansas Experiment Station. Injury occurred to young trees in late winter during periods of freezing weather following several days of weather warm enough to initiate succulent growth. To what extent this functions against the species in nature is unknown, but it may be an important factor.

**Prehistorical status as related to present performance.**—Data regarding this question as it applies to exactly this region are lacking. However, pollen analysis of peat in the Little Rock region (Sears and Couch, 1932) indicates increasing importance of the species at that spot. This is at the southern edge of the region in question and nearer the described area of continuous distribution in north central Arkansas. Observations of Professor Sears on the present distribution of the pine in Oklahoma, and his recent study of pollen in silts from an ancient lake near the mideastern edge of Oklahoma suggest current invasion of that state from southeast to northwest.

**Discussion.**—The occurrence of small, widely separated stands of southern shortleaf pine in the northwestern Ozark region suggests previous wider distribution and subsequent diminution. It seems improbable that its fruits were blown or carried over distances that exist between present day stands.

The original, or post-glacial invasion of the species into this region must have been under somewhat more favorable circumstances than now obtain, such as the absence of competing deciduous trees, or climatic conditions more favorable to pine than deciduous species, or both of these features. Presumably it entered the region either as a single, pioneer species invading an unforested area, or as a co-pioneer accompanying such species as *Juniperus virginiana* and *Ulmus alata* and ecologically equivalent species.

It is the opinion of the author that the shortleaf pine is waning in northern Arkansas, southern and eastern Missouri, and southern Illinois. This reduction in area occupied has probably been going on slowly; apparently the margin of advantage of the deciduous trees is not great. Doubtless in some areas more favorable to the pine it may hold its own for many centuries, or indefinitely. Its relatively rapid rate of growth, great motility of fruits, and fair success in reproducing itself in clearings will aid in this. On the other hand it seems certain that its area of occupation will not increase unless favored by some circumstances not now operative.

#### REFERENCES

- 1921 PALMER, E. J. The forests of the Ozark Region. Journal of the Arnold Arboretum. Vol. II, pp. 216-232.  
 1922 SARGENT, C. S. Manual of the trees of North America. 2nd Ed. p. 26.  
 1932 SEARS, P. B. and GLENN C. COUCH. Microfossils in an Arkansas peat and their significance. The Ohio Journal of Science. Vol. XXXII, No. I, pp. 63-68.  
 1935 TURNER, LEWIS M. Catastrophes and pure stands of southern shortleaf pine. Ecology. Vol. XVI, No. 2, pp. 213-15, April.

## PAPERS IN CHEMISTRY

---

### EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN

The nine papers comprising the program of the Chemistry Section were all read at the meeting and all but one are here represented.

"Economic Advantages of Water Softening," by A. M. Buswell and W. H. Hudson, State Water Survey, Urbana, was not presented for publication.

Attendance at the meeting averaged fifty-five; maximum attendance was seventy.

Dr. John H. Reedy, Department of Chemistry, University of Illinois, was elected chairman of the Chemistry Section for the year 1935-36.

(Signed) FRED A. DYKINS, *Chairman.*



# The Detection of Fortification or Adulteration of Meat Broth With Monosodium Glutamate

D. T. Englis and Bernard S. Friedman  
*University of Illinois, Urbana, Illinois*

One of the more recent additions to the group of food seasoning materials is monosodium glutamate. Han (1) has given an account of the rapid commercial development of the new chemical condiment in the Far East. Large quantities of the material are now being shipped to the United States, particularly one product of Japanese origin known as "ajinomoto", or in English "essence of taste." Ajinomoto is a white powder which is quite stable under atmospheric conditions. It has a very faint odor and the taste in proper concentration is described as "that of the red juice from roast beef, salty, meaty and appetizing" (2).

It is believed that several manufacturers have found it profitable to use the artificial flavoring substance in place of pure meat broth. The matter was brought to the attention of the writers and a request made that some method of testing be worked out whereby adulteration could be detected.

To establish adulteration, information must be available as to the average composition of samples of known purity so that a comparison can be made with the composition of non-genuine products and relationships found which are indicative of the fraudulent or unfair practice. An effort was made to secure information of this character. Samples were furnished by an interested manufacturer and considerable analytical work was carried out. The constituents determined and the values obtained are indicated in Table 1. Official methods (4) were used. All estimations were made on the liquid portion of the broth from which the suspended solids had been filtered with the aid of Filter-Cel.

An examination of the table shows that the amounts of all constituents in the simulating samples (G and H) is much lower than in the genuine products. If more ajinomoto is used to raise all the values, the ratio (g) of amino nitrogen to total nitrogen, will be increased beyond the normal average. The probability of the clever addition of other materials must also be anticipated. Perlman (5) suspecting the use of certain vegetable extracts and wheat gluten products in bouillon cubes has suggested the ratio of alkalinity of ash (as  $\text{Na}_2\text{CO}_3$ ) to the total ash as a means of detection. For broth this ratio is not as significant as the alkalinity value (c) itself. The addition of rice to the broth apparently has but little influence upon the soluble fraction. One very interesting feature is that the genuine and modified samples have a rather constant ratio (h) of alkalinity of ash to amino nitrogen.

Attempts were made to determine the actual amount of glutamic acid by the method of Plimmer (6) but it was found that the presence of other constituents of the broth interfered with the precipitation of the zinc glutamate. The procedure of Kingston and Schryver (3) was also unsatisfactory for the broth.

With the accumulation of more data, the inclusion of other determinations and evaluation of new constants, it is believed that any improper use of ajinomoto may be satisfactorily determined.

## LITERATURE CITED

1. HAN, J. E. S., *Ind. and Eng. Chem.*, 21, 984-7 (1929).
2. \_\_\_\_\_ *J. Chem. Ed.*, 8, 1586 (1931).
3. KINGSTON and SCHRYVER, *Biochem. Z.*, 73, 306 (1924).
4. *Official Methods of the Association of Official Agricultural Chemists* (1930).
5. PERLMAN, J. L., *N. Y. State Dept. Agr. and Markets, Ann. Rpt.*, 90 (1930).
6. PLIMMER, R. H. A., *Chemical Constitution of Proteins, Part I*, 34 (1917).

TABLE 1—COMPOSITION OF GENUINE AND MODIFIED CHICKEN BROTH  
*Values Expressed in g. per 50 cc. of Liquid Fraction*

Nature of sample	Sample number	(a) Total solids	(b) Ash	(c) Alkalinity of Ash as Na <sub>2</sub> CO <sub>3</sub>	(d) Ratio c/b	(e) Total Nitrogen by Kjeldhl	(f) Amino Nitrogen Van Slyke	(g) Ratio f/e	(h) Ratio c/f
Genuine chicken broth with rice added.	A	1.304	0.5207	0.0388	0.074	0.1160	0.0160	0.137	2.42
	B	1.012	0.4591	0.0475	0.103	0.0728	0.0175	0.239	2.71
	C	2.057	0.5804	0.0406	0.070	0.2338	0.0203	0.087	2.00
	D	1.861	0.5384	0.0437	0.082	0.1948	0.0206	0.105	2.12
	E	1.618	0.5347	0.0417	0.078	0.1710	0.0206	0.120	2.02
	F	1.408	0.5160	0.0248	0.053	0.1368	0.0175	0.127	1.98
	*G	0.881	0.4531	0.0189	0.042	0.0680	0.0098	0.145	1.92
	**H	0.653	0.3905	0.0135	0.032	0.0415	0.0070	0.168	1.93
Pure chicken broth									
Modified broth									

\* Sample G {50 per cent genuine broth.

{50 per cent solution of 0.8 per cent NaCl and 0.3 per cent Ajinomoto.

\*\* Sample H {25 per cent genuine broth.

{75 per cent solution of 0.8 per cent NaCl and 0.23 per cent Ajinomoto.

## Reactions in Fused Pyridine Hydrochloride

A. Long and L. F. Audrieth

*University of Illinois, Urbana, Illinois*

Water alone can no longer be considered the only solvent capable of serving as a reaction medium. The researches of Franklin,<sup>1</sup> Kraus, Walden,<sup>2</sup> and others have shown that numerous solvents yield conducting solutions; and that all substances exhibit solvent properties to a greater or lesser degree. Consequently, it has been found necessary to make decided changes with respect to the definitions of certain classes of compounds in terms of the solvent employed. Compounds ordinarily regarded as salts in the aquo-system have been found to behave as acids or bases in other non-aqueous solvents.

Thus, ammonium salts behave as ammono-acids in liquid ammonia as the solvent,<sup>3</sup> whereas acetates react as aceto-bases in glacial acetic acid.<sup>4</sup> In liquid ammonia, an ammono-base such as sodium amide,  $\text{NaNH}_2$ , reacts readily with an ammono-acid such as cyanamide,  $\text{H}_2\text{NCN}$ , to yield a well-defined salt, in this case sodium ammono-carbonate,  $\text{Na}_2\text{NCN}$ . Similarly, salts of hydrazine and hydroxylamine behave as acids in hydrazine and hydroxylamine, respectively. "Onium" salts, in general, exhibit acidic characteristics in the corresponding anhydro-bases as solvents. An extension of this concept to other solvents has revealed the existence of numerous compounds which may serve as parent substances for solvo-systems of acids, bases, and salts.<sup>5</sup> Since the number of such solvo-systems could be increased without limit, it soon became obvious that confusion would result, particularly with respect to nomenclature.

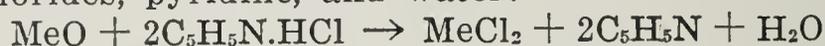
Brönsted brought order in this chaotic field by proposing a general theory of acidity.<sup>6,7</sup> The phenomenon of acidity is simply a matter of competition between the solvent and the acid anion as bases for the proton. Acidity in basic solvents is, therefore, due to the formation of the corresponding "onium" ions. In ammonia, there is formed the ammonated hydrogen ion or ammonium ion, which is the bearer of acidity. In aniline, it is the anilinium ion,  $\text{C}_6\text{H}_5\text{NH}_2\cdot\text{H}^+$ ; in hydrazine the hydrazinium ion,  $\text{N}_2\text{H}_4\cdot\text{H}^+$ .

The question naturally arises: Do "onium" salts in the solid and fused state, in which the "onium" ion must of course exist, also exhibit the properties of acids? Are these compounds a distinctive class of acids, per se? The chemical behavior of fused pyridine hydrochloride conclusively proves that this is true. All other "onium" salts, thus far investigated, have been found to behave in a similar manner.<sup>8</sup>

**Preparation of pyridine hydrochloride.**—Because of the hygroscopic nature of pyridine hydrochloride, the anhydrous salt was always prepared just before use. Three useful methods of preparation were developed: (1)—Hydrogen chloride gas prepared in a Kipp generator by reacting concentrated sulfuric acid with ammonium chloride is dried by passing through two gas-washing bottles containing concentrated sulfuric acid and then introduced into a solution of pyridine in dry ether. Pyridine hydrochloride precipitates immediately as a white salt. Pyridine must be present in excess in order to prevent the formation of pyridine dihydrochloride. The salt is filtered in

a Buchner funnel, washed with dry ether and kept in a vacuum desiccator over anhydrous magnesium perchlorate. (2)—Concentrated hydrochloric acid is added to a slight excess of pyridine and the resulting aqueous solution of  $C_5H_5N.HCl$  distilled. The distillate which comes over at  $218-218.5^\circ C.$  is collected as pyridine hydrochloride. The solidified salt is dissolved in absolute alcohol and crystallized by cooling. The salt remaining in the mother liquor may be precipitated with dry ether. (3)—Anhydrous ether is saturated with dry hydrogen chloride gas and placed in a separatory funnel. This solution is slowly added to pyridine until precipitation of pyridine hydrochloride is almost complete. The melting point of pyridine hydrochloride prepared by any of these methods was found to be approximately  $143-144^\circ C.$

**Reactions in fused pyridine hydrochloride.**—Metallic oxides such as  $CuO$ ,  $BaO$ ,  $MgO$ ,  $PbO$ ,  $Fe_2O_3$ , etc., dissolve in the fused salt to give the corresponding metallic chlorides, pyridine, and water:



Oxides of tungsten, tantalum, thorium, titanium, and tin do not react.  $V_2O_5$  and  $MoO_3$  dissolve to form compounds whose compositions have not yet been determined.

Many metallic chlorides dissolve in fused pyridine hydrochloride in most cases with the formation of double-salts, which may be recrystallized as such from various solvents.



Active metals dissolve to give hydrogen, pyridine, and the corresponding chlorides.



Silver and arsenic were found not to react with the fused solvent.

Many carbonates, hydroxides, nitrates, sulphates, and acid salts were also found to be soluble.

**Electrolyses in fused pyridine hydrochloride.**—Fused pyridine hydrochloride and the fused double salts of which a great many are noted in the literature were found to be good conductors of electricity. However, electrodeposition of metals from such low temperature melts is somewhat limited. The less active metals, arsenic, bismuth and antimony could readily be discharged in the form of good, crystalline deposits.  $Hg$  collected on the cathode in the form of small globules. Cobalt gave a lustrous plate while tin deposited in the form of loose, metallic flakes. Attempts to plate  $W$ ,  $Mo$ ,  $V$ ,  $Mn$ ,  $Cr$ ,  $Al$ ,  $Fe$ ,  $Zn$ ,  $Pb$ , and  $Mg$  were unsuccessful.

#### BIBLIOGRAPHY

1. FRANKLIN, *J. Am. Chem. Soc.*, **46**, 2137 (1924).
2. WALDEN, "Salts, Acids, and Bases", McGraw-Hill Book Company, New York (1929).
3. FRANKLIN, *J. Am. Chem. Soc.* **27**, 820 (1905).
4. DAVIDSON, *ibid.*, **50**, 1890 (1928).
5. AUDRIETH, *Z. physik. Chem.*, **165**, 323 (1933).
6. HALL, *J. Chem. Education*, **7**, 728 (1930).
7. BRÖNSTED, *Chem. Reviews*, **5**, 284 (1928).  
*Ber.*, **61**, 2049 (1928).  
*J. physik. Chem.*, **30**, 777 (1926).
8. AUDRIETH and SCHMIDT, *Proc. Natl. Acad. Sci.*, **20**, 221 (1934).

## Some Tests for Metal Ions Making Use of Organic Dyes

H. J. Long and Horace M. Tenney  
*Greenville College, Greenville, Illinois*

The idea of testing for metallic ions by means of organic dyes and other organic compounds is by no means a new one. A number of current qualitative analysis texts make use of a few such tests. Aluminon seems to be considered quite a satisfactory test for aluminum (1). Dimethyl glyoxime has a wide use in testing for nickel. Likewise the Titan yellow test (2) the Clayton yellow test (3) and the p-nitro benzene azo resorcinol test known as the " & O" test (4) are all being used to detect or confirm magnesium. Also there is quite a long list of similar tests that have been observed but which do not seem to have come into any general use.

It was with the thought of extending the list somewhat and the hope of finding some new rather distinctive tests for metals where needed, that this short and by no means exhaustive study was made at Greenville College as an honors project by a senior major student in Chemistry.

In general, the procedure was simple and consisted in adding a few drops of the dye solution to a five cc. portion of a solution of the metal salt then precipitation of the metal as the hydroxide, carbonate or sulphate.

A relatively small number of dyes was used in these tests, only those which happened to be readily available, ie, aluminon, amaranth, malachite green, aniline yellow, congo red, Clayton yellow, fluorescein, indigo carmine, methylene blue, methyl orange, methyl violet, naphthol yellow S, light green S. F., orange I, ponceau 3R, rosaniline, erythrosin, and picric acid.

Out of the three hundred, or so, possible combinations using one dye and one cation at a time there were three rather distinctive color effects obtained which were not found to have been observed and recorded. These are as follows: a fluorescein test for lead, a fluorescein test for silver, and a naphthol yellow S test for stannous tin. A more detailed description of each follows:

**Fluorescein test for lead.**—To five c.c. of solution containing lead ions are added two drops of a saturated fluorescein solution in equal parts of water and methyl alcohol. Ammonium hydroxide or sodium hydroxide is then added dropwise until precipitation results. A pink coloration usually appears at once. The pale pink or rose colored precipitate soon settles out. If no interfering ions are present the supernatant liquid usually remains the bright yellow color of fluorescein in alkaline solution. This test is sensitive to the extent of one part of lead nitrate to five hundred parts of water in absence of other ions. It is quite satisfactory even in presence of other cations, provided they are not present too greatly in excess of the lead. For instance, mercurous and some colored ions such as ferric iron or copper in appreciable quantities obscure the pink color. In presence of some ions as aluminum, magnesium and antimony the pink color appears immediately

- (1) J. A. C. S. 49:2395 (1927) (Yoe and Hill).
- (2) Biochem. Z. 185:344 (1927) (Kolthoff) C. A. 21:2632 (1927).
- (3) J. S. African Chem. Inst. 11:67 (1928) C. A. 23:1838 (Barnes).
- (4) J. A. C. S. 51:1456 (1929) (Ruigh).

on the addition of the reagent, but on standing it tends to be obscured by the other precipitates. It is rather striking that even in presence of some colored ions such as cobalt the pink lead hydroxide settles out when an excess of ammonium hydroxide is added.

**Fluorescein test for silver.**—The only insoluble carbonate that seemed to adsorb any of these dyes to give any distinctive test is that of silver which also adsorbs fluorescein. The test is performed as follows:

To five c.c. of a dilute solution of a silver salt one or two drops of a saturated solution of fluorescein in a water-alcohol mixture are added and then 4 N sodium carbonate solution added drop by drop. Much care must be used in order not to add too much reagent, as an excess will destroy the color. A pink or rose colored precipitate will settle out. The question naturally arises here whether the precipitate adsorbing the color is a carbonate or an hydroxide. To attempt to precipitate silver hydroxide by the addition of an ordinary solution of sodium hydroxide or ammonium hydroxide always produces a black, silver oxide almost immediately. However, on the addition of calcium hydroxide to the silver solution containing fluorescein there appears to be formed a colloidal suspension of silver hydroxide which has absorbed the dye in the usual manner, imparting the pink color to the entire solution. Also, when a one-tenth normal ammonium hydroxide solution is used, a similar appearance results. In time these two gradually darken and settle out, evidently as silver oxide. This test will detect silver when it is present in one part to five hundred parts of water. This test is satisfactory in the presence of some other metal ions, the pink precipitate settling out and leaving the yellow fluorescein solution above or a mixture of the precipitate of the other metals present. However, the colorless ions—mercurous, mercuric, stannous, stannic, ferrous and some colored ions, such as ferric and nickel do interfere with this test. In the main the interference is evidently due to the interfering ion reducing the silver to black, finely divided metallic silver. Ammonium ions in all concentrations, and alkali metals in high concentrations seem to interfere with this test.

**A naphthol yellow S test for stannous tin.**—If two or three drops of a 2 per cent solution of naphthol yellow S are added to a stannous salt solution and then sodium hydroxide added drop by drop, the color of the solution will change to a bright red-orange or pink. In absence of other cations this test is sensitive in solution containing one part of stannous to two thousand parts of water. However, in the more dilute solutions it is advisable to compare the solution with a blank, otherwise the slight color change cannot be detected. It should be noted that it is not a matter of the precipitate absorbing the dye, as in the two cases of fluorescein which have been described, but rather the color appears more especially in the solution when the amphoteric hydroxide has dissolved in an excess alkali.

Obviously, this test would be of no value in the presence of such metals, as mercury bismuth and silver, whose hydroxides are easily reduced to the colloidal metallic state by the sodium stannite present. Neither will it be of much value in the presence of the colored ions. A striking exception to this is seen though in the case of a dilute copper solution where a good orange color appears. It seems to work satisfactorily in presence of all other ions except that some care must be exercised in those cases where a heavy precipitate is being formed. However in the case of a heavy precipitate of lead chloride the color test is quite sensitive. In the presence of manganese the color is more of a violet, while with magnesium it is of an orchid tinge. The same test may be observed by using ammonium hydroxide or sodium carbonate, although it seems to be more delicate in the presence of sodium hydroxide.

## Some Physiological Responses to Vitamin E Feeding

August J. Pacini

*Pacini Laboratories, Chicago, Illinois*

Probably the most remarkable results of nutrition research during the past decade have been the repeated demonstrations that mammals generally can be reared successfully on simplified dietary mixtures consisting of protein, fat, carbohydrate, mineral salts, and the heretofore known vitamins, particularly A, B (complex) and D, and that although completely normal adulthood is reached the animals sooner or later show a lessened sex urge and lose entirely the power to reproduce. They become sterile.

Aside from the tremendously significant potential therapeutic application of these results to the human, the application to livestock breeding is economically important at this time, and in addition, the byways that are opened up during the more minute study of sterility, lead to findings that profoundly affect genetecists and others.

Vitamins A and B have always been associated with reproduction physiology but even the very great increase of these vitamins in the diet failed to prevent or to cure sterility (1). Finally Evans and his associates clearly established the existence of another fat soluble, Vitamin E and its indispensable relation to fertility (2). Reviews clearly indicate that insofar as reproductive physiology is concerned Vitamin E is absolutely indispensable, and that whereas Vitamins A and B contribute considerably to heightened reproductive ability, unquestionably the combination of Vitamins A, B and E are decidedly more effective. Viewed from this point, the present day vitamin combinations prescribed so freely by physicians are physiologically justifiable but nutritionally incomplete. The omission of Vitamin E is unsound and unnecessary.

Whereas Vitamin E affects particularly the tissues of the foetus and is therefore gaining considerable importance as an element for foetal infectious susceptibility that makes for abortion in cows, and whereas Vitamin E stands in many intimate correlations with animal feeding in offsetting the positively harmful effects of cod liver oil alone, this occasion does not permit of an exhaustive review of the many responses that are obtained by the feeding of Vitamin E. I have chosen to discuss one type of response that is particularly intriguing and that has to do with the artificial control of sex in which Vitamin E appears to be in some way implicated.

The experimental technic was simple. Rats of known strain such as have been bred for use in our laboratories for more than eight years were kept on a balanced stock ration of usual composition.

In place of lard we preferred to substitute refined linseed oil to insure the presence of the indispensable unsaturated fatty acids, linoleic and linolenic. Proper amounts of Vitamins A, B (complex) and D were easily furnished through present day concentrates. Our only difficulty was the insurance of biologically active Vitamin E source for which after several years of experimenting we selected cold pressed wheat germ oil, obtained from fresh germ to avoid losses due to rancidity. Solvent-extracted oils were

thoroughly unreliable in potency, and if potent, in stability. Curiously enough many writers on nutrition dismiss the subject of Vitamin E by admitting its existence and then implying that its widespreadness makes it unimportant. We thoroughly disagree with these unsupported speculations. Our finding is that Vitamin E is not nearly as widespread in sufficiently abundant amounts to prevent nutritional sterility and that anything having to do with reproductive regulation is far from unimportant. Thus, breast milk, like cow's milk, is exceedingly deficient in Vitamin E; so that sucklings dependent upon mother's milk for nutrition are threatened with the ill consequences of Vitamin E deficiency from birth. And some of these ill consequences, like male sterility, are irrevocably irreparable.

In over 7,000 experiments, our findings disclose that if male rats are kept on a diet adequate in every known respect but low in Vitamin E, the litters which they father are small in number and show a sex ratio in which the males are as low as 80 to every 100 females.

If the males are kept on a vitamin E rich diet, they father litters of average normal number and show a sex ratio in which the males exceed the females in the proportion of 110 to 100.

If both the males and the females are kept on rich vitamin E diets, the litters are about of average normal size and the sex ratio reaches as high as 130 males to 100 females.

It is unfortunate that in a brief presentation only a summary of the findings can be submitted. It is desired to indicate, however, that the effect of seasonal incidence on the sex ratio of the rat is thoroughly well known and that the sex ratios which have been presented are the averages inclusive of all the variants excepting the variant of regulated diet.

An interpretation of the observations is considerably more difficult. Such factors as selective mortality must be considered; but when the number of animals in the litters are consistently equal, and yet the ratio of males over females significantly increases, the matter of selective mortality hardly suffices by way of explanation.

There can be little doubt that the chromosomes must receive their nourishment from the nuclear material in which they are imbedded, and it would seem reasonable to assume that if the nutritional pabulum of the chromosomes is profoundly altered, some measure of differential viability might be conferred on the sex-determining chromosomes.

It is perfectly well agreed that there are two kinds of sperms, the Y-bearing or male producing, and the X-bearing or the female producing, and that these exist in millions and in practically equal numbers. It is further assumed that it is largely a matter of chance as to which one reaches the ovum first.

It appears certain, also, that males are more susceptible than females to the vicissitudes of early development and that the general sex ratio of about 105 males to 100 females at birth can be greatly altered by favorable conditions of life.

Some author has said that "if we could discover some anesthetic subtle enough to paralyze one kind of sperm and not the other, voluntary sex determination would soon be a practical possibility." Nothing of the sort has thus far been found; but it is theoretically possible, for the two kinds of sperms must be somewhat different and it would be silly to declare success impossible.

Our experiments are entirely too few to warrant even a suggestion of hope in this direction; but they are sufficiently significant to stress the imperative necessity of vitamin E in the fundamental restoration of viable strength to the male sperm which is notoriously feeble as compared with the female sperm.

## An Inexpensive Ball Mill for General Use

Laurence L. Quill

*University of Illinois, Urbana, Illinois*

A ball mill is a very useful and much needed piece of apparatus in most chemical laboratories. It is also a type of apparatus which is not in continual use except in those laboratories where the research or class work involves the use of considerable quantities of finely powdered materials. In these same laboratories it may be necessary, at times, to grind small, and at others, to grind relatively large amounts of materials. Most ball mills in general use will hold but one sized jar, unless an adapter is used to hold small jars in the larger machines.

In order to have a ball mill which would be fairly inexpensive, which would not occupy too much floor space, and which could be used for ball mill jars or other containers of various sizes, the ball mill shown in the accompanying illustration was designed.

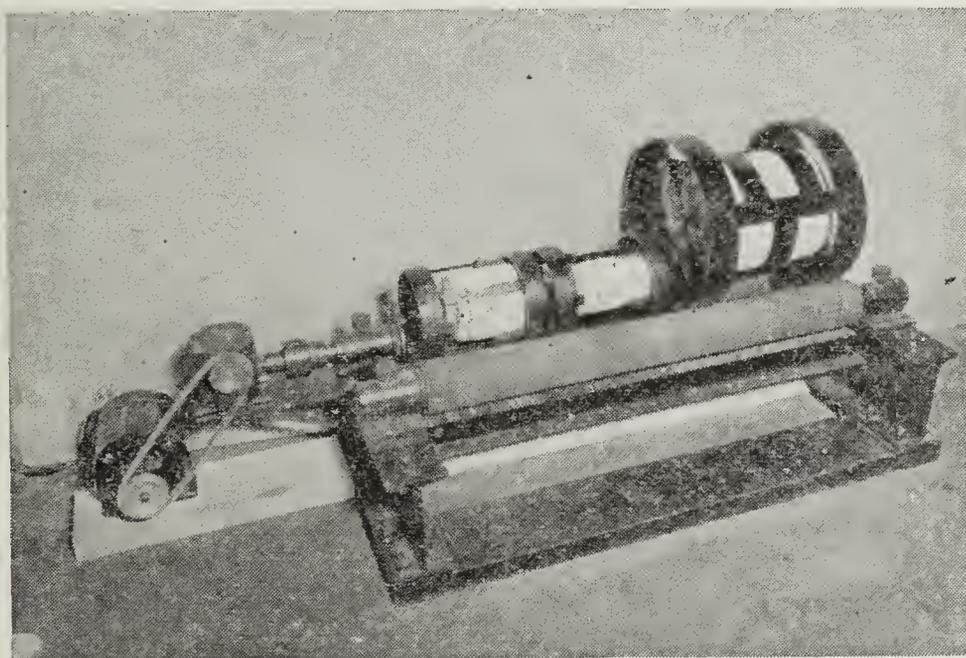


Fig. 1.—Ball mill.

The principle of the device is simple. There are two rollers on which the racks for the ball jars or other cylindrical objects may be placed. One of the rollers is connected to a motor, and may be designated at the "power roller". The other roller is free to rotate as it will. In the photograph the rear roller is connected to the motor through a speed reducer (20:1 ratio) and an ordinary V-belt. The front roller is the "idler". Both rollers were made from 3-inch pipe, into the ends of which plugs were screwed. Pieces of steel rod were inserted in each plug to serve as the bearing axles for the rollers. The bearings for these axles are ordinary brass bearing supports for holding the usual babbitt bearing metal. To increase the friction between the rollers and the racks for the jars, a piece of automobile inner tube was pulled over each of the rollers. This method permits the rubber surface to be replaced as often as needed and with the minimum of expense.

In the illustration, the support for the rollers is shown as pieces of I-beam. They are about two feet long and the distance between them is about three feet. The supports could be made from pieces of timber, railroad rail, or other strong material if I-beams were not available. It can readily be observed that each of the pieces of I-beam has a series of holes drilled in the upper surface. The two bearings for the "idler" have a pair of pins projecting from their lower surfaces. It is therefore possible to regulate the distance between the rollers by placing the pins in the proper set of holes. In the diagram, the rollers are close together as when used for the smaller jars.

The racks for holding the ball jars were also made from inexpensive and easily obtained materials. The rings for the racks were made from water pipe of suitable diameter. For the small jars shown in the illustration, 6-inch pipe was used, and for the large ones, 12-inch pipe. (The small jars have about one liter capacity, the large ones, 6½ liters.) The rings for the large jars are held apart by two pieces of T-iron, which act as the supports for the metal straps holding the jar in the rack. The rings for the small jars are held apart by ½-inch strap iron. One end of the small racks is partially closed by a cross of the strap iron. The jars are held in these small racks by the same device which holds the cover of the jar in place. This device consists of a screw passing through a small rod of iron or steel. When the rod is placed against one of the rings, the screw may be turned down against the cover of the jar, and the jar against the cross closing the other end of the rack, thus holding both the jar and the cover in their proper places.

Since there is an optimum speed for obtaining the best grinding results for different sized containers, this particular mill was driven by a direct current motor, the speed of which can be varied by a rheostat. If only one sized jar is to be used, the variable speed control is not necessary. The best speeds are from about 30 to 75 r. p. m., depending on the diameter of the object being rotated. The length of the rollers may be several feet if desired.

The ball jars used for this mill were purchased from the Ceramics Department, University of Illinois. The actual construction of the machine was done by Arthur E. Wood, mechanic for the Chemistry Department. The cost of materials, which included three small jars and two large jars was about thirty-five dollars.

## Illinois Fluorspar as a Chemical Raw Material

Frank H. Reed and G. C. Finger

*Illinois State Geological Survey, Urbana, Illinois*

Fluorine is the most electro-negative of all the elements. For years its tremendous reactivity was a barrier that resisted the efforts of the most capable investigators to isolate this element. Although Henri Moissan in 1886 finally succeeded in preparing gaseous fluorine by electrolysis of potassium acid fluoride, the reactivity of the element and the resulting difficulties in handling it, have prevented completely the commercial utilization of fluorine.

However, certain inorganic fluorine compounds have been of considerable industrial importance for years. Calcium fluoride in the form of the mineral fluorite is the most important because of its availability as a flux and chemical raw material. Among the other inorganic fluorides of commercial importance are those of sodium, potassium, barium, and zinc, and the corresponding silico-fluorides which are used as insecticides and preservatives. The acid fluorides of sodium and ammonium find use in the laundry and textile industries. A few years ago an organic fluorine compound, dichlorodifluoro methane (commercially known as Freon), came upon the market as a new refrigerant with many desirable properties. Since then many other commercially valuable organic fluorine compounds have appeared and a new industry appears in the process of development.

It is well, therefore, to consider (1) the mineral sources of fluorine in the earth's crust, (2) the present markets for fluorine-containing compounds, and (3) the direction which further utilization of fluorine compounds will probably take.

The three principal sources of fluorine today are (1) fluorapatite ( $\text{Ca}_5\text{F}(\text{PO}_4)_3$ ) in phosphate deposits containing 3.5 per cent fluorine; (2) the mineral fluorite ( $\text{CaF}_2$ ) containing 48.5 per cent; and (3) the mineral cryolite ( $\text{Na}_3\text{AlF}_6$ ) containing 54 per cent fluorine.

The world's phosphate deposits contain the greatest known reserves of fluorine. However, with the exception of fluosilicic acid which is a by-product in the manufacture of acid phosphates, recovery of the fluorine in a usable form is difficult. This by-product has become a problem and expense to the phosphate producers on account of the limited market for fluosilicates and of the problem of its disposal to avoid stream pollution. Therefore, as a raw material for a fluorine chemical industry the phosphate deposits are of limited value.

The principal raw material from which we now obtain our fluorine containing compounds is fluorite, commonly called fluorspar. That this mineral is widely distributed over the earth's surface is shown by the production of over 2,500,000 metric tons from 1922 to 1932, by countries as follows: United States, 42 per cent; Germany, 27 per cent; Great Britain, 15 per cent; France, 7.3 per cent; Italy, 2.4 per cent; Spain, 2.1 per cent; and all other countries, 4.2 per cent. In the United States approximately 80 per cent of the fluorspar produced has been used in the manufacture of basic open hearth steel, 9 per cent in glass and enamel ware, 9 per cent in the production of hydrofluoric acid and derivatives, 1 per cent in foundries, .5

per cent for export and the remaining .5 per cent for miscellaneous uses including optical fluorspar. About 90 per cent of the fluorspar produced in the United States comes from the Illinois-Kentucky mines, Illinois producing slightly more than Kentucky, and accounting for over 1/5 of the total world production.

Since fluorspar deposits vary in purity, it is marketed in various concentrations. The names, uses, and specifications of the three principal grades are: (1) Metallurgical—used principally in the manufacture of basic open hearth steel, contains not less than 85 per cent calcium fluoride and not more than 5 per cent silica; (2) Ceramic—used in the manufacture of glass and enamel ware, contains not less than 95 per cent calcium fluoride and not more than 3 per cent silica; (3) Acid—used in the manufacture of hydrofluoric acid and derivatives, contains not less than 98 per cent calcium fluoride and not more than 1 per cent silica.

The present tariff schedule favors the importation of acid spar to such an extent that it has even been imported for ceramic uses. As most of the acid spar is consumed near the eastern seaboard, the bulk of that consumed is imported. This increases the dependency of the Illinois-Kentucky fluorspar producers upon the basic open hearth steel industry and causes the demand for fluorspar to parallel even more closely the steel production curve.

The third mineral source of fluorine is in the mineral cryolite. Unlike fluorspar, cryolite is not distributed widely in commercial deposits. The only important deposit is in Ivigtut, Greenland, and is owned by the Government of Denmark, and is distributed in the United States by the Pennsylvania Salt Company. Approximately 5,000 tons per year are imported. One of the principal uses of cryolite is in the production of aluminum from bauxite. Synthetic cryolite produced from fluorspar has replaced a large amount of the natural mineral. The limited supply and high price of cryolite prevent its use as a serious competitor of fluorspar.

From the chemical viewpoint fluorspar enters two fields of utilization. The first of these is as a flux for silicate materials and includes its application in the manufacture of basic open hearth steel, cement, glass and enamels. In this field very little is known concerning the chemistry of the reactions involved and the mineral is used in a purely empirical manner. The second field of utilization is in the chemical industries. Here its use has been delayed due to the difficulties encountered in the manufacture of fluorine derivatives and the lack of information in regard to the properties of fluorine containing compounds. However, during the past five years rapid progress has been made in the industrial synthesis of organic fluorine containing chemicals, particularly refrigerants and dyestuffs. Research in this little known field should produce valuable results and promote a more balanced and diversified market for fluorspar. Concurrently, study of the chemical reactions which take place between fluorspar and silicate mixtures should prove of practical value in putting fluxing operations on a sound scientific basis.

The manner in which the fluorspar deposits are laid down makes impossible an accurate estimate of reserves. However, careful study of this field indicates definitely that sufficient fluorspar can be produced in Illinois in any grade desired to meet the demands of the consuming industries for many years.

# Micro Methods in Qualitative Analysis

J. H. Reedy

*University of Illinois, Urbana, Illinois*

Micro analysis seeks to detect very small amounts of unknown substances, either by (1) devising more sensitive tests, or (2) increasing the sensitiveness of old tests by means of improved technique. First among the new tests of high sensitiveness should be mentioned the "spot" tests of Feigl and others, using, for the most part, organic reagents. The chemistry involved is too difficult for students at the time qualitative analysis is ordinarily taken. Chamot has devised microscopic tests, in which derivatives are prepared and identified by their appearance under the microscope. But the work to be presented in this paper is not new reactions, but old reactions done in a new way. It is based upon the work of Behrends, Emich and others, who have shown that the sensitiveness of some of the older reactions may be considerably increased by means of an improved technique. It is proposed to illustrate some of these improvements by the following procedure for analyzing Group I of the cations.

**Precipitation of Group I.**—A single drop each of 1 per cent solutions of  $\text{Pb}(\text{NO}_3)_2$ ,  $\text{AgNO}_3$  and  $\text{Hg}_2(\text{NO}_3)_2$  is introduced into a small test tube, and diluted with 1 or 2 cc. of water. One drop of concentrated  $\text{HCl}$  is added, and the mixture is whirled in a centrifuge for a few minutes. (*Precipitation by centrifugation.*) The clear supernatant liquid is decanted, and the residue is washed with about 1 cc. of water, introduced beneath the precipitate by means of a pipette, so as to provide good mixing. The precipitate is again settled by means of the centrifuge, and the clear liquid is decanted. (*Washing of precipitates.*) In a complete analysis, these two solutions would be combined and used for the analysis of Groups II-V.

**Tests for the  $\text{Pb}^{++}$  Ion.**—The  $\text{PbCl}_2$  in the residue is extracted by adding 1 or 2 cc. of hot water and stirring the mixture, followed again by centrifugation and decantation. (*Extraction.*) After introducing the hot water, the mixture is stirred by blowing gently through a fine pipette extending to the bottom of the tube. Solutions should not be boiled in small test tubes, since the solution is apt to be completely "bumped out" by the bubbles of steam. Hence the water is heated before it is introduced into the tube. The extract is concentrated in a 2 cc. evaporating dish to about 1 cc. by evaporation over a micro burner, taking care that the solution does not boil over. The presence of the  $\text{Pb}^{++}$  ion may then be shown by the following tests:

(1) A droplet of the solution is drawn into a capillary tube, followed by a minute amount of  $\text{K}_2\text{CrO}_4$  solution. This is easily accomplished by touching the end of the capillary to drops of the  $\text{Pb}^{++}$  and  $\text{CrO}_4^{--}$  solutions on a microscope slide. The solutions will rise in the tube by capillary action. The  $\text{PbCrO}_4$  is easily seen at the junction of the two liquids. (*Capillary test.*)

(2) A drop of the  $\text{Pb}^{++}$  solution is placed upon a slide, and a minute crystal of  $\text{KI}$  added. A yellow precipitate of  $\text{PbI}_2$  forms, which may be recrystallized by warming carefully and cooling. It may be necessary to add a drop of water if the amount of precipitate is large. (*Recrystallization.*)

An alternate form of the test is the addition of the KI to a drop of the solution in a small test tube.

(3) If a drop of the  $\text{Pb}^{++}$  solution is placed on a piece of thread or string that has been impregnated with  $\text{ZnS}$ , there appears first a yellow color, rapidly going over into a brown. This color is due to  $\text{PbS}$ , which may further be identified by examination under a microscope. (*Fiber test.*) The sensitized thread or string is prepared by alternate treatment with  $\text{ZnSO}_4$  and  $\text{Na}_2\text{S}$ , following by washing and drying. For general use, sensitized strips of filter paper have been found more satisfactory than threads and strings. Asbestos fibers have also been used for this purpose.

(4) A very characteristic test for  $\text{Pb}^{++}$  is the formation of the triple nitrite,  $\text{K}_2\text{CuPb}(\text{NO}_2)_6$ , as follows: A drop of the  $\text{Pb}^{++}$  solution is mixed with a drop of  $\text{Cu}(\text{C}_2\text{H}_3\text{O}_2)_2$  on a microscope slide, and the mixture carefully evaporated to dryness. After cooling, a drop of a solution made by mixing equal parts of saturated  $\text{KNO}_2$  solution and glacial  $\text{HC}_2\text{H}_3\text{O}_2$  in  $M$   $\text{NH}_4\text{C}_2\text{H}_3\text{O}_2$  is placed upon the stain, and carefully mixed by means of a glass fiber. A precipitate of black cubes appears, best observed under a lens. (*Slide test.*)

**Detection of the  $\text{Hg}_2^{++}$  Ion.**—The residue, from which the  $\text{PbCl}_2$  has been removed, is dried in the original tube by careful heating on a hot plate or over a micro burner. The condensate on the cooler part of the tube may be conveniently removed by strips of filter paper. The lower end of the tube is then heated more strongly, subliming the  $\text{Hg}_2\text{Cl}_2$  on the upper wall of the tube. (*Sublimation.*) The part of the tube containing the  $\text{AgCl}$  is cut off, by scratching with a file and applying a hot end of a glass rod to the scratch. The  $\text{Hg}_2\text{Cl}_2$  sublimate may be further confirmed by adding  $\text{NH}_4\text{OH}$ , but the black stain obtained is no improvement over the original white sublimate as a test for mercurous mercury.

**Detection of the  $\text{Ag}^+$  Ion.**—The end of the tube containing the  $\text{AgCl}$  residue is placed in a micro beaker, and the  $\text{AgCl}$  is dissolved in a few drops of  $\text{NH}_4\text{OH}$ . The solution is transferred to a test tube, and a drop of  $\text{Na}_2\text{SnO}_2$  added, forming a voluminous black precipitate. (*Reduction test.*) This test is surprisingly sensitive, and will give tests for as little as 30  $\gamma$  (0.030 milligram) of  $\text{Ag}^+$ . It is hard to believe that this precipitate consists of nothing but black silver. Probably it contains considerable tin, formed catalytically:  $2 \text{SnO}_2^{--} + \text{H}_2\text{O} \rightarrow \text{Sn} + \text{SnO}_3^{--} + 2 \text{OH}^-$ . This form of test for  $\text{Ag}^+$  seems new. Tananaeff has used  $\text{SnCl}_2$  in a spot test for  $\text{Ag}^+$ , but no record has been found for the use of  $\text{Na}_2\text{SnO}_2$ .

It should be understood that the above procedure is not the one ordinarily used in a micro analysis of Group I. The usual procedure has been considerably modified and lengthened so as to illustrate several forms of the technique of micro chemistry.

## ONIUM SALTS AS ACIDS

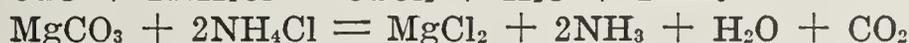
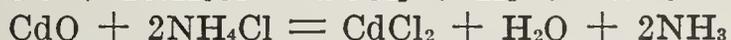
Reactions of Ammonium Chloride at Higher  
Temperatures

Marvin T. Schmidt and L. F. Audrieth  
*University of Illinois, Urbana, Illinois*

It is a well known fact that ammonium salts when dissolved in liquid ammonia behave as acids, but it has only recently been demonstrated that fused ammonium salts exhibit acidic properties.<sup>1</sup> Thus fused ammonium nitrate reacts with metals, oxides, and carbonates in a manner entirely analogous to nitric acid. The actual bearer of acidity in this case is the ammonium ion, which under the circumstances may release the proton (hydrogen ion). It thus fulfills the conditions postulated by Bronsted<sup>2</sup> who defines an acid as "any molecule or ion which may lose the proton".

Reactions in the solid state are also well known. Since the ammonium ions are present as a definite constituent in the crystal lattices of ammonium salts, it was to be expected that the latter might under proper conditions react as acids even in the solid state. Consideration from this point of view of many solid reactions involving the use of ammonium chloride brings clearly to light the true character of these reactions. Thus, the use of ammonium chloride as a flux before soldering operations is based upon its ability to react with metallic oxides. Rose<sup>3</sup> has shown that many metallic oxides and compounds react quite readily with ammonium chloride at higher temperatures. Ammonium chloride has been used widely in the dehydration of hydrated chlorides at higher temperatures in order to repress hydrolysis and the consequent formation of basic salts. In the J. Lawrence Smith method<sup>4</sup> the addition of ammonium chloride aids in the opening up of silicate ores. In the electrolysis of fused chloride melts for the preparation of various metals, the occasional addition of ammonium chloride to remove the basic chlorides which form is recommended.

In further extension of our proposal we are summarizing briefly some of the experimental work carried out in this laboratory during the past few years involving the action of ammonium chloride at higher temperatures upon various metals, oxides and carbonates. All reactions are characteristic acid reactions and may be expressed by the following equations:



**Experimental.**—Rare earth oxides,  $\text{Fe}_2\text{O}_3$ ,  $\text{MgO}$ ,  $\text{PbO}$ ,  $\text{PbO}_2$ ,  $\text{CdO}$ ,  $\text{MnO}_2$ ,  $\text{Sb}_2\text{O}_3$  react completely with ammonium chloride at  $250^\circ$  to yield the corresponding chlorides. The oxides of calcium and barium react more slowly.  $\text{NiO}$ ,  $\text{CuO}$  and  $\text{V}_2\text{O}_5$  give products of indefinite composition. Zinc oxide reacts to give a mixture which, after the removal of the excess ammonium chloride, yields a product that may be distilled unchanged at a red heat and is presumably the compound,  $\text{ZnCl}_2\text{NH}_3$ . Oxides of uranium are converted into uranyl chloride.  $\text{ZrO}_2$ ,  $\text{Al}_2\text{O}_3$  and  $\text{BeO}$  appear to react but slightly.

Carbonates such as  $\text{CaCO}_3$ ,  $\text{MgCO}_3$ ,  $\text{MnCO}_3$  and  $\text{ZnCO}_3$ , were also found to react completely with ammonium chloride under the same conditions. The ammonium carbonate which is formed is dissociated and removed at the temperature of the reaction.

Reactions of this type have been utilized for the preparation of pure anhydrous rare earth chlorides.<sup>5</sup> The oxides are heated with an excess of ammonium chloride until complete reaction takes place. The mixture of rare earth chloride and excess of ammonium chloride is then placed in an all glass vacuum furnace and heated to remove the latter by sublimation at temperatures between 300-320°. In a similar manner anhydrous magnesium chloride and manganous chloride were prepared in better than 98 per cent purity. It should be noted that in the case of manganous chloride, a high purity material could be obtained only if the manganese dioxide was pure. Commercial  $\text{MnO}_2$ ,  $\text{Mn}_2\text{O}_3$  or  $\text{Mn}_3\text{O}_4$  reacted only partially.

In contact with air and at temperatures between 200-300° C. ammonium chloride rapidly corrodes most of the common metals such as iron, nickel, copper, tin, magnesium and alloys such as brass, bronze, Monel metal, Inconel, Hastelloy A, C and D, and high and low carbon steels. In a vacuum, nickel seems to stand up best. It is significant in this connection that ammonium chloride vapor is more active than dry hydrogen chloride.<sup>6</sup>

In the reaction of ammonium chloride with various oxides it has been noted that such volatile chlorides as ferric chloride are removed along with the excess ammonium chloride during the process of vacuum sublimation. This suggests the possible utilization of these reactions in the removal of objectionable impurities from such materials as sand, zirconia, and clays.

#### BIBLIOGRAPHY

1. AUDRIETH, L. F., SCHMIDT, M. T., Proc. Natl. Acad. Sci. 20, 221 (1934).
2. See articles by HALL, N. F. on modern conceptions of acids, J. Chem. Ed. 7, 782-93 (1930); Chem. Reviews 8, 191-221 (1931).
3. ROSE, H., Pogg. Ann. 73, 582 (1848); 74, 562 (1848).
4. TREADWELL and HALL, Analytical Chemistry, 7th ed., John Wiley and Sons, Inc., New York, 1928, vol. 2, p. 425.
5. REED, J. B., J. Am. Chem. Soc. 57, (1935).
6. EDWARDS, R. E., Unpublished investigations.

## PAPERS IN ECONOMICS

---

### EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN

The five papers on the program of the Economics Section concerned the general topic, "Population Trends in Illinois and their Relation to Economic Problems of the State."

Presentation of the papers was followed by a 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.

No chairman was elected for the following year.

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



# Population Trends in Illinois and Their Relation to Economic Problems of the State

Symposium

NOTE: The first paper in the symposium, "History of Population Growth in Illinois and a Forecast of the Future," by H. L. Kellogg, State Planning Engineer, Chicago, was presented at the Friday morning General Session, and is published in No. 1, Volume 28, of the Academy's *Transactions*.

---

## Occupational Changes in the Gainfully Employed Population of Illinois From 1870 to 1930 With Economic Consequences

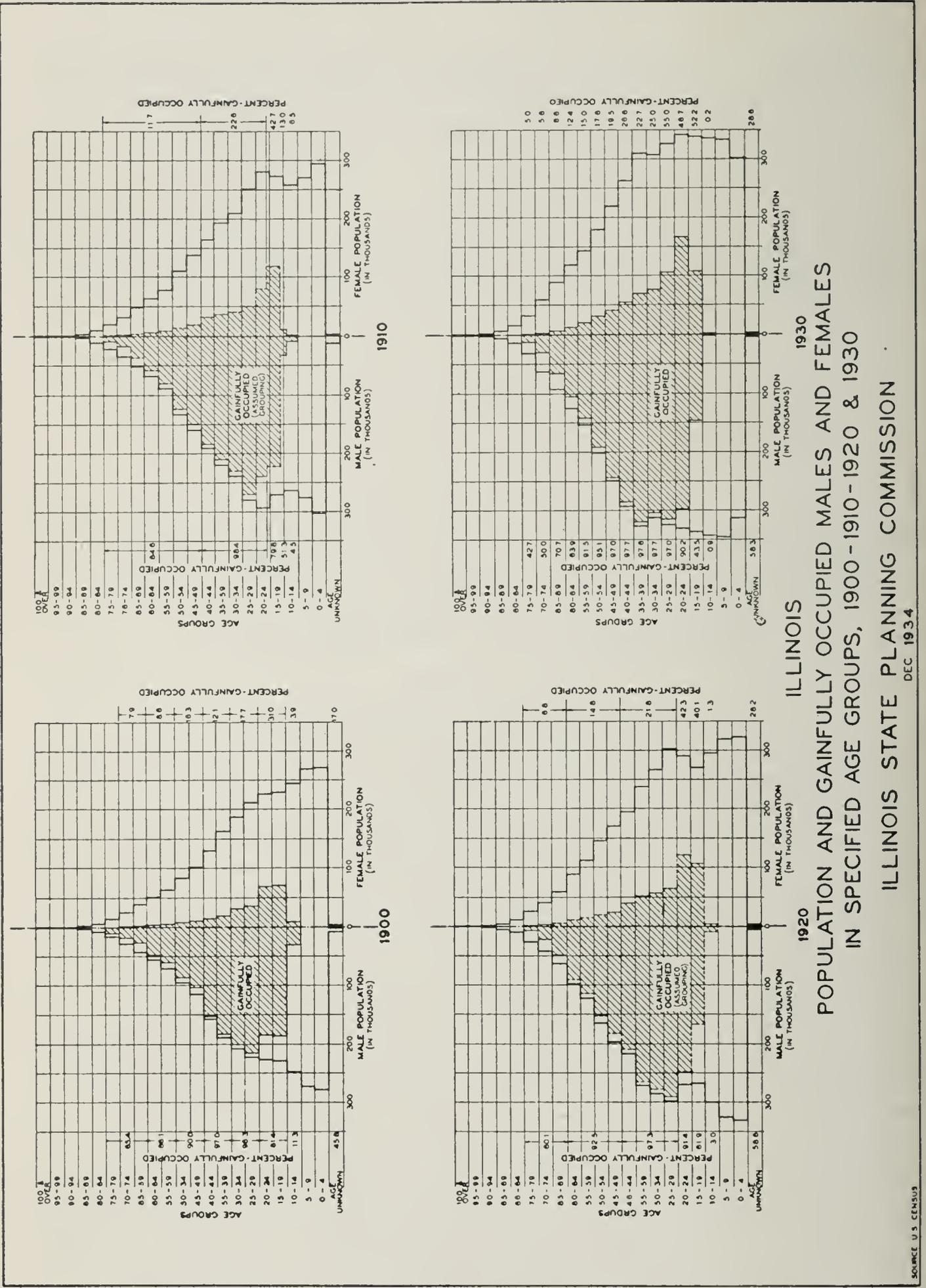
H. L. Kellogg

*State Planning Engineer, Chicago, Illinois*

In 1930 one-fourth of the gainful workers in Illinois were in the manufacturing and mechanical industries. Another 15 per cent were in trade and 22 per cent were almost equally divided between clerical and domestic and personal service. These four classifications totalled 62 per cent of all gainful workers. Agricultural pursuits claimed only 11.1 per cent. Of all those gainfully occupied (3,184,684) 72.8 per cent were native white, 21.2 foreign-born white, 5.5 per cent negro and 0.6 per cent other races. Of the negroes 42 per cent were in domestic and personal service and 31 per cent in the manufacturing and mechanical industries.

The statistics pretty clearly indicate the reasons why unemployment in Illinois is so widespread during depressed times. Since the manufacturing and mechanical industries in this state are largely dominated by those making durable goods, Illinois is, under normal conditions, more unfortunate than states whose gainful workers are more evenly distributed among all the occupations.

This situation is much more acute than it was in 1900. Thirty years ago the number of persons gainfully occupied (not necessarily employed) in durable goods manufacturing was around 185,000. Those gainfully occupied in the consumption goods field numbered about 256,000. Agriculture claimed a much larger number—462,000. In 1930 the gainfully occupied were: durable goods manufacturing, 700,000; consumption goods, 415,000; and agriculture, 354,000. Thus we see that the gainfully occupied in durable goods manufacturing have increased 278 per cent; those in consumption goods have increased 62 per cent, and those in agriculture have decreased 24 per cent.



ILLINOIS  
POPULATION AND GAINFULLY OCCUPIED MALES AND FEMALES  
IN SPECIFIED AGE GROUPS, 1900-1910-1920 & 1930  
ILLINOIS STATE PLANNING COMMISSION  
DEC 1934

Fig. 1.

SOURCE: U. S. CENSUS

Two other important trends in employment are noted: (1) the unusual increase in those in the service industries as compared with production; and (2) the steady gain made in the number of women in the various occupational groups.

In 1870 almost 69 per cent of all persons gainfully occupied in Illinois were in the production industries, and 31 per cent were in the service industries. By 1930, of all persons occupied 45.50 per cent were in the production industries and 54.5 per cent in the service industries, an increase of 76 per cent in the case of the service industries and a decrease of 34 per cent in production. Despite this occupational shift the gain in numbers of those occupied in production increased in Illinois from 1870 to 1930 much more rapidly than in the United States, the respective percentages being 725 and 427. Another comparison along this line is illuminating: In 1870 Illinois contained 6 per cent of all persons in the service industries and in 1930, 7.5 per cent, although it contained (1930) only slightly more than 6 per cent of the total U. S. population. In 1870 more than half of all workers in Illinois were in agriculture; in 1930 only 11 per cent were.

In 1870 slightly more than 29 per cent of the total population was gainfully occupied; of males 10 years and over, 41 per cent were occupied; of females the same age, 7.3 per cent. Since 1870 the percentage of females occupied has been rapidly increasing until in 1930 almost 30 per cent were occupied. The proportion of occupied males 10 years and over had increased by 1930 to 76.8 per cent, yet had fallen back to that point after attaining 80 per cent in 1910. Undoubtedly the World War had something to do with that displacement of men by women.

This increase in women in the various occupational classes leads us to inquire further where the greatest occupational increases have been. The 1930 census shows us that of all women (10 years old and over) in Illinois gainfully occupied, 26.9 per cent were in domestic and personal service, 26.6 per cent in clerical occupations, 17.5 per cent in the manufacturing and mechanical industries, 13.5 per cent in the professional class, and 10.5 per cent in trade. What is more illuminating is the fact that in 1930 women constituted 58.4 per cent of all those gainfully occupied in domestic and personal service, 50.1 per cent of all those in clerical positions, 43.4 per cent of all the gainfully occupied in professional service, 16.1 per cent of all in trade, and even 12.1 per cent of all the gainfully occupied in the manufacturing and mechanical industries. Only 2.3 per cent of women are now reported as gainfully occupied in agriculture.

Viewing all of those in Illinois gainfully occupied from the economic point of view, we find that the numbers in the least secure occupations, the wage-earning class, have increased by more than 1,000,000 since 1900; while the middle class, composed of officials, those in trade, most of the professional class, those in public service who are not owners, and some of the personal service class, have increased by 175,000. This middle class now represents about 10 per cent of all those gainfully occupied. The owners of businesses, clergy, the top professional class and the farm owners and tenant farmers, all of whom have been in the past relatively secure economically, comprise almost another 10 per cent, though their numbers have increased only 35,000 in the past 30 years. Putting the farmer in the secure class under present economic conditions is a dangerous procedure, for about 10 per cent of farm families are now on relief. Further, the U. S. Department of Agriculture finds that the net cash income per farm *family* in the United States has decreased from \$564 in 1929 to \$116 in 1932. Should the farmers be removed from the secure class we are left with a group occupying but 3.2 per cent of all gainfully occupied persons in the state.

If we further examine the economic status of our wage earning classes we find that the average annual wages of full-time employees in the manufacturing industries in 1929 was \$1,482 per individual worker; in the service industries (1933), \$1,235; in retail distribution (1933) \$1,010; and in wholesale trade (1933) \$1,630. These figures do not represent a very large average income for any of the major classes of work.

Retail and wholesale sales, and service establishment receipts have fallen off almost 50 per cent from the 1929 level, making the return on capital invested in such enterprises so low that domestic and personal service workers have been thrown out of employment, adding greatly to the public relief load. In 1929 per capita retail sales for the state were \$486, but in 1933 they were only \$218.

In examining farm incomes, we find that in 1929 the average gross income per farm in seven southern counties was less than \$1,000, and in 37 counties it was less than \$2,000. For farmers' dwellings, in some 17 southern townships the average 1930 valuation of the farm houses is less than \$250. In 25 southern counties the bulk of the townships show an average valuation per farm house of less than \$1,000. Contrasted to these low valuations, a number of northern townships show an average for farm houses above \$4,000.

Viewed also from the standpoint of relief, evidence that Illinois' problem is more acute than that of many other states is found in examining unemployment figures. In 1930 Illinois had 6.2 per cent of the total U. S. population, 6.5 per cent of all those gainfully occupied in the United States, but 8.9 per cent of all the unemployed were in Illinois. Sixty per cent of the unemployed were in the production industries and 30 per cent in service industries.

Twenty per cent of all those in Illinois listed as gainfully occupied in 1930 applied for jobs to the National Re-employment Service or to the Illinois Department of Labor Employment Service during the 10-month period ending in June, 1934.

In conclusion, attention should be called (1) to the large proportionate shift from employment in production industries to the various classes of service employment, (2) to the large proportionate decrease in agriculture, (3) the large proportionate increase in manufacturing and mechanical industries, and (4) the fact that the economic effect of these changes tend to some extent to offset each other in times of depression.

## The Future Population in the Agricultural Industry in the State of Illinois

D. E. Lindstrom

*University of Illinois, Urbana, Illinois*

The population living in unincorporated places and in the open country in Illinois declined steadily in the forty-year period, 1890 to 1930, from 1,630,960 to 1,343,659 people, a decline of 17.6 per cent. The number of people actually living on farms in Illinois in 1930 was 999,391.<sup>1</sup>

The decline of farm population in these 40 years was both in numbers of families on farms and in size of families, for there was a decrease of from 262,953 to 235,974 families on farms, or 10.3 per cent in this same forty-year period. The decrease in the number of families on farms was not a steady decrease, for there was an increase in the decade 1890 to 1900, and in the decade 1910 to 1920. There was an increase in families per farm, for the number of farms decreased about 20 per cent in 1910-30.<sup>2</sup>

The movement away from the farms in the forty-year period prior to 1930 in Illinois was occasioned by a number of factors, including expansion of agricultural opportunities in the western part of the United States, the attraction of opportunities in non-agricultural pursuits in urban centers, the excess of population in the country due to a higher birth rate than in the city, and in the last decade to advancing agricultural technique, a gradual decline in the per capita consumption of foodstuffs, the increased difficulty in maintaining our agricultural export trade, and the disparity of prices unfavorable to the farmer.

Under pre-depression conditions it might be expected that the numbers engaged in the agricultural industry would continue to decrease, for even now half the farms of America produce almost 80 per cent of the products "sold or traded," according to the census definition.

The recent depression has reversed the trend of the movement of population to and from farms. In 1930, the first year of the depression, migration to and from farms about balanced. By 1931 migration from farms in the United States had decreased to two-thirds of a million below the pre-depression level, while migration to farms continued at the old level. In 1932, there was a further drop of nearly half a million in the number of migrants from farms, while migration to farms diminished only slightly. During 1931 and 1932 the farm population increased 750,000 in the United States by migration from the cities, in addition to about 900,000 excess of births over deaths; but in 1933 migration from the farms increased slightly, while that to farms decreased greatly with a resultant net migration from the farms of about 225,000. For 1934, the two movements may again be almost balanced, despite drought and cotton and tobacco acreage reduction.<sup>3</sup>

In Illinois the migration to farms occurred in areas near urban and industrial centers, and in general, onto the poorer lands. For example, studies which have been conducted by the Agricultural Experiment Station of the University of Illinois indicate that there was very slight migration to farms

<sup>1</sup> Fifteenth Census of the United States: 1930, Composition and Characteristics of the Population of Illinois.

<sup>2</sup> Ibid: Population Bulletin on Families in Illinois.

<sup>3</sup> O. E. Baker and T. B. Manny, "Population Trends and the National Welfare," mimeographed publication of the Bureau of Agricultural Economics, United States Department of Agriculture, page 7.

in Champaign County from 1930 to 1935, whereas the open-country population in Alexander County, near Cairo, increased over 10 per cent in the same period. Moreover, early returns from the 1935 Agricultural Census show an increase in the number of farms in 58 of 61 counties on which data have been released.<sup>4</sup> The largest increase, 42 per cent, occurred in Alexander County where over half the population were on relief in July, 1934.

This movement back to farms in Illinois may be a temporary movement, and as soon as economic conditions improve in the urban centers there may again be a movement away from the farms, causing a still further decline in the farm population. In this connection, it was interesting to note that most of the migrants from the farms in the United States in 1934 were apparently people who had sought safety with rural relatives or friends during the depression, and who were now able to resume their work in the cities or to obtain aid from the civil work officials, or the relief agencies. Relatively few, apparently, were young people going to the cities for the first time.<sup>5</sup>

Present indications are that Illinois may, however, have more people on the land in the next ten years than in the past ten years. The cities are interested in moving their unemployed onto the land, in order to reduce the relief burden in the cities. There is an effort to move families off so-called sub-marginal land, which is being purchased for forest and pasture uses by governmental and other agencies. Many young people who normally leave the farm are remaining because of a lack of opportunity for employment elsewhere. It is difficult to predict how many will thus be added to the farm population in Illinois in the next five or ten years, but with improving economic conditions in non-agricultural pursuits, it would be surprising if there were more than a ten per cent increase in the next decade.

Urban centers have not had a sufficient natural increase in population to maintain themselves.<sup>6</sup> In every state of the United States without exception the ratio of children under five years of age to women 15 to 45 years of age (child bearing age) was lower in the urban than in the rural population according to the Census of 1930. The number of children under five years of age in all cities of the United States over 100,000 population lacked 20 per cent of being sufficient to maintain the population of those cities. There was a deficit of from six to eight per cent in towns of 2,500 to 100,000 population. Villages and suburbs, on the other hand, have a surplus of 30 per cent. The farm population had a surplus of 50 per cent. From one-half to five-eighths of our natural increase is now found in the farm population, although this group constitutes about one-fourth of the total population of the United States.<sup>7</sup> It is to be expected, therefore, that with the return to normal industrial conditions, the net migration will be again toward the cities.

If there is to be an increase in the number of people on farms in the State of Illinois over the next quarter of a century, this increase probably will not be in the number of commercial farmers, but rather in the number of those who operate so-called family-size farms, part-time farms, or subsistence farms. It is expected that the largest increase will come in part-time farms, and the smallest in farms furnishing a subsistence living. The extent of the movement of urban families to rural areas will depend to a large degree on the amount and rate of decentralization of industry which will minimize the problem of transportation.<sup>8</sup>

---

<sup>4</sup> Press Releases on the Preliminary Agricultural Census Reports, Bureau of Census, United States Department of Commerce.

<sup>5</sup> O. E. Baker and T. B. Manny, *op. cit.*, page 7.

<sup>6</sup> *Ibid.*, page 10.

<sup>7</sup> Warren S. Thompson, "Movements of Population," *American Journal of Sociology*, Volume XL, Number 6, May, 1935, page 719.

<sup>8</sup> Cf., F. L. Morrison and J. H. Sitterly, "Rural Homes and Their Non-Agricultural Workers," Bulletin 547, Ohio Experiment Station, Wooster, Ohio, February, 1935, page 34.

# Population Problems in Illinois Mining Communities

W. H. Voskuil

*State Geological Survey, Urbana, Illinois*

The two unusual characteristics of the mineral industries that distinguish them from the others are (1) The exhaustibility of mineral deposits, and (2) the irregular geographical distribution of deposits of the various minerals. The consequence of these two characteristics of mineral deposits is that mining communities are frequently isolated and far removed from market centers, and that the productivity of a mining district registers a small beginning, a gradual rise to maximum output, followed by decline and eventual extinction. In Illinois, where coal mining is carried to a greater or lesser degree in nearly half of the counties of the state, examples of each of these stages in the history of a mining district may be found. Some of these coal mining districts are located in or near agricultural districts and urban communities and the unemployment resulting from fluctuations in the mining industry may be absorbed by economic activity in other fields. Such for example, is likely to be the case in such important coal mining counties as Peoria, Sangamon, Madison, and St. Clair. On the other hand, coal producing counties in southern Illinois are more or less isolated, the dominant activity is coal production, and the economic welfare of the local population, both miners and tradesmen, is primarily dependent upon the activity of the mines. A serious problem of unemployment, therefore can arise, apart from any major cyclical movements of general industrial activity, due to changing conditions within the mining industry itself. The purpose of this brief paper is to analyze some of the changes that have occurred in the mining districts of southern Illinois, and to consider the problems arising out of these changes.

Before considering the trend of employment in the coal industry of the southern fields, it may be of interest to point out some of the general characteristics of the coal industry in Illinois since 1905. In figure 1 are shown the curves of production, number of men employed, number of days worked, and output per man per day.

The decline in output of coal, due to competitive fuels, and the decline in employment opportunity due both to falling demand for coal and increasing effectiveness of production has affected the southern Illinois mining district as well as the other coal districts in the state.

Particular attention should be directed to the declining portion of the employment curve in its bearing on employment opportunity. This becomes especially significant when an analysis is made of the occupational distribution of gainfully employed and the geographical distribution of population in these southern counties.

Suggested means for redirecting unemployed into productive work include the following:

- (a) Moving the men out of the community (not feasible as a mass movement).
- (b) Broadening the industrial base of the community, i. e., a diversification of industry.
- (c) The possibilities offered by reforestation.
- (d) Possible industries based upon forest resources.
- (e) Industries based upon local resources other than forests.
- (f) Public works.
- (g) A rehabilitation of coal mining.
- (h) Subsistence homesteads.

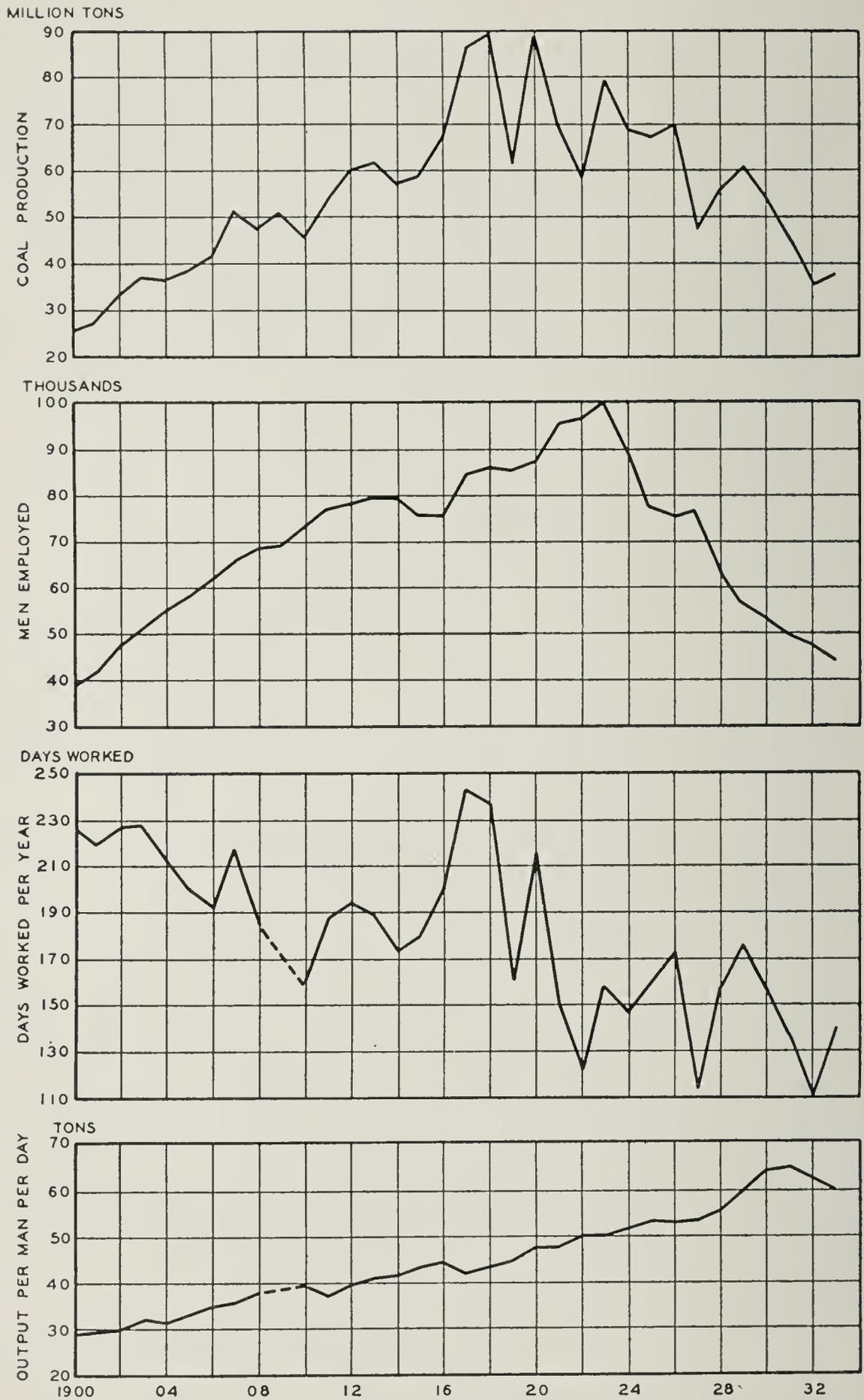


Fig. 1.—Coal produced, number of men employed, days worked per year, and output per man per day, 1900-1933.

## Industrial Opportunities in Illinois for the Absorption of a Growing Wage-Earning Population\*

William A. Newton

*State Geological Survey, Urbana, Illinois*

In spite of a decline in the rate of population growth in the United States, each year adds more persons to our wage-earning class. Fifty per cent of the increase comes from farms. Agriculture in Illinois, which is a wealthy agricultural state, has developed to a point where increased productivity per acre makes present acreage and man power adequate to supply present and near-future needs, so that the farms cannot absorb their surplus population. This group, then, must seek work in the non-agricultural industries—production, manufacturing, and marketing.

The industrial opportunities that Illinois can offer to the on-coming wage earners are based upon certain natural advantages. Illinois occupies a keystone position as an industrial state in the Upper Mississippi Valley with its large consuming market, adequate transportation facilities, available power, and abundance of diverse mineral materials. The Great Lakes, the now completed Illinois Waterway, and the usual railway transportation facilities combine to make this state the focal area for the assembly of raw materials and the distribution of manufactured goods into the surrounding states.

Illinois' raw materials include coal and oil, which form the basis of an energy-using civilization, and the state supplies a large part of the energy needs of seven states. Illinois has the largest coal reserves east of the Mississippi River, and although the industry has suffered from the invasion of fuel oil, natural gas, and Appalachian coals into the Illinois coal market area, coal will nevertheless continue to form the basic energy-fuel for domestic and industrial use. Improvements in the preparation of coal, more equitable competition, the restoration of industrial production, and the adaptation of coal to uses now served by oil and gas, will be reflected in a larger and more prosperous coal industry for the southern Illinois counties.

Chicago is a strategic center for the steel industry, using ore from the Minnesota mines and cheap Lake-cargo coke from the Appalachians. This enables the Chicago district to deliver the steel ingots or semi-finished steel shapes to the fabricators of steel goods in competition with steel from other districts. Eastern Wisconsin and northern Illinois and Indiana furnish a large market for steel goods. Another large market exists in the southwestern states. The transportation of steel goods down the Ohio River from the Pennsylvania and Ohio mills, finally to penetrate this vast market by rail, has increased yearly. The opening of the Illinois Waterway will doubtless be to the advantage of the steel mills in the Chicago district in transporting their product to St. Louis, which is Chicago's distributing center for the southwest territory. There are fewer locks to negotiate on the Illinois Waterway as compared with the Ohio River, and the lower production costs in Chicago further favor Chicago in capturing this market.

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

The non-metallic materials offer another important field of opportunity, particularly the structural clay products industries. This is peculiarly a local industry because of the wide distribution of suitable raw materials and because of the local market for this type of product. Obsolescence of homes, needed repairs, increasing demands of the home-owner for better ventilation, improved insulation against heat and cold, better protection against fire and vermin, and in general a demand for more comfortable and complete living quarters at lower cost, is confronting this industry. Research is continually working towards satisfying these requirements. The present tendency of urban population to move to suburban areas and the perceptible trend toward decentralization by industries from the congested urban centers into smaller communities is further creating new demands from the building industry. The construction industry is certain to advance with the restoration of industrial activity in general. The necessary resources are abundant and readily available in Illinois, including clay, limestone, sand and gravel, building lime, and glass sand.

Illinois possesses almost unlimited supplies of excellent glass sand, among the purest sand deposits in the world. These deposits along the Illinois River valley are favorably located, with reference to markets, fuel, and transportation, for the manufacture of glass products. Although this state ranks first in output of glass sand, it is fifth in the manufacture of glass products. A substantial quantity of the sand is exported to eastern states for manufacture of glass products which in turn are imported. However, the location of industrial enterprises is constantly changing in favor of more economical relations between raw materials and markets. The enlargement of glass making facilities in the midst of large glass markets of the Upper Mississippi Valley will ultimately be brought about.

Research is continually revealing new uses for our natural wealth. New demands are created, and Illinois' geographic position, mineral wealth, and populous market will enable her to increasingly open up industrial opportunities in the manufacture of products based on mineral utilization.

## PAPERS IN GEOGRAPHY

---

### EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN

The program of the Geography Section consisted of eleven papers, all of which are here represented except the following:

"Land Utilization and Crop Production of Illinois by Counties," by Emerson Hall, Southern Illinois State Teachers College, Carbondale.

"Coal in Illinois," by Harry L. Adams, Bloomington High School, Bloomington.

"Land Utilization in the Town of Portland, Maine," by Mabel P. Crompton.

The present chairman was re-elected to serve for the year 1935-36.

(Signed) FLEMIN W. COX, *Chairman*



## Palestine in Transformation

W. O. Blanchard

*University of Illinois, Urbana, Illinois*

**The Palestine of Yesterday.**—Southwestern Asia is usually credited with having been the cradle of the human race. Likewise it was for centuries a great transit land across which goods and peoples moved between Europe and the Far East. Curiously enough, in spite of the advantages of an early start and the stimulus of commercial intercourse, Palestine and its neighbors have been rated among the most backward of civilized countries.

The responsibility for this retardation lies in the human rather than the environmental factor. For the past 400 years the country has been under the iron heel of the Turk—a fact of profound significance. Centuries of misrule and oppression have borne their natural fruit and in 1918 little Palestine was a country impoverished and almost depopulated.

**The Palestine of Today.**—Yet in the past 15 years the Holy Land has been witnessing a remarkable transformation. The ousting of the Turk and the substitution of British authority set the stage. The influx of Jewish immigrants with their initiative, enterprize, and capital has provided the action, and a colorful drama is being enacted. It is a case of “new wine in old bottles,” and a land historically “old” is today economically “new,” with the stimulant reaching almost every one of the country’s activities.

Since the British have taken over the mandate, the population of the country has more than doubled. A single city, Tel-Aviv, whose site in 1909 was marked by a row of sand dunes, has today a population of over 70,000, making it rank second only to Jerusalem.

Agriculture, the mainstay of the country, has taken on a new lease of life. Present accomplishments include the reclamation of thousands of acres of sandy waste and malarial swamp. The orange acreage has been expanded until it now covers an area eight times that of eleven years ago. Jaffa, the chief port, recorded an export in 1912 of 1.8 million cases of the fruit; in 1934 this had grown to 5.5 million cases; and oranges now constitute about 80 per cent of the value of all Palestine exports.

Industry has likewise made notable advances. Under the old regime, soap from olive oil and wine from local grapes were the only manufactures of any size and these were operated with crude apparatus and primitive methods yielding a product of low grade. It is estimated that at present there are almost 4,000 industrial plants, employing some 20,000 workers and representing an investment of over \$20,000,000. About  $\frac{2}{3}$  of these plants are still operated by manual labor, but mechanical energy now being made available is changing this condition materially.

Two industrial projects are of more than passing interest and deserve special mention. They are located in the Jordan-Dead Sea depression at the eastern edge of Palestine.

The Jordan River has a total fall of about 3,000 feet and hydroelectric plants are being constructed to utilize the power of the river and its tributaries. One unit is complete and others are being constructed, the total capacity to be some 100,000 h. p. Galilee and an artificial lake will provide

storage so essential in a region of long summer drought. In a land without coal, cheap electric energy will be all important in providing light and power over the country.

At the southern, or Dead Sea, end of the same valley another unique industry is getting under way. The Sea is some 1,300 feet below sea level, is without an outlet, and has an average annual temperature of about 100° F. Thus the Sea is a gigantic natural evaporating pan. Insolation here is 2.5 times as effective as on the Mediterranean and the waters carry 25 per cent salts instead of the 3-4 per cent of ordinary sea water. Tests show that 125 gallons of water may be evaporated daily by the sunshine, from every square foot of surface.

Among the salts present are two of special importance—potassium and bromine. The maximum concentration of these was found at a place 175 feet below the surface and a 30 inch intake pipe was laid to this point. The brine is pumped into great shallow concrete basins and the valuable salts recovered by differential dessication. The plant is partially completed and some salts have been exported. At full capacity it is expected to yield some 70,000 tons of potash annually. One of the problems confronting the enterprise is transportation of the product to the rail head at Jerusalem 25 miles away. The Sea is 4,300 feet below the Hebron ridge 10 miles away. Trucks, now used, will be eventually supplanted by a railroad extension.

Improvements in transportation have kept pace with other activities. Sixty years ago Palestine had no wheeled traffic and no surfaced roads. In 1913 there was one automobile; in 1932 there were 3,000 and most of the main roads had been macadamized. Some 600 miles of government railroad, much of which was a legacy of the World War, is now supplemented by both motor and air transport.

For Haifa, at the foot of Mount Carmel, there has just been completed the best harbor in the eastern Mediterranean, and for the first time shipping may load and unload at the docks instead of by lightering. Haifa is also one of the termini of the famous oil pipe line carrying crude oil from Iraq to tankers here and at Tripoli. Plans contemplate the erection of storage tanks and refineries at Haifa.

Of fundamental importance to all progress is the education of the native population. The most serious problem in Palestine today is the Arab-Jew question and education should serve to make cooperation between the two easier.

In 1927 there were over 750 schools providing a general education maintained by the government and various religious organizations.

All in all, the changes in both material and intellectual conditions is little short of phenomenal. Everywhere from Dan to Beersheba, construction, planting, and manufacturing are proceeding at a swift pace. Palestine has changed more in the past 15 years than it has in the preceding 15 centuries.

# Surface Temperatures of the Gulf Stream and the Waters on Its Margins

Phil E. Church

*University of Washington, Seattle, Washington*

Oceanographers agree that the term Gulf Stream should be restricted to that portion of the great North Atlantic current system which flows from the edge of the Pourtales Plateau (south of Cape Hatteras) to the Tail of the Grand Banks (Fig. 1). The name Florida Current is reserved for that portion of the system which issues through the Straits of Florida and continues to the edge of the Pourtales Plateau. This discussion is limited to the western half of the Gulf Stream as defined above.

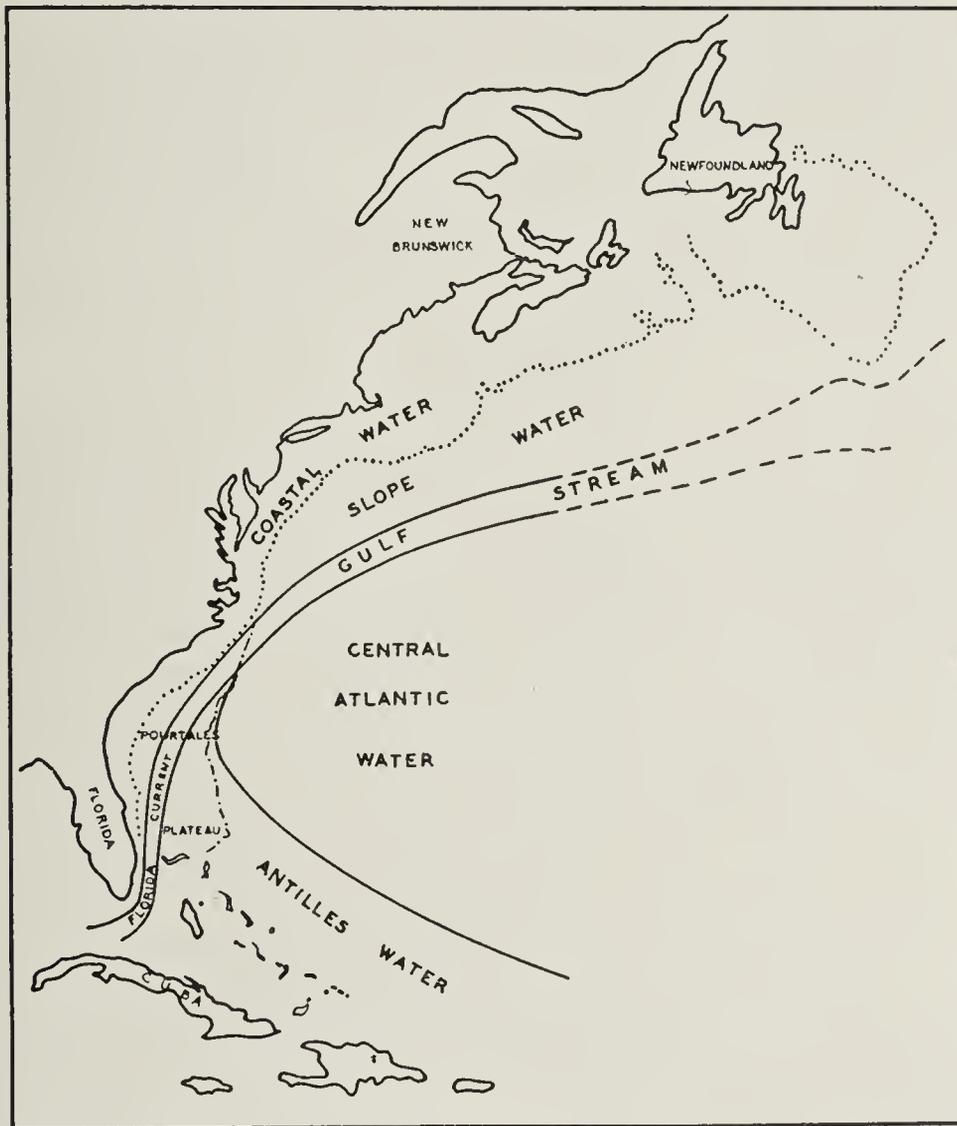


Fig. 1.—The location, width, and relative position of the coastal water, slope water, Gulf Stream, Florida Current, central Atlantic water, and Antilles water. The dotted line is the 100-fathom curve. The dot-dash line indicates the seaward limit of Pourtales Plateau.

About eight years ago a thermograph for automatically recording sea-surface temperatures was installed on the commercial vessel *Coamo*, which plies between New York and Puerto Rico. Since that time the Weather Bureau, steamship companies, the Canadian Meteorological Service, and the American Meteorological Society have cooperated in installing additional thermographs on commercial vessels which sail on regular schedules over various routes on the western North Atlantic. The thermograms, which are

all sent to the Marine Division of the United States Weather Bureau, form the basis of the discussion. At present more than 1,000 records have been sent in and many of them have been reduced from a temperature-time graph to a temperature-position chart. About 100 such charts have been constructed, which show the temperature pattern over a wide area within any particular week. From these charts various definite areas are distinguished by to their surface-temperature characteristics.

Seaward from the 100-fathom curve is an area which varies in width with the temporary migrations of the Gulf Stream. From no width at Cape Hatteras this deep water area increases to a maximum of about 180 miles to the south of Narragansett Bay. Owing to its great depth, 1,000 to 3,000 fathoms, it has a smaller annual temperature range than the coastal water to the north and west. Data from the New York-Bermuda route show the minimum to be about 42°F. which occurs the last week of March, and the maximum to be about 75°F. which occurs early in September. This annual range of 33 degrees is only slightly less than the 35 to 39 degree range for the shallow coastal water.

In the winter and early spring months the temperature of the water at any latitude and longitude close to the average position of the Gulf Stream is apt to change within a few days as much as the annual range for the year. Such an event is occasioned by offshoots of warm surface water from the Gulf Stream invading the area generally occupied by this slope-water. These invasions are but short-lived at best. Preliminary investigations do not seem to bear out the thought that they might be wind driven.

Between the slope-water and the Gulf Stream is a narrow band which, owing to its contrast in temperature to that of the Gulf Stream, is popularly called the "cold-wall". Its average width is approximately 21 miles and it has an average change of temperature of one degree per mile.

The Gulf Stream is that narrow band of warm water that flows on the outside rim of the Central Atlantic area, or Sargasso Sea. Off Cape Hatteras the stream is only 50 miles wide, between New York and Bermuda 60 miles wide, and south of Halifax 70 miles wide. By the time it reaches the Tail of the Grand Banks it has probably widened to about 100 miles though there is no definite information at this point. The Gulf Stream is distinctly set off from water on either side by sharp temperature contrasts.

The annual range of temperature is smallest off Cape Hatteras being about 11 degrees normally (from 74°F. to 85°F.). The minimum comes in March and the maximum in September. In its movement to the northeast the stream cools and the annual range increases slightly. South of Halifax the lowest is about 69°F. and the warmest about 82°F., a range of 13 degrees. The surface temperatures of the Gulf Stream do not vary more than 2 degrees from their normal and a variation of as much as 2 degrees is most likely in the winter. The period of record has still been too short to determine whether there will be a cyclical variation from the normal.

Warm offshoots of Gulf Stream water invade the slope-water area and cause a temporary migration of the main body of Gulf Stream water. There is no indication of any definite seasonal migration of its course.

South and southeast of the Gulf Stream lies the broad expanse of Central Atlantic water. West of the longitude of Bermuda, its most striking characteristic is the homogeneity of surface temperatures. It has a mean annual range of about 17 degrees in the northern part. The southern limit of this body has been tentatively set at the place where there is an annual range of about 11 degrees. Here there is a small but distinct break in the temperature consistent throughout the year though varying in latitude from winter to summer. This break in temperature probably coincides with the northern edge of the North Equatorial Current and Antilles Water.

# A Field Study of Bloomington-Normal<sup>1</sup>

Clarence Burt Odell

*Fellow in Geography*

*University of Chicago, Chicago, Illinois*

## INTRODUCTION

The Bloomington-Normal urban area<sup>2</sup> includes 6.95 square miles and is occupied by approximately 37,000 people. These people in their utilization of this area, have unconsciously divided it into six land utilization patterns which include several types of distribution from the one extreme of an even scattering over the area to the other extreme of a concentrated arrangement of forms within the landscape. It is the ultimate purpose of this survey to study this variety of land uses and the various types of patterns found within the Bloomington-Normal urban area.

This report is a summary of a survey made during the first week of January, 1935, of the land utilization in the Bloomington-Normal urban area. No attempt has been made to cover the complete geography of the area.

## PROBLEM

The area dealt with in this report is called the Bloomington-Normal urban area. The first problem becomes that of defining this area. The incorporated area of Normal directly adjoins the northern limits of the incorporated area of Bloomington, thus making a contiguous political area. In some cases, however, the corporation boundaries are unsuitable for the urban area boundary. Some of the town of Normal in the western and the eastern portions is omitted because the areas are not built up for urban uses but are small tracts of land used for farming, gardens, or pastures. It is also necessary to omit a small portion of the northwest and northeast sections of Bloomington for the same reasons. In the case of Bloomington, however, it is necessary to include additional areas outside of the city limits along a few streets which are built up for urban uses. The Bloomington-Normal urban area is therefore a distinct, irregular area with boundaries directly established according to the urban uses and occupancy of the land, and is determined through actual field observations.

The second problem consists of the recognition of the types of land uses within the urban area. The site of the Bloomington-Normal urban area includes the junction of railway routes and highway routes, and embraces land near the headwaters of the Sugar Creek drainage system which flows southward toward Illinois River. Within this urban area there are distinct patterns of land occupancy or use which together make up the complete and unified pattern of land utilization within the Bloomington-Normal urban

---

<sup>1</sup>The writer wishes to acknowledge the valuable assistance of those persons who furnished information for this survey. Special thanks is given to "The Daily Pantagraph" of Bloomington who furnished the air photos.

<sup>2</sup>Bloomington-Normal is located in Central Illinois on the Alton Railroad 15 miles north of the midpoint between Chicago and St. Louis.

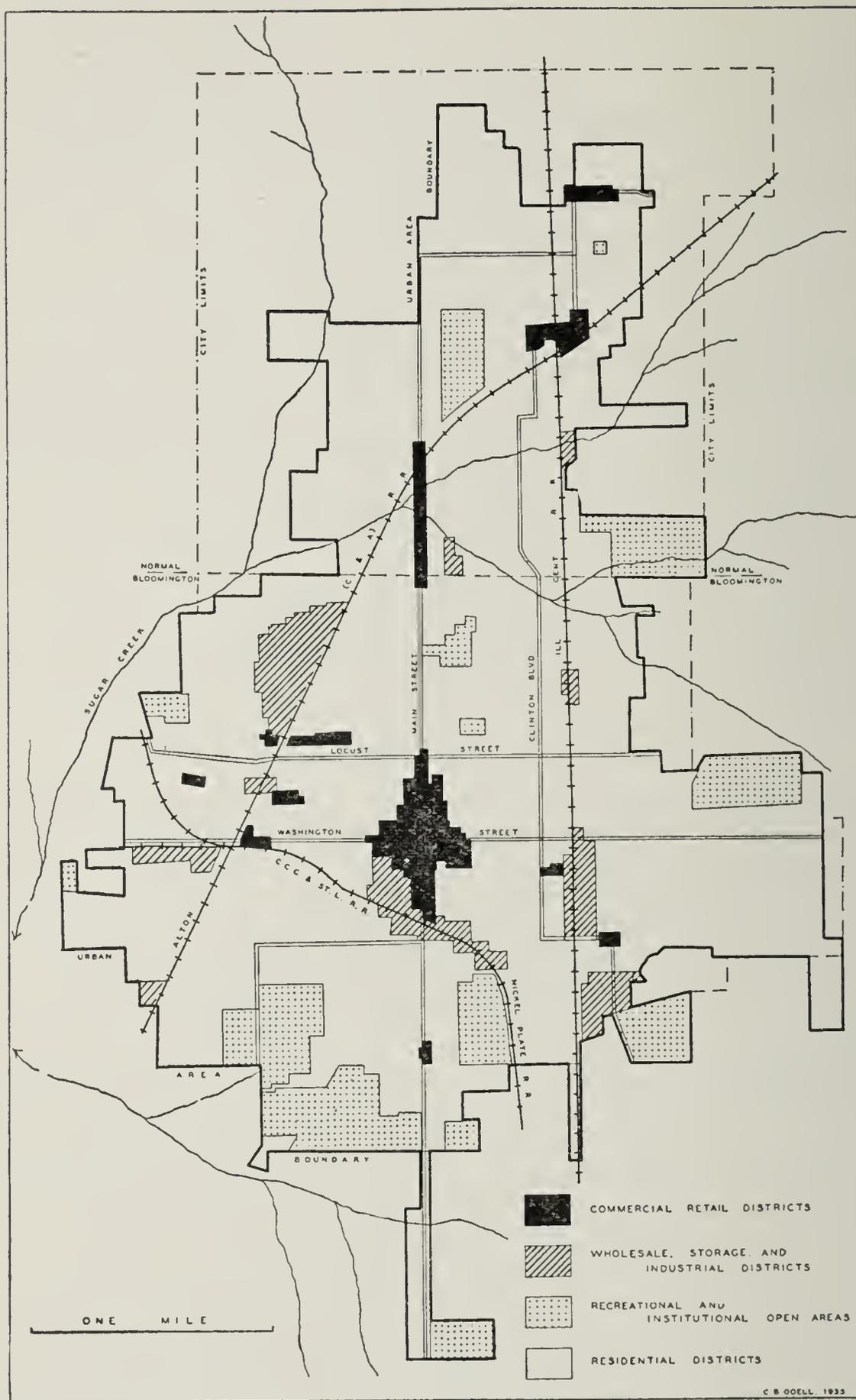


Fig. 1. Map showing land utilization in the Bloomington-Normal urban area. A composite of six maps each showing a single type of land use. Wholesale, storage, and industrial areas are here combined because they overlap. Open air recreational and institutional areas are likewise combined; indoor units of these two uses are located throughout the patterns of commercial retail and residential uses, and occupy areas too small to be shown on this scale map. Residential districts are not here subdivided as described in the text.

area. These distributions include the following types of units found in the landscape:

- (1) The transportation units include railroads as external units, and street cars, busses, etc., as internal units.
- (2) The production units include factories, industrial plants, etc.
- (3) The commercial units are divided into wholesale, retail, and storage groups.
- (4) The residential units are divided according to poor, medium, and superior groups.
- (5) The recreational units include parks, playgrounds, etc.
- (6) The institutional units include government, with city hall, jail, etc.; religion, with churches; education, with schools; and others, including charitable homes, hospitals, cemeteries, etc.

### DISTRIBUTION OF THE SIX TYPES OF LAND USES

The distribution of these units was first recognized by six individual maps, each showing the distribution of one group of units as listed above. These six maps were then combined to make the composite map of the entire urban area (Fig. 1). The patterns or distributions were analyzed through the aid of photographs. An analysis included the relationships of the patterns, one to another, and the mutual relationships of the cultural items to the natural within these patterns of land occupancy units. Thus the complete report classified and presented the distribution of items in many sub-patterns of land occupancy units within the Bloomington-Normal urban area. This brief summary will attempt to present only a few of the findings and conclusions resulting from the field survey and subsequent report.

**Transportational units.**—The distribution of transportation units is characterized by alignments which divide the urban area into numerous districts of irregular shapes and sizes. Some of the larger areas, particularly those set up by the railroad pattern, including the large triangular one, can be taken as areas in the study of other land use patterns. The large area used by the Alton Railroad Shops (Fig. 2) separates residential districts. Other transportation patterns act as webs connecting and holding the other types of land use distributions together in the complete land utilization pattern of the area. For example, the street car and bus lines are connecting links between retail and residential sections.

The complete transportation pattern is divided into an external pattern including units operating beyond the limits of the urban area, and the internal pattern including units operating entirely within the urban area. The external transportation pattern includes the railways, highways, both state and federal, and airways. The internal transportation pattern includes streets and alleys, street cars and busses, and other public utilities, including the distribution of water mains, sewer and gas mains, telephone, and telegraph. These lines of transportation and communication occupy rectangular patterns and in many cases are coincident with one another. All of these items occupy relatively small percentages of the total urban area, but are of extreme importance in the complete land utilization pattern by setting up districts within the urban area.

**Production units.**—The production units include one per cent of the total area (according to planimeter measurements on the original maps). The factories are concentrated in two alignments with a few outlying units located upon sites of particular interest to them. Use is made of the wide right-of-way along the Illinois Central as well as land along the Big Four and Nickle Plate roads. As far as areal coverage is concerned this pattern is of the least importance but becomes of value through its distinct relationship with the railroad pattern.



Fig. 2. Air photo of the Chicago and Alton Railroad shops in the northwest part of Bloomington. This view also shows portions of the residential sections.

Fig. 3. The central portion of the Bloomington-Normal urban area from an elevation of 4,000 feet. The central business district, a part of the transportation pattern, and portions of the residential districts are shown. The light patch of the central business district is shown by an absence of trees and corresponds in shape to the central black area on the map (Fig. 1).

**Commercial units.**—The distribution of the commercial units of the Bloomington-Normal urban area is concentrated for the most part in the southern half within the triangle set up by the railroad pattern (Fig. 3). The commercial establishments of the urban area may be divided into three groups according to type, namely, retail, wholesale, and storage. Three distinct sub-patterns can thus be recognized, and the location of each in conjunction with the other patterns of land use can be shown.

The retail pattern is divided into three separate district groups, namely, central business district, outlying business districts, and outlying business units not included in the other two types of units. The first, central business district, is an example of a concentration of interests into a compact area; the second, the outlying districts, of a decentralization of interests from the central business area to various communities; and the third, individual units, of the dispersion of individual units into individual neighborhoods.

In spite of the small proportion of the total area included within the central business district, there are a large number of total retail establishments of the city compactly arranged within the area. Of 502 retail stores in Bloomington as listed by the United States Census for 1930, there are 229 located in first floor units on Washington, Jefferson, Main, and Center streets within the central business district.<sup>3</sup> These streets are on the four sides of the Court House square. In addition to the retail stores on these streets there are 53 personal service establishments. On Main street alone there are 155 establishments and 15 vacancies in first floor units.

The utilization of the square for upper floor units is important. The concentration decreases with distance from the square with the long axis coinciding with Main Street. In general, the elevations of the buildings increase nearer the square, a fact which further emphasizes the concentration and overlapping of activities within the central business district. The profile of the buildings seems to correspond with the profile of the hill upon which the original town was laid out. The foresight of the early settlers in choosing a high, well drained site, yet level enough for building purposes, is thus recognized.

The wholesale and storage sections of the urban pattern are concentrated into alignments within the southern portion and coincide somewhat with the transportation pattern. In general, the commercial pattern (particularly the central business district) is the focusing point of the entire urban area.

**Residential units.**—One of the most important patterns of land use within this urban area is the one of habitation or residential units. Residential units occupy three-fourths of the total urban area. The lower grade sections comprising about a third of the total urban area are closely related to the railroad pattern and are mainly in the western portions. The medium sections make up about two-fifths of the total urban area and include districts in the central and east portions. The superior sections, including about one-twelfth of the total area, are located in the east and a few scattered sections in the central parts. The extremes in quality of residences, from the lowest to the highest grade is great. About 58 per cent of the houses are home owned with 90 per cent of the total units being single family dwellings.

**Recreational units.**—The two groups in the recreational pattern, outdoor and indoor, present examples of the two extremes in types of distribution. The outdoor pattern is one utilizing land on the periphery of the urban area,

<sup>3</sup> Profiles of these streets were made with the classification of the United States Census for retail establishments with an additional item of personal services for banks, professional offices, etc.

Since this survey was made there have been a few changes in number of establishments but not enough to alter the large percentage within the district.

where land is more available and less likely to be occupied in other urban uses. The indoor pattern is for the most part concentrated within the central business district and illustrates the extreme of compactness in the distribution of units. The areal expanse of the recreational pattern is not large as compared with the other urban patterns in amount of built up land, but is of importance in its tendencies to prevent expansion of sections of the other patterns by being of enough importance to many persons so that plans to encroach upon it with other land uses are at present prohibited.

**Institutional units.**—The institutional pattern is of minor importance in proportion to the total area involved, but is of much importance in linking up other patterns of land use within the urban area. Concentration of units within or near the edge of the central business district further emphasizes the importance of the central position of the urban area. Small scattered units intermingled within the other patterns is characteristic of the institutional pattern.

### CONCLUSIONS

(1) The use of land within the Bloomington-Normal urban area is primarily related to the railroad pattern which is, in turn, closely related to the topographic pattern.

(2) The original town of Bloomington which occupied a relatively high site between two branches of Sugar Creek has become the central business district of the present urban area. The profile or skyline of the buildings closely corresponds to the profile of the hill.

(3) The residential pattern which occupies 78½ per cent of the total urban area is divided into sections by railroad and topographic patterns.

(4) The distribution of commercial units is directly related to the compact distribution and the quality of the residential units.

(5) The percentages of the total Bloomington-Normal urban area included within each pattern of land use units are given in the following list:

	<i>Per cent</i> <sup>4</sup>
Transportational Units .....	4.2
Production Units .....	1.0
Commercial Units .....	6.3
Central business district.....	1.7
Outlying business districts.....	1.3
Wholesale districts .....	1.5
Storage districts .....	1.8
Habitation Units .....	78.5
Poor sections .....	31.0
Medium sections .....	40.0
Superior sections .....	7.5
Recreational Units .....	7.0
Institutional Units .....	3.0
	<hr/>
Total.....	100.0

From this list it is found that the three closely related transportational, commercial, and residential patterns cover 89 per cent of the Bloomington-Normal urban area. These important patterns are directly related to the rolling topography of the natural environment by varying degrees of compactness and groupings of quality.

<sup>4</sup> Percentages calculated from planimeter measurements on the six original land use maps.

## A Guatemalan Banana Farm

Robert S. Platt

*University of Chicago, Chicago, Illinois*

### ABSTRACT

This paper is a report of field work in the eastern lowlands of Guatemala. The subject is an establishment known as Maya Farm, a basic functional unit in a district of banana production, not "Mayan" except by virtue of proximity to the Mayan ruins of Quiriguá.

The farm occupies a section of the floodplain on the north side of the river between the stream bank and the mountain foothills. The area is about four square miles. A third of this is virgin forest, a dense stand of tall trees and vines, broad leaved evergreens flourishing in a perpetual abundance of heat and moisture, not jungle in the sense of tangled thicket but high woods in which the ground is fairly dark and free of undergrowth. Most of the trees are fast growing weeds of no value for lumber. The forest is at the north end of the farm, away from the river, where the floodplain land is low, heavy and swampy, and adjacent hill land is leached and infertile.

The rest of the farm has been cleared for bananas. The process is one of felling the forest and leaving the wood to rot on the ground while the banana plants are growing up. Of land once planted to bananas a large proportion has been abandoned, having proved unprofitable for production and now being reoccupied by forest. In general the productive lands are on the natural levees, and the abandoned lands are at a greater distance from the river, where drainage is poor, near the still swampier lands left in virgin forest.

After reduction of the plantation area to about 800 acres there has been some increase to a total of about 1,000 acres, made possible by construction of a carefully planned system of drainage. Since the farm is practically all floodplain, occasional flooding is to be expected in almost every part of it.

The annual output of the farm is nearly 300,000 stems of fruit for the American market. This is equivalent to a capacity of nearly 400,000 stems for the English market, the difference being due to the picking of less mature and therefore more quickly produced fruit for the more distant market.

This output involves a capacity for cutting and transporting 6,000 stems of American fruit in one day. The fruit matures at a rate which allows for cutting a week's quota at one time, and after cutting immediate shipment is required. Therefore harvesting and shipping on one day a week is expedient. Organization of the farm is based on this fact.

Prompt shipment is made possible by a mule tram system reaching every part of the plantations and coming to a focus at a railway siding whence passing trains carry the product on scheduled time to a ship in port.

In charge of the farm is an American overseer, living with his family a life that is rather isolated but otherwise pleasant and comfortable. The overseer's house is an attractive modern bungalow surrounded by well landscaped grounds.

The laborers are Guatemalans and other Central Americans of Indian and mestizo blood and Jamaicans of negro blood. They work under a foreman who has risen from the ranks. Their quarters are in a separate grassy clearing and consist of a row of well built barrack-like "camps," simple but adequate, providing a one-room dwelling for each laborer and his family.

There are no other forms of occupance on the farm. The laborers' camps and supervisor's house front on the railway, which is the only highway, and which serves as a line of attachment in the occupance of the whole floodplain. As already indicated, Maya Farm is part of a much larger enterprise. A tract of a thousand acres has been found large enough for one unit of production under an overseer. Accordingly some twenty-four farms of approximately this size have been established along the railway, for the development of nearly all available banana lands of the Motagua floodplain, to form the Guatemalan Division of the United Fruit Company.

Nearly all of the older lands have become unproductive, on account of soil depletion in general and the Panama disease in particular, a persistent blight destroying the crop. It is not yet known whether the banana can ever become a permanent occupant of fertile land or whether a suitable product can be found to succeed it on worn out land—a product which, like the banana, is perishable and yet portable, attractive and unique.

## London and Paris: A Comparison of Their Locations

E. Muriel Poggi

*University of Illinois, Urbana, Illinois*

**Early sites of the two cities.**—There is a marked resemblance between the original locations of London and Paris. London grew up on a hill in the marshes bordering the Thames, while the earliest site of Paris was the island of Lutetia in the Seine. Each was situated at the lowest point at which the river could be bridged. London had one advantage—the Thames is tidal 20 miles above London Bridge. Paris, on the other hand, is below tidal limit.

**Surroundings of the two cities.**—The cities are each in the center of a shallow basin or syncline which formed economically self sufficient regions in the Middle Ages. The London and Paris Basins differ in shape, but structurally are much alike, both being composed of a series of cuesta and intervening clay vales. There are minor differences—one being that while clays predominate in the innermost layer of the London Basin, there are more limestones in the Tertiary rocks around Paris, and again there are sections of the London Basin covered with glacial till whereas there was no glaciation in the Paris Basin.

**Tertiary Rocks.**—Travelling east from Paris or west from London to the outer edge of the basins, the Tertiary beds are crossed, which have always been rich wheatlands. Near the center of each basin there were clay deposits which gave rise to brick and tile, and porcelain industries. In addition Paris had limestone for building material, while early London relied more on brick for this purpose. The limey soils on the eastward facing edge or scarp of the Tertiary rocks in the Paris Basin are covered with vineyards.

**Cretaceous Rocks.**—In both basins Cretaceous rocks, chalk and clay, extend under and beyond the Tertiary beds. In the London Basin the chalk forms the Chiltern Hills to the north and the Downs to the south. The pasture on this porous limey soil is excellent sheep pasture. Beyond the chalk the gault clay extends in a wide belt, of which the Oxford Clay vale forms a part. Here is some of the richest land in England. Sugar beet and fruit crops have led to the development of the jam industry, and beef and dairy cattle are raised.

Beyond the vineyards of the Tertiary escarpment of the Paris Basin the chalk country of Champaign is reached. The soil here is more suitable for sheep grazing than for crops. This is Champaign *Pouilleuse*, meaning dry, dusty or poor country, but owing to use of fertilizers most of it has been improved, and in some of the deep valleys vineyards cover the lower slopes. The chalk ends in a steep brink, at the base of which the clay crops out in a belt corresponding to the Oxford Clay in England. This is Champaign *Humide*, or moist Champaign, and when drained it forms excellent agricultural land. At the base of the chalk escarpment where the soils are a mixture of chalk and clay are the vineyards from which the famous Champaign wines have been produced for centuries.

*The Rocks beyond the Cretaceous Beds.*—The cuesta formation is continued around the London and Paris Basins in oölitic (Bedford) limestone scarps, famous for sheep grazing, good building stone and iron ore, while beyond it lies another clay region which when well drained is used for vineyards and crops. Space does not permit a description of the grassy scarps and wooded vales between the Cretaceous rocks and the ancient massifs, but they have also contributed largely to the wealth which has made London and Paris what they are.

**Conclusions.**—After comparing the location of these two cities and noting points of resemblance in their hinterlands it seems inevitable that the development of London and Paris should be somewhat similar. The structural variations are reflected in the great variety of natural resources, agricultural and otherwise, which led to the self sufficiency of the London and Paris Basins. As the natural wealth of the two regions was developed and the natural routes which converged on the two cities were followed by roads, London and Paris became market centers, and later, manufacturing towns.

In the Middle Ages, as the surplus of the products of their surroundings increased, London and Paris rose to importance as great seaports. In modern times, however, it would seem that the similarity in their development is at an end. Paris remains the chief market and manufacturing center of Northern France, but as a port she is superceded by her outports of Rouen and Le Havre. London, too, is still a market and manufacturing center, but she has also held her own as a seaport, and is the chief entrepôt of the world (largely because she is the market for the British Empire). Owing to the increase in the size of ocean vessels, however, modern port development tends to gravitate down the Thames estuary, and the largest ocean liners dock at Southampton, which for passenger traffic, at least, may now be looked upon as the outport of London.

# Industrial Survey of LaSalle-Peru-Oglesby

Mary A. Robinson

*LaSalle-Peru Township High School and LaSalle-Peru-Oglesby  
Junior College*

## ABSTRACT

Landscapes of the LaSalle-Peru-Oglesby area are dotted with industrial smokestacks. Although located in the very heart of the Corn Belt, this tri-city area is notably industrial. What kind of industries are here? Why are these particular industries here? These are the questions which come immediately to the mind of the geographer who visits LaSalle-Peru-Oglesby.

The major industries of the area are closely related to the mineral resources here, and may be classified as falling into three groups (1) cement, (2) metal and metal products, (3) chemical. The development of these industries is due chiefly to the presence of rich deposits of two basic minerals, coal and limestone. Three local bituminous coal mines are the principal sources of fuel in all of the industries, and local *LaSalle* limestone is the chief raw material used in the cement mills.

The industries most closely related to the natural resources of the area are those engaged in the manufacture of Portland cement. There are three of these, having a combined total capacity output of approximately 22,200 barrels of cement daily, or, 8,103,000 barrels annually. The Marquette mill alone, which is one of the largest single cement units in the world, has a storage capacity of 1,500,000 barrels. All three mills obtain their principal raw material from their *LaSalle* limestone deposits, and the clays and shales juxtaposed with them. These deposits are near the surface, being quarried in two of the mills and both mined and quarried in the other. The estimated supply is enough to last from one to two hundred years at the present rate of extraction. Gypsum is brought from Ft. Dodge, Iowa. Coal is obtained principally from local mines, although some is shipped from Wilmington and southern Illinois.

Ten of the leading fourteen industries of this area are engaged in producing metal and metal products. These plants may be grouped as (1) those either producing zinc or using zinc as a principal raw material, and (2) those producing other metal products. In the first group there are seven which are concerned with zinc. Two of these are zinc mills in which zinc ore and zinc concentrates are smelted, zinc is rolled for commercial use, and sulphuric acid is made as a by-product. The first of these was established here in 1857 by Frederick Matthiessen and Edward Hegeler, two graduates of the School of Mines in Freiburg, Saxony. The location at LaSalle was selected because the coal supply here is the best within convenient transportation distance from Mineral Point, Wisconsin, the source of the first zinc ore to be used. The Illinois Zinc mill was located in Peru for the same reason. There are only two other zinc plants in Illinois, and Illinois is second only to the state of Pennsylvania. Hence, LaSalle and Peru are notable as producers of zinc.

Three of the zinc-using plants are those which make pre-finished metals for fabrication in metal products, to eliminate plating after the article is

shaped. All three use zinc smelted in the local mills as one of the basic raw materials, and each plant is unique in the type of metals produced.

Zinc weatherstrips and zinc-coated shingle nails are the chief products of two other industrial plants of this area which draw upon the local zinc mills for their supply of basic raw material.

The Western Clock Company, the largest producer of alarm clocks in the world, is located in Peru. This plant at present employs 2,300 persons, makes many thousands of clocks and watches daily, and pays out more than two million dollars annually in salaries. Raw materials used come from all over the world, and Westclox timepieces are marketed in every civilized country in the world. Local mines usually provide the coal used.

Parts for agricultural machinery are made in two other industrial plants of this area. The chief products of these plants are wheels of all sorts, tractor attachments, and grey iron castings. Local coal serves as fuel, and the Corn Belt is the area served.

A chemical plant which is the sole American producer of potassium permanganate as well as a producer of other valuable chemicals is located near the zinc mills. Coal from the zinc company's mine and sulphuric acid from the zinc concentration process are used in the chemical plant.

## Corn Yield and Climate in Illinois\*

John Kerr Rose

*University of Chicago, Chicago, Illinois*

In eight sample counties in Illinois the correlation of variations in corn yield with fluctuations in climatic factors reveals striking differences within the state, a condition not revealed when the state is studied as a unit. In numerous instances the correlation coefficients differ so much and so gradually that the difference is probably not due to sampling or to accident. For example, Wallace<sup>1</sup> found an insignificant coefficient of  $+0.22$  between May mean temperature and corn yield in Illinois. However, when sample counties are studied, the dividing line between the negative coefficients (to the north) and positive coefficients (to the south) corresponds roughly with the May mean temperature isotherm of  $61^{\circ}$  F.

The lateness of spring frost, measured by the number of days between the last killing frost in spring and June 1, gave significant negative coefficients in the west central part of the state. In the computation of partial correlations this same factor came out even more significantly negative in the same area.

Phases of June temperature included mean temperature, accumulated degrees above  $90^{\circ}$  F., number of days  $90^{\circ}$  F. or higher, accumulated degrees below  $60^{\circ}$  F., number of nights  $60^{\circ}$  F. or lower. The mean and low temperature phases gave significant negative correlation with yields in the northern part of the state, while high phases of June temperature are negatively significant in the south.

Significant negative correlations with high phases of July temperature are found as far north as McLean County, but in the north part of the state significant correlations were not discovered for any phase of July temperature.

Both mean and high phases of August temperature give significant negative correlation with corn yield in the south and central parts of the Illinois Corn Belt. The north part of the state shows significant negative correlations with low temperature phases and significant positive coefficients with mean temperatures.

The coefficients for May precipitation, some above  $\pm 0.30$ , are all negative for the north part of the state and positive for the south part, although none are significant. Thus we can easily understand how the state as a whole gave  $+0.09$  for this factor.<sup>2</sup> For June rainfall the three most southerly counties gave significant positive coefficients, while Kane, Bureau, and McLean counties gave negative coefficients.

<sup>1</sup> Wallace, H. A.: "Mathematical Inquiry into the Effect of Weather on Corn Yield in the Eight Corn Belt States," *Monthly Weather Review*, XLVIII, No. 8 (Aug., 1920), 439-446.

\* NOTE: The eight samples from Illinois (Bureau, Coles, Kane, Macoupin, McDonough, McLean, St. Clair, and Stephenson counties) were included as part of a larger study of fifty-five counties within and just beyond the margins of the Corn Belt of the United States. Thirty-five climatic factors were investigated. The period of years, in all cases ending in 1932, for Illinois was 22 years for eleven of the factors and 19 years for the other twenty-four.

<sup>2</sup> Wallace, Op. cit.

Both weighted and unweighted July rainfall were investigated. In general, the southern two-thirds of the Illinois Corn Belt gave coefficients of positive significance, while the northern samples were either positive or negative and without significance.

In Illinois no sample counties gave a simple correlation coefficient as high as  $\pm.40$  for August precipitation. (In this study coefficients as high as or higher than  $\pm.40$  were considered significant.)

**Conclusions.**—Variations in the average per acre yield of corn in the eight Illinois counties studied as samples seem to be correlated significantly with several climatic factors rather than with one single critical factor. Temperature factors correlate more significantly as a group than do precipitation factors. In addition, variations in temperature extremes, measured in accumulated degrees above  $90^{\circ}$  F. and below  $60^{\circ}$  F., seem to be more significant than mean temperatures.

In a more comprehensive study the Corn Belt of the United States was divided into four major forecast areas on the basis of the correlations between corn yields and climatic factors. Three of the four areas are represented in Illinois.

Of the two southwestern sample counties (St. Clair and Macoupin), and Coles County to a lesser degree, it may be said that mid-season temperatures are very important and that early-season temperatures and mid-season precipitation are somewhat less important. Thus a later-than-average spring, with May and June having cooler temperatures and greater precipitation than is normal, is mildly indicative of a higher than average corn yield. If July has more than average precipitation and both July and August are cooler than normal, a higher than average corn yield is strongly indicated.

Thus it would seem that the southern boundary of the Corn Belt in Illinois, commonly explained by soils and topography, may depend just as much on the fact that temperatures, especially mid-season temperatures, to the southward are increasingly unfavorable to corn yield.

Of the two northern sample counties (Stephenson and Kane) it may be said that they are representative of a more extensive area along the northern margin of the Corn Belt, in which early-season temperature factors seem to be critical. This area seems normally to lack sufficient heat during the period preceding reproduction, while more than normal precipitation during the same period seems disadvantageous. Variations in mid-season temperatures and precipitation, except night temperatures lower than average during August, seem to have little relation to the yield per acre in this area.

The three central counties (Bureau, McDonough, and McLean) belong to what may be referred to as the central core of the Corn Belt. Although in these counties corn yields are nearly a hundred per cent greater in some years than in others, such fluctuations seldom correlate significantly with fluctuations in any of the thirty-five climatic factors investigated. The explanation is not at all clear. It is perhaps because of a blending of the factors important on the north with those significant on the south, with the result that fluctuations in any single factor are of minor importance as an influence in reducing or increasing corn yields in this central core area. Of the thirty-five factors investigated, not one gave a coefficient as high as  $\pm.40$  for Bureau County.

The areal divisions herein mentioned have no regard for state boundaries. It would seem, then, that their discovery is dependent upon the use of areas smaller than states.

The relatively low multiple correlation coefficients obtained for Kane, McLean, and Macoupin counties suggest that it is not yet possible to forecast the yield of corn in Illinois several months in advance with the same degree of certainty with which it can be done for some other areas of the Corn Belt of the United States.

# A Gazetteer of the Origin of Illinois Nomenclature

Alden D. Cutshall

*University of Illinois, Urbana, Illinois*

*A Gazetteer of the Origin of Illinois Nomenclature* is a compilation of the origins of the names of the counties and principal cities, rivers, and lakes of Illinois. This has previously been done for several states of the Union, but never, so far as the author is aware, for this state. The origins of these names were summarized under two classifications: (1) geographic or non-geographic and (2) linguistic.

From these two summaries we find that the origins of only 24 per cent of the Illinois names can be traced to geographic features. Of the remaining 76 per cent, about  $\frac{2}{3}$  (50 per cent of the whole) are named after men (prominent citizens, early settlers, founders, war heroes, governmental officials, etc.), and 19 per cent after other places, most of which are in eastern United States.

If a detailed summary of each division is made we find an interesting correlation. The county names are predominantly (80 per cent) named after men, mostly war heroes and governmental officials. The origins of the city nomenclature is fairly evenly divided. Those that are named after men are largely named for founders, early settlers, or prominent citizens. About 90 per cent are named after men, places, or geographic features, and these three origins stand in the ratio 7:5:4. About  $\frac{4}{5}$  of the rivers and lakes are named after geographic features. This variation can probably be explained by the fact that the rivers and lakes were largely named by the Indians, who, as was their custom, gave names taken largely from their surroundings; while in contrast, the cities and counties were usually named by the founders or early settlers, in some cases long after the Indian had been removed. They named their new home after a former home or after some prominent citizen or official. For this reason, in the second classification we find that the state, river, and lake nomenclature is primarily of an Indian origin, whereas the names of the counties and cities are predominantly of an English origin.

## SUMMARY

	Counties	Cities	Rivers and lakes	Total
Named after a geographic feature.....	12	43	18	73
Non-geographic feature.....	90	147	5	242
Named after men.....	80	74	1	155
Named after places.....	8	52	2	62
Unclassified.....	2	21	2	25
English.....	89	138	8	235
Indian.....	7	22	12	41
French.....	5	13	2	20
Spanish.....		2	1	3
Classical.....		3		3
Biblical.....		4		4
All others.....	1	8		9

If anyone is interested further in this work, a copy is available at the Urbana division of the Illinois Historical Survey and at the University library.



## PAPERS IN GEOLOGY

---

### EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN

All seventeen papers on the program of the Geology Section were read at the meeting, and all but three are here represented. Those omitted are:

"The Bearing of Field Relations in the Illinois Coal Field on the Time of Coalification," by Harold R. Wanless, State Geological Survey and University of Illinois.

"Some Evidences of the Shrinkage of Certain Illinois Coal Beds Since Their Burial," by Gilbert H. Cady, State Geological Survey.

"Taxonomy of Certain Mississippian Productidae," by A. H. Sutton, University of Illinois.

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

Dr. Harold R. Wanless, Department of Geology, University of Illinois, was elected chairman of the section for 1935-36.

(Signed) D. JEROME FISHER, *Chairman*



## Some Recent Attempts to Correlate the Later Paleozoic of America and Europe

A. C. Noé

*University of Chicago, Chicago*  
*Illinois State Geological Survey, Urbana*

In a paper presented before the Illinois Academy of Science in 1929, the author presented a correlation of the Illinois coal seams with European horizons. Coal seam No. 2, whose flora is best known, was correlated with the floras of the coal seams in Ibbenbüren and Piesberg in the Ruhr district. There is an exhaustive monograph of the flora of Ibbenbüren by Hans Bode published in 1927 by the Prussian Geological Survey. Furthermore, an extensive correspondence between Dr. W. Gothan of the Prussian Survey and Dr. Hans Bode and myself, and the exchange of many specimens made it apparently certain that the correlation was correct. Since the coal seams of Ibbenbüren and Piesberg belong to the upper part of the Westphalian group C, it seemed evident that the Pottsville would fill the remaining portion of group C, probably the entire B and A of the Westphalian, and perhaps reach into the Namurian. On the other hand, our entire McLeansboro and the Carbondale above coal No. 2 would necessarily fall into the Stephanian of the European classification. This is further borne out by the similarity of the floras in coal No. 5 and No. 6 with the Stephanian floras of Western Europe. More weight is added to this argument by the coal ball floras of Illinois from coal seams No. 5 and No. 6 which are distinctly Stephanian in character.

Two European visitors to the International Geological Congress of 1933 attempted correlations which were published in the autumn of 1934. Paul Bertrand of Lille in France accepts for his correlations the statements of the late David White and of the writer, admitting that we both have collected for many years in our respective territories and taking for granted that our determinations are correct. Dr. Jongmans had a different attitude. He made an extensive collection in the field covering West Virginia, Pennsylvania, Illinois, and Kansas, during his stay in this country, which extended from the middle of July to the end of September, 1933. He came to the conclusion that there is no Stephanian to be found in the United States, and that part of the Pottsville, the entire Alleghany, Conemaugh, and Monongahela, and part of the Dunkard, correspond to the Westphalian C. He correlates Westphalian A, B, and part of C, with the Pottsville, while Bertrand believes that the uppermost Namurian also corresponds to the American Pottsville.

As may be seen on the chart, my Carbondale corresponds somewhat to the Westphalian D of Bertrand. I have made no attempt to fix definitely the lower boundary of the Pottsville, since the investigation of the Pottsville has been in the hands of the late David White, whose authority in these matters was unquestionable. I sincerely hope that when White's great work about the Pottsville of Illinois is published by Dr. Charles Read, he will make a special effort to determine the lower boundary of the Illinois Pottsville in its relation to the Westphalian and Namurian of Western Europe.

While Paul Bertrand accepted my own determinations as made in my publications and in the collections which he inspected, Dr. Jongmans disagrees in many points of determination. For instance, he does not accept our *Pecopteris miltoni* which is actually the most common fern of coal No. 2, and which is also one of the most common ferns in the corresponding coal formations of Western Europe. He and Gothan, whose collaboration was published in the Yearbook of the Geologic Bureau of the Netherlands for 1933, based their conclusion on the comparatively small collection of material

WESTERN EUROPE		PENNSYLVANIA (J.&G.)	WEST VIRGINIA (J.&G.)	ILLINOIS (J.&G.)	UNITED STATES (P. BERTRAND)	ILLINOIS (A. C. NOÉ)
STEPHANIAN		—	—	—	MONONGAHELA CONEMAUGH	MC LEANSBORO
WESTPHALIAN	(D)	DUNKARD (IN PART) MONONGAHELA CONEMAUGH ALLEGHENY (POTTSVILLE)	DUNKARD (IN PART) (MONONGAHELA) (CONEMAUGH) ALLEGHENY	MONONGAHELA CONEMAUGH ALLEGHENY	ALLEGHENY IN WESTPHALIAN(D)	CARBONDALE
	C					
	B	POTTSVILLE	KANAWHA GROUP	POTTSVILLE (MILL CREEK) (CROFTON, KY)	UPPER POTTSVILLE	POTTSVILLE
	A		NEW RIVER GROUP	POTTSVILLE BATTERY ROCK	LOWER POTTSVILLE	
NAMURIAN	C	?	UPPER POCAHONTAS	PROBABLY ABSENT		?
	B	?		NOT INVESTIGATED BY JONGMANS	?	?
	A	MAUCH CHUNK POCONO (IN PART)	LOWER POCAHONTAS			

Fig. 1.—Chart showing correlation of Pennsylvanian strata in western Europe and United States.

which Jongmans brought home from his trip. In some cases he and I mean the same thing, but give it different names, and I hope by correspondence to be able to coordinate our determinations and nomenclature. He is quite right when he says, in his joint article with Gothan, that American and European paleobotanists should cooperate rather than work entirely independently.

# Spores Characteristic of Illinois Coal No. 6\*

James M. Schopf

State Geological Survey, Urbana, Illinois

A large variety of fossil plant spores, many of them distinct from described forms, have been obtained from macerated residues of coal No. 6 in Illinois. This report discusses only a few of them, chiefly those which have been reported by earlier investigators, and are now identified for the first time from this country.

Although it has long been known that spores occur in Paleozoic coals, and it has been suggested that they be employed in stratigraphic correlation, only recently has enough evidence been collected to test their usefulness. Zerndt,<sup>1</sup> Potonie<sup>2</sup> and their students and collaborators have shown that different types of spores in the Polish basin and the Ruhr, although not confined to single coal seams, have more or less restricted ranges and are characteristic of different parts of the stratigraphic succession.

The need for additional information for geologic use makes desirable a systematic classification of these spores, following the conventions of taxonomic usage. Many of the spore forms will probably never be identified in terms of species as they are conceived from studies based on other parts of the plant because, if Paleozoic plants resemble modern plants, the spores of closely related species are often indistinguishable. Hence it is recognized that a classification based on spore form is of limited value in approaching a natural system, and should be accorded consideration mostly from the standpoint of convenience. The varieties of spores are sufficiently distinct to constitute valuable indicators of vegetational change and it is in this sense that it is proposed to use them. At present it appears essential as a means to that end to apply a system of binomial designation which is consistent with that of general Paleobotanical practice.<sup>3</sup>

## Genus TRILETES Reinsch, 1883

Division LAEVIGATI Bennie and Kidston, 1886

*Triletes reinschi* (Ibrahim)

Figs. 1 and 2

1886, *Triletes* I Bennie and Kidston, Proc. Roy. Phys. Soc. Edinburgh, Vol. IX, p. 107, Pl. III, Figs. 1a, b.

1930, Spore 1.9 mm. Zerndt, Ann. de la Soc. Geol. de Pologne, Tom VI, p. 308, 312, Pl. I, Fig. 5a, b, Pl. III, Fig. 5a, b.

1930, *Triletes* Typ I Kidston, Zerndt, Bull. Int. de l'acad. Polon. des Sci. et des Lettres, Ser. B, p. 43, Pl. 1, Fig. 1.

\* This work has been supported jointly by the Illinois Geological Survey and the National Research Council, the author having worked under the direction of Dr. G. H. Cady while this information was accumulated.

<sup>1</sup>Zerndt, Jan, Les Megaspores du Bassin Houiller Polonais, l'ere partie. Academie Polonaise des Sciences et des Lettres, Comite des Publications Silesiennes, Travaux Geologiques No. 1; 1-55, 1934.

<sup>2</sup>Potonie, R., F. Loose, und C. Wicher, Zur Mikrobotanik der Kohlen und ihrer Verwandten, Arbeiten aus dem Institut für Paläobotanik und Petrographie der Brennsteine, Band 4; 1-212, 1934.

<sup>3</sup>R. Thiessen (U. S. Bur. Mines Bull. 117, p. 71, 1920) has objected to the naming of isolated spores, but his studies here and especially those of later date have been chiefly concerned with thin sections in which it is doubtful that spores can be consistently identified.

- 1931, Typ 10 Zerndt, Bull. Int. de l'Acad. Polon. des Sci. et des Lettres, Ser. A, p. 172.
- 1931, *Triletes* I Kidston, Stach und Zerndt, Glückauf, Jahrg. 67, p. 1122.
- 1932, *Triletes* Typ I Kidston, Maslankiewiczowa, Acta Societatis Bot. Polon., Vol. IX, p. 158.
- 1932, *Sporonites reinschi* Ibrahim, Neues Jahrbuch f. Min. Geol. u. Paläont., Beilage Bd. 67, Abt. B, p. 449, Pl. XVII, Fig. 28.
- 1933, *Laevigati-sporites reinschi* Ibrahim, Dissertation T. H. Berlin.
- 1934, *Sporites primus* Kidston, Wicher, Arbeiten aus dem Institut für Paläobotanik und Petrographie der Brennsteine, Band 4, p. 169.



Fig. 1. *Triletes reinschi* (Ibrahim), 1800 microns diameter. Spore nearly opaque, photo by reflected light.

Fig. 2. *Triletes reinschi* (Ibrahim), oval specimen with distal side removed, photo by transmitted light showing the arcuate ridges and pyramic apex darker, due to local exine thickening.

Fig. 3. *Triletes* sp. (Type 14, form 1 of Zerndt) half of an individual. *a*, reflected light, *b*, (slightly smaller magnification) transmitted light.

This spore, reported from Scotland, Poland, and the Ruhr of Germany, appears to be the most widely distributed of the forms now well known. The nomenclature, however, has become somewhat confused so that a brief explanation seems necessary.

The rules of scientific biological nomenclature require that the first name, properly established for any organism, be applied thereafter in accordance with the law of priority, notwithstanding any seeming inconsistency due to inappropriateness or sentiment. In order to establish a new species, however, a latinized name must be applied. Numerical designations cannot be accepted.

*Triletes* I Bennie and Kidston, 1886, therefore does not constitute a valid species name and the first latinized name subsequently applied should be given recognition. The name "*Sporites primus* Kidston, 1886", recently given by Wicher is also in error. In the first place the name is new, Kidston never having used it in that form in the literature; hence the new name is attributable to Wicher, 1934, and to no one else. Secondly, since Wicher considers *Sporonites reinschi* Ibrahim, 1932, synonymous with Bennie and Kidston's *Triletes* I, it is evident that this was the first correct species name proposed for it.

The diameter of moderately large specimens of *Triletes reinschi* is nearly 2 mm. The surface has a smooth to granulose texture, and due to

preservation, is generally slightly undulatory. The pyramic areas are well defined; taken together they occupy about one-half the proximal side of the spore. (Kidston, 1886, states "two-thirds", but a planimetric measurement of his original illustration gives a value of about 47 per cent.) The exine is quite thick. This is the most common megaspore found in coal No. 6.

*Triletes cf. giganteus* Zerndt, 1930

- 1930, *Triletes giganteus* Zerndt, Bull. Int. de l'Acad. Polonaise des Sci. et des Lettres, Ser. B, p. 71-79, Pls. 9-11.  
 1931, Typ 1 Zerndt, Bull. Int. de l'Acad. Polonaise des Sci. et des Lettres, Ser. A, p. 170.  
 1934, *Triletes giganteus* Zerndt, Acad. Polon, des Sci. et des Lettres; Travaux Geol. No. 1, p. 13-15, Pls. 1-5. Text fig. 2.  
 1934, *Sporites giganteus* Zerndt, Wicher, Arbeiten aus dem Institut für Paläobotanik und Petrographie der Brennsteine, Band 4, p. 172, Pl. 8, fig. 9.  
 1935, *Triletes cf. giganteus* Zerndt; Schopf, Trans. Ill. Acad. Sci. Vol. 28, p. 106, Pl. 1, fig. 5.

This species is the largest yet recorded for any type of spore. Zerndt mentions a specimen 6.4 mm. long and Wicher reports a large spore encountered in the Ruhr coals attaining a length of 7.5 mm. An individual, probably identical with this species, from Illinois coal No. 6 at Johnson City has a length of 7.8 mm., folds transverse to the long axis, and a small portion of the apex missing. It is probable therefore that these are not extreme measurements and in life the spores may have been even larger. It is not surprising that such bodies were mistaken by earlier workers for sporangia rather than individual spores. Other smaller specimens, one of which is figured, are discussed in the author's previous paper cited above. These must be considered as closely related to Zerndt's species since the wall texture, size, and morphology are in general agreement. *T. cf. giganteus* is not as abundant in Illinois coals thus far studied as it apparently is in many Polish coals.

Division APICULATI B. and K. 1886

*Triletes* sp.

Fig. 3a, b

This characteristic Illinois form is assigned to the division Apiculati although the spines are very short and rarely, obscure. It is found abundantly with *T. reinschi* just above the blue band in the No. 6 bed at Belleville, Illinois. The figured specimen is smaller, and the pyramic areas which ordinarily occupy about half the proximal side, are for this reason proportionately larger than the average. The lips are characteristically spread apart leaving a wide trilete aperture. The texture of the lip is somewhat distinctive in that it forms a margin for the aperture which is narrow, glossy, rounded and somewhat articulated. This spore is quite similar to a specimen figured by Zerndt<sup>4</sup> in 1932 which would now be included in his Type 14, form 1.<sup>5</sup>

Division ZONALES B. and K. 1886

*Triletes triangulatus* Zerndt, 1930

- 1930, Spora 0.5 mm. Zerndt, Ann. de la Soc. Geol. de Pologne, Tom VI, p. 306, 312, Pl. I, fig. 1a, c, Pl. III, fig. 1a, b.

<sup>4</sup>Zerndt, J. Megasporen aus dem Zwickauer an Lugau-ölsnitzer Karbon. Jahrbuch für das Berg- und Hüttenwesen in Sachsen, Jahrg. 1932; Pl. 3, fig. 15.

<sup>5</sup>Zerndt, J. Op. cit. 1934; p. 18.

- 1930, *Triletes triangulatus* I Zerndt, Bull. Int. de l'Acad. Polon. des Sci. et des Lettres, Ser. B, p. 51, Pl. 7, figs. 19-24.
- 1931, Typ. 17 Zerndt, Bull. Int. de l'Acad. Polon. des Sci. et des Lettres, Ser. A, p. 178.
- 1932, *Sporonites regalis* Ibrahim, Neues Jahrbuch f. Min. Geol. u. Paläont. Beilage Bd. 67, Abt. B, p. 449, Pl. XVI, fig. 24.
- 1934, *Triletes triangulatus* Zerndt, Acad. Polon. des Sci. et des Lettres Travaux Geol. No. 1, p. 19, Pl. 18, fig. 1-24.
- 1934, *Sporites triangulatus* Zerndt, Wicher, Arbeiten aus dem Inst. für Paläobotanik und Petrographie der Brennsteine, Band 4, p. 175.
- 1935, *Triletes triangulatus* Zerndt, Schopf, Trans. Ill. Acad. Sci. Vol. 28, p. 107, Pl. 1, fig. 6a, b.

This form is discussed elsewhere in this volume (Schopf, Op. cit.) and requires no further mention at this time. It seems to be limited to short zones of frequency, sometimes recurring several times in the height of a single coal bed.

#### Genus LAGENICULA B. and K. 1886

At least two species occurring commonly in Illinois No. 6 coal are referable to the genus *Lagenicula* as interpreted by Zerndt. One of these may be identical with *Lagenicula* Typ. 30 of Zerndt. The other and more common form is about equal in size (nearly 1 mm. long) and has a characteristic translucent exine. Descriptions will be published later.

#### Genus MONOLETES (Ibrahim, 1933)

##### *Monoletes ovatus* Schopf, 1935

- 1935, *Monoletes ovatus* Schopf, Trans. Ill. Acad. Sci. 28, p. 108, Pl. 1, fig. 7.

This spore is small in comparison with the large macrospores previously discussed. Since spores of similar type have been found in the "pollen" chambers of large pteridospermic seeds, it may have functioned as a microspore, although some individuals of this type are quite large (approaching 700 microns). There is no evidence that a pollen tube was produced, so that it can be considered as a probable *microspore* which functioned most likely, under very specialized conditions. It may be permissible to call such spores "prepollen" as Renault<sup>6</sup> does, however it is doubtful that any features are present which would clearly distinguish prepollen morphologically from monolete microspores or isospores. It is still more doubtful that such prepollen is the phylogenetic forerunner of true pollen such as possessed by Angiosperms. There is some similarity between it and cycad pollen.

The predominance of *Monoletes ovatus* at two localities examined, and its presence at others, suggests that the plant which produced it must in some instances have contributed largely to the mass of the coal.

From the preliminary studies made thus far, the different spore species appear to be quite definitely limited to distinct zones of abundance within the coal bed. This zonal distribution will be of importance by its application to the theory of coal accumulation and in bed correlation.

The writer wishes to express his gratitude to Dr. J. Marvin Weller and to Dr. G. H. Cady for suggestions and assistance in the preparation of this paper.

<sup>6</sup> Renault, B., Bassin Houiller et Permien d'Autun et Epinac, Paris 1896, p. 270.

## Results Obtained by Chromic-Sulphuric Acid Etching of Illinois Coals\*

W. S. McCabe

*Illinois State Geological Survey, Urbana, Illinois*

The present paper gives some of the results of the use of the etching method in studying a complete column of Herrin (No. 6) coal collected at Nashville, Washington County, Illinois.

Seyler's method<sup>1</sup> was used in this study, with some slight modifications. Blocks of coal cut across the bedding were first polished. These blocks are as large as can be conveniently handled under the microscope, since large surfaces are desirable in order to follow changes in structure. This surface was ground with progressively finer grades of carborundum, then on a Belgian hone, after which it was polished with No. 2 and No. 3 alumina on billiard cloth. By reflected light the polished surfaces reveal no internal structure in the banded ingredients. The etching liquid consists of 10 cc. of strong sulfuric acid added to 30 cc. of a saturated solution of chromic acid with enough water to make complete solution possible. The solution is boiled until the chromic acid begins to precipitate. The block of coal is then placed in the solution, which is kept at the boiling point during the time of the etching, 45 seconds for Illinois coal. The blocks are taken from the etching solution, cooled, washed with water, dried, and gently rubbed with the repolishing cloth. The sections are examined with reflected light using an Ultropak objective.

The technique is relatively simple and the etched surfaces offer several advantages over thin sections. Etched surfaces frequently reveal structures not revealed in thin sections, in spite of the greater general usefulness of the latter for petrographic studies. The etching is selective in its action on the coal constituents. The resins, spores, cuticles, and fusain are not attacked, vitrain is next most resistant, certain parts of the clarain are least resistant. Some of the broad vitrain bands lose their brilliant color and become grayish black in color, but vitrain that is comprised largely of resin-filled cells retains its luster and the minute details of cell structure; even the pitting, middle lamellae, and original shape of the lumens are revealed, making possible the identification of the tissues in some instances. This woody lustrous variety of vitrain often grades into the gray, apparently structureless variety. These differences have not been observed in thin section. Often the broad bands of vitrain show no trace of structure under very high magnification. This variety of vitrain may be due to the complete disintegration of the cell structure. Xylem cells (Fig. 1, *a*) of the conducting tissue, parenchyma cells of the pith, and crushed steles (Fig. 1, *b*) are some of the structures found in the vitrain.

In one preserved fragment (Fig. 1, *c*) the lumens of the cells are filled with kaolinite, and the middle lamellae, the thickened lignified portion of the woody part, and the pitting in the cell walls are well preserved. Resins (Fig. 1, *d*) stand out conspicuously in the vitrain. Sectioning in two planes

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

<sup>1</sup> Seyler, *Fuel*, vol. 4, No. 2, Feb., 1925.

shows the elliptical bodies to be resin rodlets, 3 to 4 mm. long. Some of the resins appear to have a darker ring around the outer margin, and this may be explained as the result of oxidation of the resin rodlet. Distinctly different globular bodies with a marginal ring and perforate openings in the center have been identified by some investigators as sclerotia (fungal bodies).

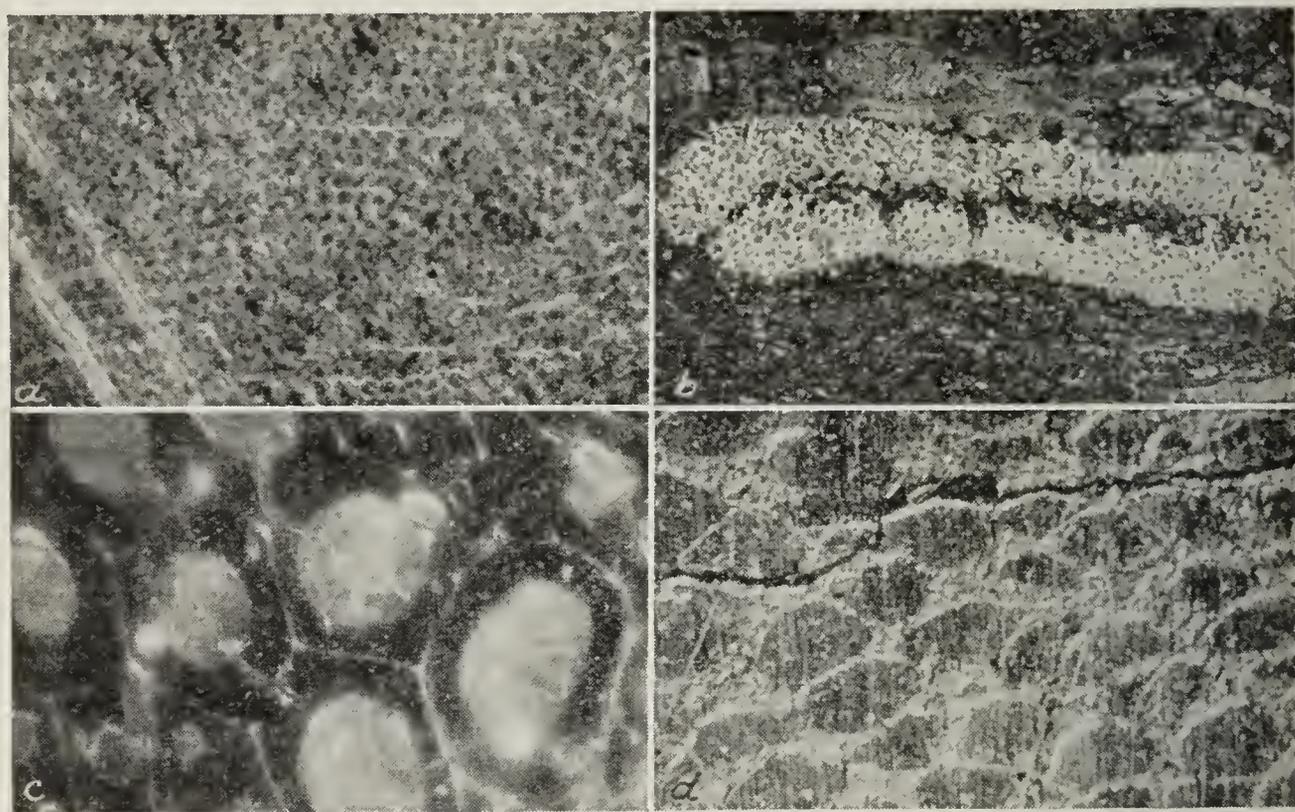


Fig. 1.—(a) Xylem cells of the conducting tissue ( $\times 86$ ); (b) crushed steles ( $\times 25$ ); (c) lumens filled with kaolinite ( $\times 285$ ); (d) resins preserved in vitrain ( $\times 367$ ).

In the clarain, the resins, spores, and cuticles are well preserved in a groundmass of heterogeneous detrital material. The resins occur singly and in groups, resin rods predominating over small lenticular bodies. The spores often show a black central portion which may be the gametophyte carbonized. The cuticles show the serrate edges of cell impressions. Certain tissues of cortical origin appear to be present as the suberized part of the periderm.

Fusian is preserved in lenticular fragments often showing well preserved cell structures, such as tracheids or a group of steles or a polystelic fragment. Resins occur in fusian in partings in the coal. These resins show peculiar concentric markings and some have mineral matter in the center of the rods.

## Geologic Dating of Time of Coalification

D. Jerome Fisher

*University of Chicago, Chicago, Illinois*

**Statement of problem.**—Did a given coal bed in the Pennsylvanian system of a certain part of Illinois reach essentially its present condition by the close of the Paleozoic era, or at any other fairly specific past geologic date, or must we consider that it has only recently reached its present rank and is still undergoing important change, be it ever so slow? It seems probable that such a question can now be answered definitely for given coal seams in certain areas, and that if criteria be assembled and coal-bearing strata studied with these problems in mind, additional worth-while results will be obtained.

**Causes of coalification.**—It seems true that the only everlasting thing is change, and that alteration of materials results from the constant variation in environment which prevents attainment of anything but a geologically temporary state of equilibrium at best. We thus expect that coalification might have occurred rapidly in those situations where environmental change was rapid, and vice versa. We know that in some cases coalification has been exceedingly slow or at least has never proceeded very far; thus our oldest very extensive coals, those of the Moscow Basin in Mississippian strata, are of lignitic rank. But do we know cases of an opposite nature, always excepting those where igneous metamorphism has been of obvious or suspected importance?

**Significant Examples.**—Rounded coal pebbles found in sediments in close association with the seam from which they were probably derived indicate that the embryo coal early reached a stage in the coalification process in which it was brittle. This would hardly be short of the lignite stage, and might be closer to sub-bituminous, depending of course on the amount of moisture present. Considerable significance should possibly be attached to the question of whether a given coal pebble shows the effects of definite subsequent differential compaction as compared to that of the matrix sediments, especially if these are not shaly. Examples illustrative of these points may be taken from the literature covering Great Britain, Germany, France, Poland, Ohio, and West Virginia.

Sandstone dikes cutting coal seams in Utah and Illinois are described. These indicate that the embryo coal was brittle enough to crack before consolidation of the superjacent sandstone, and that subsequent to consolidation of the sand of the dikes there has been no important differential compaction between coal and sandstone dike.

Other criteria, such as folding in a coal-bearing series due to largely contemporaneous differential compaction below a channel sandstone, and the relations of partings and splits to the coal seam, are cited as significant in this connection.

**Conclusions.**—It seems clear that there is strong evidence that coalification may under certain conditions proceed with great rapidity, geologically speaking, even away from the igneous contact environment. Coals of

bituminous rank occur in the Miocene of California and in the Oligocene, even though not intensely folded nor deeply buried, in Czecho-slovakia (Gonobitz and Schega), western Rumania (Zsil valley in Siebenbürgen), and Sumatra. Sub-bituminous beds of Miocene age are not very rare. Anthracites of Eocene age occur in highly folded rocks of Switzerland (Diablerets) and Thrace (Sulfil).

While no one will question the fact that increased pressures and temperatures may be important agents of the coalification process, the burden of proof rests on those who say that these are the sole ones, as is shown by the evidence cited. Each seam in a given area should be examined and its origin interpreted in light of its own field and laboratory evidence.

The theory of progressive regional carbonization, first emphasized by David White, who considers that lateral pressure is the most important agent of coalification, receives important modification if the evidence here presented is granted to demonstrate early coalification in at least some cases. It follows from this that coal can form without the action of significant lateral pressures and with only minor load pressures. Moreover neither long time intervals nor important increases in temperature would seem to be necessary.

It has been suggested that syneretic changes may be a possible explanation of the phenomenon; careful observation and experimentation are needed to clear up many details. In especial, if this is on the right track, one would like to know why there is so much lignite. Is syneresis so exceedingly slow? Time is not the only factor, as is certainly shown by the Moscow Basin lignites. Has pH value been an important control? This and many other possible factors need investigation. The McKenzie Taylor theory of base-exchange (substitution of sodium) in roof strata with subsequent hydrolysis giving alkaline conditions, and so permitting long-continued bacterial action, thus controlling rank of coal, seems to fall down when examined closely on the following counts: lack of satisfactory evidence that hydrolysis has occurred (sodium clay is particularly impervious to water, though less so to dilute solutions of calcium salts); general but not universal agreement that bacterial action insofar as it is important in the coalification process is limited to the peat stage; and, at least for the higher coal ranks, evidence brought out in connection with the theory of progressive regional carbonization.

That the latter theory is at least partially applicable to the post-sub-bituminous stages is not questioned. In short so far as devolatilization is concerned, the theory has much to recommend it. But that important lateral pressure is unnecessary to account for the early dehydration of coals (down to a moisture content of 20 per cent or less, ash-free basis), is a major tenet of this paper. Advocates of the theory as applicable to the earlier stages of coalification can hardly substantiate their positions by studies in areas of higher ranks. As a matter of fact it is in just such areas that most of the field evidence cited in this paper has been obtained.

# Possible Relations of Mineral Matter in Coal to the Time of Coalification

Clayton G. Ball

*State Geological Survey, Urbana, Illinois*

The results of detailed petrographic investigations of visible mineral matter in Illinois coals, while not complete, are nevertheless sufficiently conclusive to justify certain generalizations in regard to the identity and occurrence of the component minerals.

It has been observed<sup>1</sup> that the mineral matter separable from coal consists of (1) those minerals which were washed, blown or otherwise transported into the coal basin during the time of peat accumulation, consisting mainly of detrital clay and small amounts of minerals similar to those in the associated sediments, and (2) those minerals deposited from solution or suspension in the interstices of the bed after the coal was buried. Minerals of the second group are generally restricted to pyrite, kaolinite, and calcite. The characteristic occurrences of kaolinite and calcite in coal permit definite establishing of time relationships in their deposition.

## THE OCCURRENCE OF KAOLINITE AND CALCITE IN COAL

1. **Original openings.**—Those natural openings which existed in the plant at the time of deposition in the peat or which were developed within the peat-forming constituents during or very soon after peat accumulation are here considered as original openings. The most prominent constituent of coal which possesses such original openings is fusain. Another naturally porous ingredient in coal, closely related to fusain, apparently represents a transition stage between vitrain and fusain. This form has been named "bogen" structure.

In general, both of these coal constituents are mineral-filled, usually with kaolinite. Calcite has been observed in some fusain lenticles, however, usually appearing in the larger and more centrally located cavities, while the smaller and marginal openings of the same lenticle are filled with kaolinite.

Of frequent occurrence in fusain partings and in the clarain bands are tiny, elongated cylinders which have been interpreted as resin rodlets. When partially or completely hollow, these rodlets are generally filled with kaolinite.

Small, irregular openings which may have been inherent to some particular plant are sometimes seen in vitrain bands. These are filled with kaolinite. Spores are occasionally observed with kaolinite fillings, although such occurrences are rare. Small structures with quartz-filled cavities are found to some extent in vitrain and clarain and may represent the medullary rays of certain plant varieties.

2. **Desiccation cracks.**—Desiccation cracks in Illinois coals are characteristic of and commonly restricted to vitrain bands.<sup>1</sup> In most Illinois

<sup>1</sup> Ball, C. G. The mineral matter of No. 6 bed coal at West Frankfort, Franklin County, Illinois: Illinois State Geol. Survey Report of Investigations No. 33, 1935.

coals the desiccation cracks have been filled with kaolinite, especially the fine cracks occurring in the thinner vitrain bands. Calcite may be present in desiccation cracks, particularly in high-calcite beds, or in distinct portions of any single bed which contain abundant calcite. These calcite fillings are in general thicker than those formed of kaolinite, and may even occur in the same cracks with kaolinite. In such cases the calcite usually slightly overlaps the kaolinite, suggesting that desiccation was not complete at the time of deposition of the kaolinite.

3. **Fracture cracks.**—Fracture cracks in coal are those cracks extending across one or more of the banded constituents, either vertically or at nearly vertical angles to the bedding. The oblique or zig-zag pattern often characteristic of the fracture cracks is thought to show evidence of dynamic strain within the coal bed, although the apparent lack of displacement either in the lithologic constituents of the coal or in the mineral-filled desiccation cracks suggests that the stress was very slight. These cracks are filled dominantly with calcite. The calcite, moreover, seems to be definitely post-kaolinite in age. Fracture cracks, filled with calcite, may cross and horizontally displace fusain lenticles already filled with kaolinite. They may widen and overlap kaolinite-filled desiccation cracks.

### TIME OF COALIFICATION

With the above relationships in mind, a tentative summary of part of the coalification process is offered for consideration. It is suggested that deposition of kaolinite in the original openings of the coal took place shortly after, if not actually during, the process of peat accumulation. The fact that the porous fusain lenticles and resin rodlets were not crushed and broken prior to kaolinite deposition, and that the constituents of the clarain are frequently bent and distorted downwards around these ingredients is strongly suggestive of early kaolinite infiltration. This can not be considered as direct evidence, it is true, since the inherent strength of the fusain and resin rodlets may have been sufficient to resist crushing without the support of mineral fillings.

If it be assumed that the original cavities were filled shortly after peat deposition, it would appear that the desiccation cracks were formed and mineralized at a similarly early stage in the coalification process, since the natural openings in coal and the desiccation cracks are both kaolinite-filled. The pattern of most desiccation cracks is so strongly suggestive of the drying-out of a gel-like material, undisturbed by structural movement, that it is believed the kaolinite deposition took place before the coal bed had suffered any dynamic movement, unless the coal had retained its peat-like plasticity for a long period of time.

The fracture cracks are believed to represent the effects of some form of stress other than vertical compression. The origin of the pronounced cleating in coal has not been considered here, but it is believed that this jointing took place at a period later than the formation of the fracture cracks. It is possible that the cleat would most logically represent the results of the late Paleozoic dynamic movements, while the minor fracture joints were formed by previous and less extensive movements such as concluded a megacyclothem.

## Status of the Carbon-Ratio Theory in Illinois

Alfred H. Bell

*State Geological Survey, Urbana, Illinois*

According to the carbon-ratio theory, dynamic metamorphism increases the percentage of fixed carbon in coal and the Baumé gravity of oil until a limit or "extinction zone" is reached beyond which oil does not exist in liquid form at ordinary temperature and pressure. The sequence of variations in average carbon-ratios (per cent fixed carbon in moisture- and mineral matter-free coal) of the coals and in the average gravities of the oils in going from a region of relatively undisturbed rocks to one that has been highly disturbed is believed to be indicative of the progressive change in these properties of the coal and oil in a locality structurally disturbed since their deposition.

The pertinent data on coal and oil in Illinois are reviewed and their bearing on the carbon-ratio theory is discussed. Progressive increase is noted in the carbon-ratios in going from the northern to the southern part of the Illinois coal basin. In the extreme southern part there is an east-west belt of faulting and some igneous intrusion. However the stage of dynamic metamorphism reached here is far short of that reached in the folded areas of the Appalachian mountains. The highest carbon-ratios in Illinois are approximately 62 per cent which is in the extinction zone for oil, announced in a recent paper by David White as from 61 to 63 per cent. The range in degree of dynamic metamorphism in Illinois is, therefore, insufficient for a complete test of the carbon-ratio theory.

The isocarb maps prepared during this investigation are based on more data than similar maps prepared by Moulton in 1925. They do not entirely support his conclusion that the isocarbs parallel the structure contours.

Study of oil gravities in Illinois with respect to their areal distribution does not reveal any relation either with the variations in carbon-ratio of coals or with degree of regional dynamic metamorphism. The known variations in oil gravity seem to depend largely on geologic age of the oil-bearing rock and on depth of burial. The majority of the known oil fields are located on or near carbon-ratio "highs" and therefore knowledge of carbon-ratios may be of some value in future prospecting for new oil fields.

## Temperature During Coal Formation

Gilbert Thiessen

*Illinois State Geological Survey, Urbana*

The more important factors influencing the degree of metamorphism of coal are pressure, temperature, type of cover, and the time through which these factors act. From all considerations temperature is probably the most important factor influencing the rank of coal. What the maximum temperatures were to which a given coal was subjected has been the subject of much speculation and some not very conclusive research. In general, students of the subject have come to two different conclusions. One group believes that rather high temperatures, that is, 200° C. for brown coals and 300 to 350° C. for bituminous coals, were responsible; the other group is inclined to believe that relatively low temperatures were effective. The present author holds to this latter view.

The evidence put forth for the high temperature view is based largely upon the minimum temperatures required to cause visible or measurable changes to coal in laboratory tests. B. Newmann,<sup>1</sup> for example, on the basis of the softening point of the resins, places the temperature to which a Chinese bituminous coal and a Westphalian high volatile coal were subjected at 265-320° C. and 230-300° C. respectively. His conclusions are based upon an assumption that the rounded shape of the resins in the coal is a proof that the resins had been subjected to temperatures equal to their melting points. The argument is inconclusive since resins will flow at very low temperatures under the influence of pressure. The temperature at which coals begin to evolve decomposition products does not necessarily bear any relationship to their previous thermal history. Many organic compounds, synthetic and natural, behave similarly to coal when subjected to heat. That temperatures of 300° C. are required to produce artificial "coalification" of organic material in the laboratory is also regarded as incomparable with natural conditions of coalification.

The author believes that: (1) The behavior, under the microscope, of coal when heated, (2) the behavior of moisture in coal, (3) the temperatures at present associated with coal beds, (4) the properties of coals which have been subjected to higher temperatures brought about by igneous intrusions, and (5) the rate of increase of chemical reaction rates with temperature increase, are sufficient evidence to prove that the maximum temperatures during the formation of bituminous coals was not greatly in excess of those found today in coal beds, certainly not much greater than 100° C.

R. Thiessen<sup>2</sup> has shown that at 150° C., dark-bordered cracks appear in the anthraxylon bands of bituminous coal, and that at 330° C. vacuoles appeared in certain leaf tissues. We conclude from this that bituminous coal had not previously been subjected to temperatures higher than 150° C.

Coal moisture is largely held colloiddally. A coal will not reabsorb as much moisture as it loses on drying. It is difficult to account for the high moisture content of Illinois bituminous coals if one assumes that they have been subjected to temperatures far above the boiling point of water.

<sup>1</sup> Newmann, B.—*Brennstoff-Chemie* 15 (2): 25-7 (1934).

<sup>2</sup> Thiessen, R. and Sprunk, G. C.—*Fuel* 13 (4): 116-125 (1934).

Coal formation is apparently taking place today. We find all ranks of coal represented, from young peats to anthracites, yet nowhere do we find unusual temperatures associated with these beds. Present geothermal conditions do not lend much evidence to support the theory that coal formation depended upon high temperature. However, in certain localized areas, igneous intrusions have resulted in relatively high temperatures. Under such conditions, the coal in contact with the intrusive material has been greatly altered. Here, where we do have a definite condition of high temperature, coalification has taken a different course than in the rest of the deposit.

Finally, the rate of change of chemical reaction rates with temperature changes lends further support to the idea of low temperatures. The rate of a chemical reaction roughly doubles for each  $10^{\circ}$  C. rise in temperature. On that basis, a reaction should go the same amount in ten days at  $320^{\circ}$  C. as in thirty million years at  $20^{\circ}$  C. High temperatures result in coalification (polymerization, decomposition, and dehydration) rates which are far too high.

The author concludes, therefore, that normal coalification occurred at relatively low temperatures, that is, at approximately those found today in coal beds.

## Local Calorific Variations in Coal No. 6 and the Geological Implications\*

E. T. Benson

*State Geological Survey, Urbana, Illinois*

The area under discussion lies in southern Illinois south of T. 3 N., and west of R. 5 E. In this area No. 6 coal is the most extensively mined coal, so its structural features and chemical character are relatively well known. No. 6 coal averages more than 6 feet in thickness throughout the area, and attains thicknesses as great as 15 feet in small areas.

In the northwest part of the area the structure of the coal is without notable features, gentle regional dip to the east and north being characteristic. In the southern part of the area three belts of structural irregularity are prominent. They are: (1) The DuQuoin anticline, or monocline, which extends from northern Jackson County northward to the Centralia-Sandoval region. This flexure is most prominent in Jackson and Perry counties; (2) a zone of structural irregularity consisting of faults and reverse dips extending from T. 8 S., R. 4 E., in Williamson County westward to T. 7 W., R. 1 W., in Jackson County. This faulted belt is along the eastward projection of the Campbell Hill Anticline<sup>1</sup> and the westward projection of the Cottage Grove or Harrisburg<sup>2</sup> fault; (3) a minor belt of deformation consisting of faults and reverse dips extending slightly west of north from central Williamson County up into central Franklin County.

The chemical character of No. 6 bed coal in the area under discussion is interpreted from the analyses of 437 face samples collected from 103 mines. The calorific values of the coal are given on the unit coal basis,<sup>3</sup> which is essentially a moisture and mineral-matter-free basis. This is used in order to do away with irregularities which might be caused by variations in moisture and mineral matter content. Isocalorific lines are drawn through points having equal calorific value. The distribution of the lines with respect to the structure contours should indicate whether calorific value has any relationship to structure.

In Franklin and Williamson counties it can be seen from the map that the 14,600 unit B. t. u. line entirely surrounds the area where structural deformation of the coal has occurred. The faulting and folding has apparently taken place after the consolidation of the coal, and the stresses involved in the deformation have apparently so affected the coal that its calorific values are higher than in the areas where such deformation is not prominent or entirely absent. An example of this latter condition is the western half of the area shown on the map. Here the structure is gentle and featureless, and the calorific values are fairly regular in their distribution and bear no apparent relationship to structure.

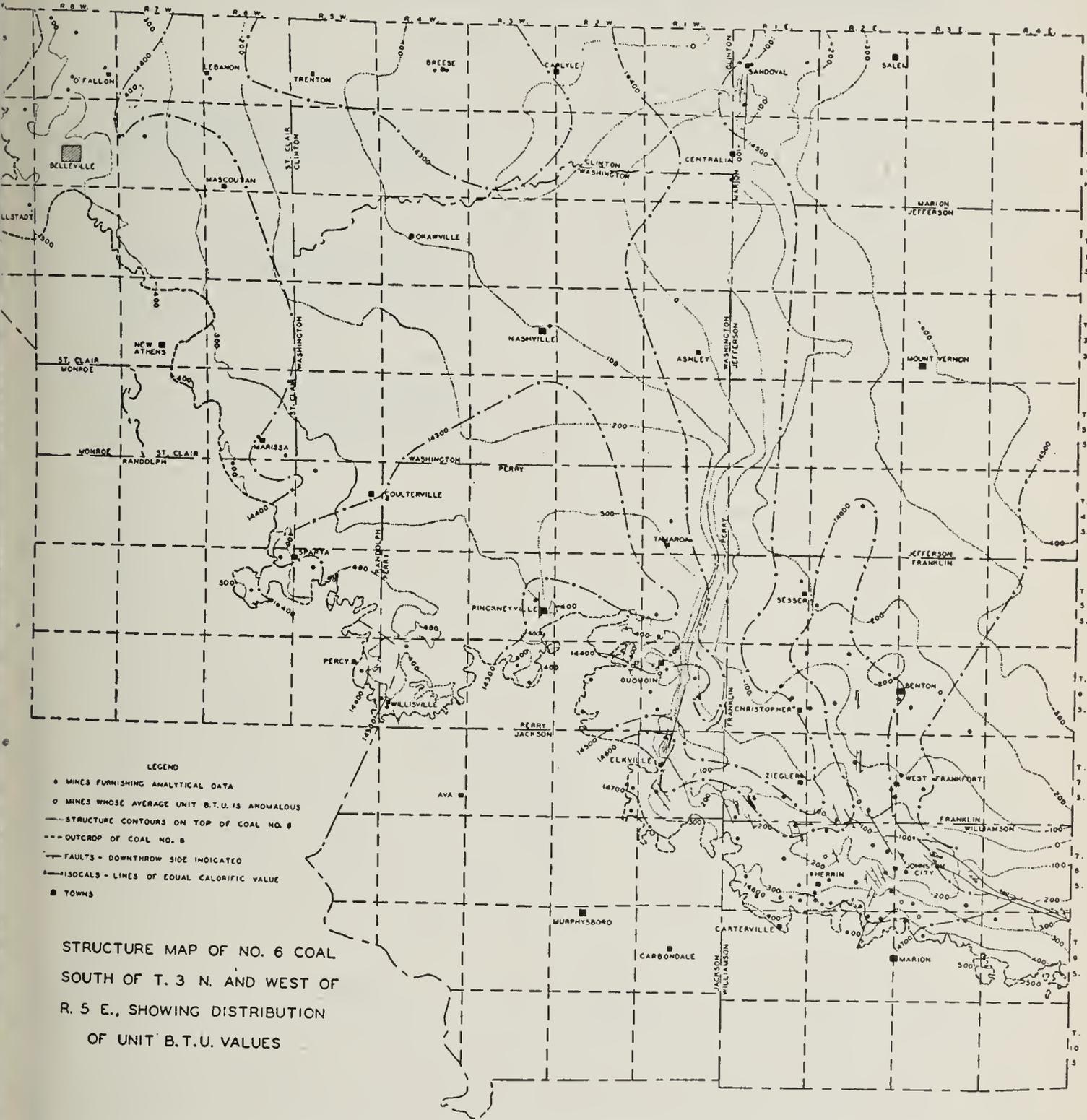
\* Presented by permission of the Chief, State Geological Survey.

<sup>1</sup> St. Clair, Stuart, Oil Possibilities of the Ava Area, Illinois State Geol. Survey Bull. 35, pp. 57-65, 1917.

<sup>2</sup> Cady, G. H. Coal Resources of District V, Illinois State Geol. Survey Coop. Bull. 19, p. 31, 1919.

<sup>3</sup> Parr and Wheeler. Unit Coal and Composition of Coal Ash, University of Illinois Eng. Exp. Station Bull. 37, 1909.

It was formerly thought that the DuQuoin anticline marked a distinct change in the character of the coal. This is not demonstrated by the present study, for the isocaloric lines cross this structural feature with little or no apparent relationship to the deformation. The 14,400 and 14,500 B. t. u. lines roughly parallel this flexure, but there is no abrupt increase in calorific value of the coal where the structure is prominent. This suggests that the DuQuoin anticline existed as a structural feature prior to or contemporaneously



with the deposition of No. 6 coal, and that subsequent movements along this line of deformation occurred before the coal bed was consolidated, and therefore did not effect changes in the character of the coal itself. There is other evidence available to substantiate this time relationship of the structure and coal deposition, but space does not permit its presentation here.

The calorific value of No. 6 bed coal is undoubtedly affected locally along the outcrop by being excessively wet or dried out. Variations arising from these conditions have not been considered here.

Blue print enlargements of the map are available upon request to the State Geological Survey, Urbana.

## Significance of Banded Ingredients in Coal\*

Louis C. McCabe

State Geological Survey, Urbana, Illinois

In 1931 the coal division of the State Geological Survey began an investigation of the physical and chemical characteristics of the bands which make up Illinois coals. Information subsequently collected has demonstrated that the three banded ingredients, vitrain, clarain, and fusain have chemical and physical differences which are significant in the utilization of coal.

To date columns have been cut from the seam in 46 mines in the State and the relative percentages of the important ingredients have been carefully determined. Table 1 shows the distribution in ten mines in No. 6 coal. Vitrain and clarain are to a certain extent complementary and make up the greater part of the coal. In No. 6 coal in the southern part of the State vitrain becomes progressively greater in quantity from the Belleville region toward the Franklin-Williamson County district (Fig. 1).

TABLE 1—PERCENTAGES OF BANDED INGREDIENTS

Mine	County	Banded coal ingredients				Banded impurities		
		Vitrain	Clarain	Durain	Fusain	Pyrite	Bone	Clay
A	St. Clair	13.16	76.51		3.38	5.12		1.33
B	St. Clair	7.83	83.09		2.62	4.76		1.70
C	St. Clair	9.95	77.58		7.43	1.82	1.33	1.89
D	Montgomery	19.5	62.1	14.9	.8	1.5		1.2
E	Washington	13.40	68.70	15.0	2.9			(a)
F	Randolph	14.76	75.88		4.77			4.59
G	Perry	19.00	69.90		4.50		2.6	4.00
H	Franklin	18.81	77.68		1.50	.42	.61	.98
I	Franklin	22.70	72.40		2.3	.10	1.60	.9
J	Williamson	20.1	76.55		1.35		2.0	

(a) Eight-inch clay band removed in mining.

Some sixty analyses of bands are now available and some conclusions concerning differences in chemical character may be drawn. Figure 2 shows the characteristics of samples of bands taken from the same mine.

The analyses of fusain show great variability in moisture and ash content. Within the same mine, moisture values vary from 8.99 to 22.8 per cent and the ash from 4.86 to 16.91 per cent. This variability in moisture and ash content is due to the porous nature of the fusain; air drying loss is for the same reason very high. Other noteworthy chemical peculiarities of fusain are a very high content of fixed carbon, which in the dry, ash-free

(FC)

coal is about 75 per cent, so that the fuel ratio  $\frac{\text{FC}}{\text{VM}}$  is commonly more

(VM)

than 3.0. The unit coal value of fusain is fairly constant at about 15,000 B. t. u., although there are erratic and unexpected variations from this value.

Vitrain is generally characterized by less ash than the other ingredients

\* Published by permission of the Chief, Illinois Geological Survey.

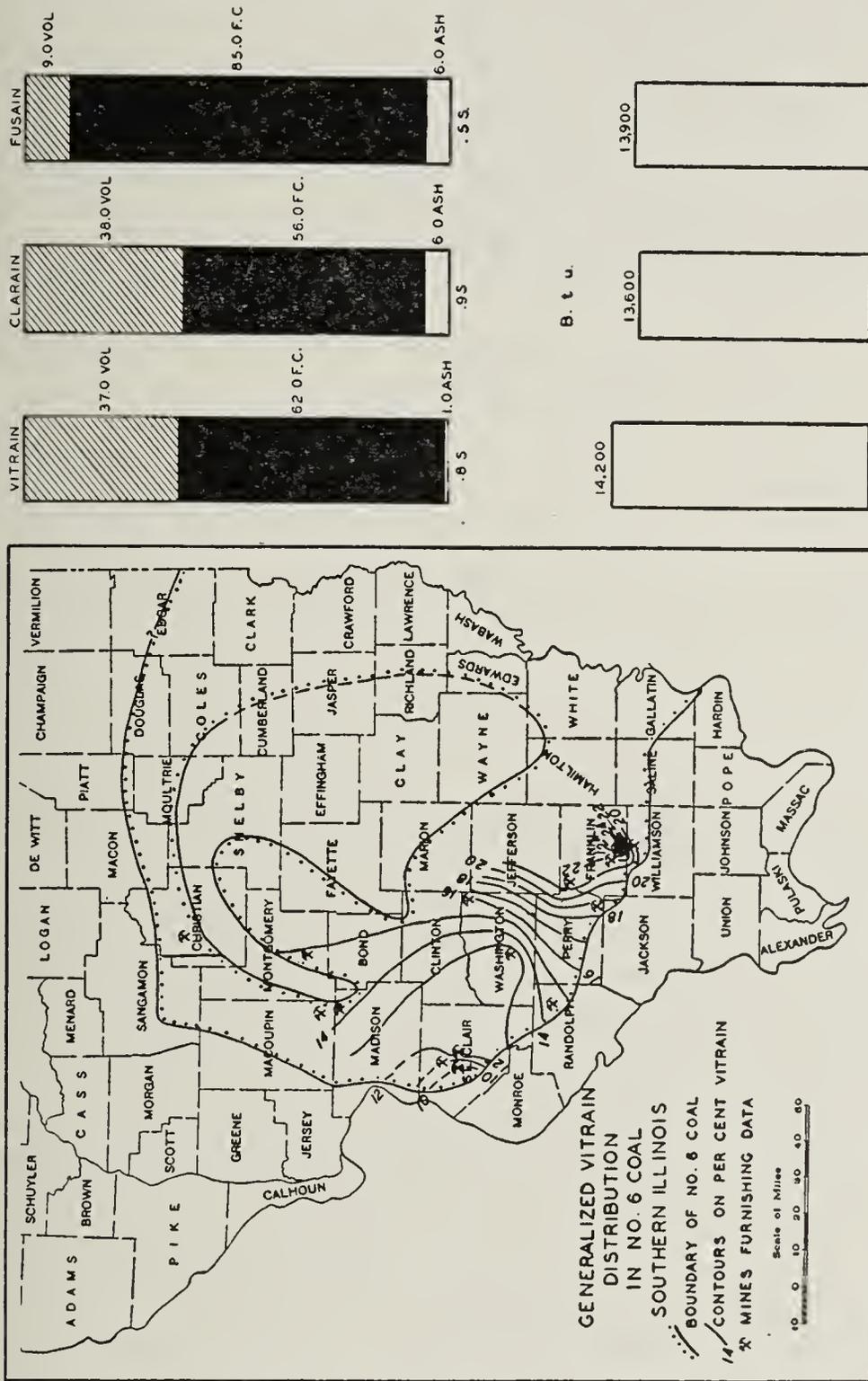


Fig. 1 (Left).—Map showing distribution of vitrain in southern Illinois.  
 Fig. 2 (Right).—Content of volatile matter, fixed carbon, and ash in samples of vitrain, clarain, and fusain, and the B.t.u. values of the same banded ingredients.

(0.49 per cent ash samples have been collected) and a relatively low unit coal value. The composition of clarain does not differ markedly from the raw coal. The fuel ratio of clarain and vitrain is much lower than that of fusain, but in samples from the same mine the fuel ratio of clarain is found to be lower than that for vitrain. In general there is an increase in the fuel ratio for the bands as well as for the raw coal southeastward across the southern part of the State.

The proportion of these ingredients in a coal is of utmost importance in many industrial processes which require carefully controlled fuels. Vitrain swells more than clarain when it is heated. Fusain is non-coking. Stach states that vitrain is suited to coking, clarain to liquefaction and carbonization and mineral charcoal to fuel-dust firing.

The desirability of mechanically separating or concentrating the different ingredients becomes apparent with the realization that a single ingredient or a particular blending of ingredients may more satisfactorily meet a certain fuel requirement than the coal as it is recovered in mining. Table 2 shows the amount of concentration attained in standard washability tests. The

TABLE 2—SPECIFIC GRAVITY DISTRIBUTION OF BANDED INGREDIENTS IN SAMPLE FROM MINE J  
(Per cent by volume)

Specific gravity	Vitrain	Clarain	Fusain	Mineral matter
1.30 float.....	10.7	4.3	trace	.0
1.35 float.....	6.1	20.1	trace	.0
1.40 float.....	2.2	34.3	trace	.0
1.50 float.....	.8	12.2	.1	.2
1.70 float.....	.3	2.1	.1	.3
2.00 float.....	.2	1.0	.1	1.5
2.00 sink.....	.2	.9	.1	2.2
Total.....	20.5	74.9	.4	4.2

ingredients were so distributed that the 1.3 specific gravity fraction contained 52.2 per cent of the total vitrain in the sample, 71.3 per cent of the fraction being vitrain. The fractions of 1.35 to 1.70 specific gravity contained 91.7 per cent of the clarain. Fusain was largely removed in the minus 48 mesh dust which was screened out before the tests were run. Comparable separation no doubt takes place in many of the cleaning plants recently established in Illinois for cleaning fine coal though at this time actual separation is confined to ash and undifferentiated coal.

Sizing concentrates the ingredients to a considerable degree. In investigation of screenings it has been found that the  $1\frac{1}{4}$  x  $\frac{1}{2}$  inch coal is largely clarain. Vitrain, because of its friable nature, tends to concentrate in the  $\frac{1}{2}$  inch x 48 mesh fractions and is at a maximum between 10 and 48 mesh. The minus 48 mesh dust is relatively high in fusain which in some instances may be as high as 60 to 70 per cent.

As with ores, differential flotation of coal may be effected in some instances. Chapman found that with kerosene certain British coals produced froths containing 76 per cent vitrain and 24 per cent clarain and when phenol was used the froths contained 80 per cent clarain and 20 per cent vitrain. Price has found it possible to depress clarain by adding organic colloids such as starch without affecting the flotability of vitrain.

The ability to control the nature of the coal reaching the market is particularly significant as: (1) It permits close control over coking mixtures; (2) segregation of those parts of the coal best suited for liquid and gaseous fuels is possible; (3) blending to produce satisfactory burning characteristics in stoker fuels is in many instances necessary; and (4) isolation of easily pulverized ingredients for powdered fuels is desirable.

## “Grassy Creek” Shale\*

J. Marvin Weller

*State Geological Survey, Urbana, Illinois*

The name Grassy Creek was originally proposed by Keyes<sup>1</sup> for a series of “black and green shales”, which have also been called Hamilton shale by Rowley,<sup>2</sup> supposedly lying between the Silurian and Louisiana limestones in Pike County, Missouri, and said to achieve their greatest development in the drainage basin of Grassy Creek. Later Keyes restricted this name to the lower, hard, black, sheety beds occurring in this interval and proposed the name Saverton<sup>3</sup> for the upper greenish or bluish shale. Some subsequent authors have concluded that the subdivision of these shales into two formations is unjustified because they grade both vertically and laterally into one another and they have continued to apply the name Grassy Creek to the entire interval.

Keyes did not definitely designate a type locality for the Grassy Creek shale. Branson and Mehl<sup>4</sup> have concluded that Louisiana is the type locality, apparently because this place was mentioned before Grassy Creek, but others have believed that the latter locality must be considered the type because it is there that this shale was said to achieve its greatest development and because it received its name from that stream.

Keyes’ knowledge of the stratigraphy of Pike County was obtained largely from Rowley who had explored its hills and valleys from early boyhood. The fact that Rowley included in his Pike County report a photograph and columnar section of the “Hamilton” shale as exposed on Grassy Creek near the center of section 19<sup>5</sup> is evidence that this is probably the best exposure of the shales in this vicinity and this conclusion is substantiated by a day’s field work which failed to reveal any other outcrops of comparable perfection. This outcrop, therefore, was probably considered by him to be the best exposure of this part of the section. Under these circumstances it seems logical to assume that this best exposure of Rowley’s “Hamilton” shale is likewise the type outcrop of Keyes’ Grassy Creek shale.

An effort to establish the precise type locality of the Grassy Creek shale would be superfluous were it not for the fact that the so-called Grassy Creek shale at Louisiana is not equivalent to the Grassy Creek shale on Grassy Creek. Krey<sup>6</sup> was the first to discover that the Silurian limestone is absent in section 19 and that the lower, lighter gray shale, not distinguished from the overlying darker beds by Rowley, is typical Maquoketa. Later Banson and Mehl<sup>7</sup> independently determined the Maquoketa age of these lower shales as a result of their conodont studies but they differ from Krey in their correlation of the overlying strata.

The section exposed in the south bank of Grassy Creek near the center of section 19, T. 54 N., R. 2 W., is as follows:

	Thickness Feet
5. Louisiana limestone, many fragments, stratum not seen in place....	.....
4. Covered interval .....	.....
3. Shale, light bluish-gray, argillaceous, weathering to light greenish-gray clay .....	15 to 20
2. Shale, dark gray, rather hard with abundant liguloids and fragments of graptolites—at top and bottom are very fine grained sandstone layers .....	about 10
1. Maquoketa shale, medium gray, slightly bluish, thickly bedded with discontinuous, irregular, thin layers of earthy gray limestone in upper part .....	about 30

Branson and Mehl<sup>8</sup> correlate the dark shale, member 2, with the black shale (Grassy Creek restricted) at Louisiana. Krey<sup>9</sup> states that this shale

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

overlies the typical Maquoketa unconformably but underlies the horizon of the Silurian limestone which is locally absent and concludes that its age is either early Silurian or late Maquoketa. This member does not resemble the black shale at Louisiana as it is not black but dark gray, nor is it sheety or fissil but somewhat imperfectly laminated like a more ordinary type of shale.

Branson and Mehl<sup>10</sup> state that they have collected "Grassy Creek" conodonts from the shales in section 19 on Grassy Creek but in none of their systematic descriptions is any reference made to this locality. We may conclude, therefore, that probably the conodont fauna obtained at this place was very scanty or poorly preserved and perhaps was not sufficiently diagnostic for an accurate age determination. Scepticism regarding their statement is occasioned by the occurrence of fragmentary graptolites in the dark shale member. Such fossils have not previously been noted at this locality nor have they been reported anywhere in the upper Mississippi valley from beds of lower Kinderhook age. In addition Branson and Mehl do not record the horizon in the Grassy Creek section from which their conodonts were collected and if their specimens actually are indicative of "Grassy Creek" age they almost certainly came from above the dark shale of member 2.

Another exposure located about one mile to the northeast, in the southwest  $\frac{1}{4}$  of section 17, shows member 3 of the Grassy Creek section overlain by a layer of hard brown sandstone 2 to 4 inches thick containing abundant fish teeth. This bed is quite similar to the fish bearing sandstone at the base of the Kinderhook at Louisiana and is further evidence that the entire section exposed in section 19 is pre-Kinderhook and that the "Grassy Creek" shale, reported by Krey<sup>11</sup> to be 5 to 10 feet thick in this vicinity, occupies the covered interval below the slumped Louisiana limestone. The greenish shale, member 3, which is not mentioned in Krey's report, is quite different from the main part of the Maquoketa of Pike County and was correlated with the Saverton shale by Keyes but it closely resembles the uppermost Maquoketa of Calhoun County, Illinois, to which it probably is equivalent.

The confusion that has resulted from the misinterpretation of the Grassy Creek section seems to necessitate a redefinition of formations. The simplest solution is to relinquish the name Grassy Creek for the basal black Kinderhook shale. If it is desirable, this name might be redefined and applied to the dark shale member in the upper part of the Maquoketa. At the present time it does not seem advisable to distinguish the basal black shale from the overlying greenish or bluish beds and it is therefore proposed to expand the Saverton formation to include the basal Kinderhook black shale exposed in the vicinity of Louisiana which has been known formerly by the name Grassy Creek.

1. KEYES, C. R., Some geological formations of the Cap-au-Gres uplift, Proc. Ia. Acad. Sci., vol. 5 (1898), p. 63.
2. ROWLEY, R. R., The geology of Pike County, Mo. Bur. Geol. and Mines, ser. 2, vol. 8 (1908), p. 24.
3. KEYES, C. R., Marked unconformity between Carboniferous and Devonian strata in upper Mississippi valley, Am. Jour. Sci. ser. 4, vol. 36 (1913), p. 160.
4. BRANSON, E. B., and MEHL, M. G., Conodonts from the Grassy Creek shale of Missouri, Univ. of Mo. Studies, vol. 8, No. 3 (1934), p. 171.
5. ROWLEY, R. R., op. cit. pl. 8; fig. 8, p. 25.
6. KREY, FRANK, Structural reconnaissance of the Mississippi valley area from Old Monroe to Nauvoo, Illinois, Ill. State Geol. Surv., Bull. 45 (1924), p. 23.
7. BRANSON, E. B., and MEHL, M. G., Conodonts from the Maquoketa-Thebes (Upper Ordovician) of Missouri, Univ. of Mo. Studies, vol. 8, No. 2 (1933), p. 122.
8. BRANSON, E. B., and MEHL, M. G. op., cit. (1934), p. 173.
9. KREY, FRANK, op. cit., p. 23.
10. BRANSON, E. B., and MEHL, M. G., op. cit. (1934), p. 176.
11. KREY, FRANK, op. cit., p. 34.

## Geological Setting of the Aurora Mastodon Remains

William E. Powers

*Northwestern University, Evanston, Illinois*

Since March, 1934, excavation for a municipal lake in Phillips Park, Aurora, has yielded remains of a surprising assemblage of now extinct animals. Among these remains are three skulls of the American mastodon, three tusks, a lower jaw, and other smaller parts of the same animal, together with bones belonging to the trumpeter swan, giant beaver, deer, elk, bear, and other animals. These bones have been carefully studied by Professor Clarence R. Smith of Aurora College. Largely through his work, they have become well known to the local public and have aroused large popular interest.

The area from which these remains were taken is a peat bog in the southeastern part of Aurora. Part of the bones came from the peat itself, but practically all the bones of the mastodon and trumpeter swan were found in the upper part of shell marl that underlies the peat. The flat bog lies between a high rolling ridge, the Minooka glacial moraine, on the east, and a flat terrace of gravel on the west. The gravel terrace stands 50 to 60 feet above the Fox River and evidently marks a period when the Fox River valley was filled with gravel to the level of the present terrace top. Later, the river ceased depositing gravel and eroded its valley to its present level. The peat bog is about one mile long by four-tenths of a mile wide. Irregular salients and reëntnants in the western margin of the bog suggest that the gravel terrace was built as a series of overlapping bars that blocked the drainage of the somewhat lower area now occupied by the bog. The excavation made during the last 15 months is a triangular area about 500 yards long by 300 yards wide, and four to six feet deep.

The peat is a fibrous mass of the grass or *carex* type. It attains a maximum thickness of about six feet, and everywhere except at the edges it rests on shell marl. The peat is rudely stratified in more fibrous and less fibrous layers. In certain thin layers near the base small molluscan shells similar to those in the marl are rather numerous, not throughout the whole bog, but in definite belts that probably mark old stream channels across the bog.

Beneath the peat is white to light gray marl known to attain a thickness of 30 feet. The marl is well stratified and consists of the shells of small gastropods and pelecypods in a limy matrix. Dr. F. C. Baker of the University of Illinois has identified the following genera and species:

Anodonta species.

Pisidium species.

Valvata tricarinata (Say).

Valvata tricarinata perdepressa Walker.

Valvata tricarinata unicarinata DeKay.

Valvata tricarinata infracarinata Vanatta.

Valvata tricarinata simplex Gould.

Valvata sincera illinoisensis F. C. Baker—Not known living.

Amnicola leightoni F. C. Baker—Not known living.

Amnicola walkeri precursor F. C. Baker—Not known living.

*Amnicola greenensis* F. C. Baker—Not known living.  
*Lymnaea stagnalis jugularis* Say.  
*Fossaria obrussa decampi* (Streng).  
*Helisoma anceps striatum* (F. C. Baker).  
*Helisoma campanulatum* (Say).  
*Planorbula armigera* (Say).  
*Menetus exacuus* (Say).  
*Gyraulus altissimus* (F. C. Baker).  
*Physa integra* Haldeman.  
*Physa* species.

The thickness of 30 feet was attained in one of a series of test holes in a north-south line across the bog. In other holes depths of 13, 16, and 18 feet were recorded, and from one of these a strong odor of hydrogen sulfide was emitted. The mastodon and swan remains were taken from the upper few feet of this marl.

Geological interest in these vertebrate remains centers about their age and the conditions of their entombment. The peat, which contains the bones of deer, bear, and perhaps even animals buried by man, cannot be more than a few hundred years old. A common estimate for the rate of peat accumulation in a fresh water marsh is two feet per hundred years. However, Capps has proved that a certain deposit of peat in the White River valley, Alaska, has accumulated at the rate of only one foot in 200 years.<sup>1</sup> If these two estimates be taken as extremes, the six feet of peat in Phillips Park bog accumulated in from 300 to 1200 years.

The marl accumulated in a fresh water lake between the Minooka moraine on the east and a gravel terrace on the west. The terrace is one of a series that rise at the rate of about five feet per mile as one ascends the Fox River, only to end at the West Chicago or outermost Valparaiso moraine near Algonquin. These terraces clearly are a valley train formed as outwash during the West Chicago ice-stand. Therefore the lake at Phillips Park originated in the early part of the Cary substage of the Wisconsin glaciation, when the glacier first began its final retreat from the region.

Dr. Baker reports that the fauna of the marl indicates a cold-temperate climate, and is "quite like the marl fauna found a few years ago in the bottom of Green Lake, Wisconsin, which is certainly Middle Wisconsin in age, not later."<sup>2</sup> This interpretation of the climate is further supported by the occurrence of hemlock and spruce cones in association with the mastodon remains, and by the proportions of coniferous and deciduous pollen in the marl itself. Although these evergreens do not now occur as native forest trees in this region, their cones are found in the marl, and a count of pollen grains washed from the upper part of the marl showed 20 per cent coniferous pollen, 80 per cent deciduous. These facts indicate that the climate was considerably cooler, though not glacial, during the time when the upper part of the marl, was deposited. It is likely that the mastodon remains were buried only a few thousand years ago.

The fact that the bones were inarticulate and rather widely scattered in the marl indicates that these animals did not drown or become mired in the lake. Rather, they probably met their death on the banks, perhaps in winter, when their bones would have been scattered on the frozen lake surface by wolves or other carnivorous animals. With the melting of the ice, the bones must have dropped into the marl where they remained to the present time.

<sup>1</sup> Capps, S. R., Glaciation in Alaska: U. S. Geol. Survey, Prof. Paper 170 A, pp. 5-6, 1931.

<sup>2</sup> Baker, F. C., Personal communication.

## Mastodon and Other Finds at Aurora

Clarence R. Smith

*Aurora College, Aurora, Illinois*

Finding the remains of mastodon and other forms of life in an old bog at Aurora has furnished a glimpse of that locality in a more or less fragmentary sequence from early post-glacial times down to the present.<sup>1</sup> The locality is within the limits of Phillips Park in Aurora and about a mile and a half east of the Fox River. The bog itself is surrounded on three sides by hills of glacial till, and the formation consists of a deep deposit of gray marl surmounted by a layer of peat, in turn covered by a layer of black muck which has comprised the bottom of the modern swamp.<sup>2</sup> The specimens were found by CWA workmen while excavating for an artificial lake.

The mastodon parts were found in the upper 3 feet of the marl deposit and consist of three skulls (one including the mandible), three tusks, a scapula, an ulna, a femur, a number of vertebra, ribs, and several foot bones. In color the bones were brownish-yellow to brown and were in a good state of preservation except for the scapula and one skull which were very fragile. One skull measured 45½ inches long and 28½ inches wide. Two of the tusks appeared to constitute a pair, nearly white in color, of similar curvature and lengths—8 feet 2 inches and 8 feet 3 inches. The third tusk was not well preserved and broke into three pieces during exhumation. Mr. E. S. Riggs, paleontologist at the Field Museum of Natural History in Chicago, identified the species as *Mastodon americanus*.

For preservative treatment the mastodon bones were saturated with the following mixture: Varnish having 100 per cent bakelite base 70 cc., turpentine 18 cc., raw linseed oil 10 cc., and oil of wintergreen 2 cc. The use of bakelite varnish for fossils is not new; the other ingredients were added after experimentation by the author. It was hoped that the penetrating properties of oil of wintergreen would be an advantage with dense materials such as tusk ivory and teeth. The mixture is more efficacious than shellac in hardening fossil bone and in retarding the cracking as the bone dries and shrinks.

At the pulp end of the two better preserved tusks were a series of six or eight faint ridges or so-called "growth rings". Such rings have been mentioned by Kunz<sup>3</sup> and others but their true significance is uncertain. However, if we entertain the possibility of their representing years of growth, the figures are interesting. The average width of the rings is 62 mm., and assuming uniformity for the entire length of the tusks, would represent the age of the animal as 41 years. Within each of the wide rings is a series of about seven narrower rings of differing widths, and in any two adjacent wide rings these secondary ring patterns are remarkably similar. This seems to support the theory that the wide rings represent yearly growth and that the secondary pattern represents a physiological response to change in weather, abundance of food, kind of food, etc., within the year.

<sup>1</sup> Smith, Clarence R., *Science* 81:379 (April 19, 1935).

<sup>2</sup> Powers, William E., *Geological setting of the Aurora Mastodon remains*, this volume, p. 193.

<sup>3</sup> Kunz, George F., *Ivory and the Elephant* (New York, 1916), p. 399.

In the north area of the marl deposit were found at about the same level as the mastodon parts, three pairs of bird humeri and breast portions which were identified by Dr. Alexander Wetmore, assistant secretary of the Smithsonian Institution, as being of the trumpeter swan (*Cygnus buccinator*).<sup>4</sup> The species is now said to be almost extinct, being found only in parts of northern Canada, although according to Audubon<sup>5</sup> and other early writers it was abundant in the Mississippi Valley a century ago. It is of no small interest to trace its residence here back to Pleistocene time.

A jaw and right femur have been identified as being of the giant beaver (*Castoroides ohioensis*), the jaw having been identified by Mr. E. S. Riggs of the Field Museum and the femur by Professor L. A. Adams of the University of Illinois. The reports of workmen are obscure as to depth and other circumstances, but there is reason to believe that the specimens came from the upper marl layer.

In the peat layer above the marl, and consequently of later date, were found several horns and numerous bones of the Virginia deer, also skull and other parts of elk. Most of this material was submitted to Professor Adams who very kindly studied the collection and made identifications.

Buried in the black earth above the peat was a small skull identified as muskrat by Dr. S. H. McFarlene of Aurora College. Its condition suggests an age of perhaps a hundred years, thus bringing the sequence up to modern times. The black earth layer also produced the skeleton of a buffalo which does not show evidence of having been buried more than 30 to 50 years. The Custodian of Phillips Park is sure it could not be a captive buffalo which died in the park, his opinion being based on the skeleton having been found outside of the former park boundary. The finding of a buffalo skeleton, however, would not be out of harmony with the well known fact of their inhabiting this area in modern times.

A small cone found with the marl in the hollow end of one of the mastodon tusks has been identified by Dr. W. T. McLaughlin of Northwestern University as being of the species *Tusga candensis*, and throws some light on the vegetation of the time. Numerous sticks and logs of wood were found deep in the marl as well as in the upper layers. Some of these were twisted similar to cedar. The tapered end of one stick suggested that it may have been cut by a beaver.

The City of Aurora plans to keep the specimens. They are at present on display in a temporary museum at Phillips Park, and an attempt is being made to promote interest in a better housing for the material.

---

<sup>4</sup> Wetmore, Alexander, *Wilson Bulletin*, XLVII:237 (Sept. 1935).

<sup>5</sup> Audubon, J. J., *U. S. National Museum Bulletin* 130, p. 300.

# The Bottom Sediments of Southern Lake Michigan

J. L. Hough

*University of Chicago, Chicago, Illinois*

## ABSTRACT<sup>1</sup>

Gravel and sand occur in a zone adjacent to the shore, silt occurs beyond the sand, and the deeper parts of the lake, generally below 250 feet, are covered with a fine clay. Areas of rock bottom are known in several places, all of which are within a few miles of the shore.

A detailed quantitative study of the sediments shows, however, that their size variations do not conform to the principles stated in geological texts. In the six principal series of samples, which were taken on lines perpendicular to the lake shore on both the eastern and western sides of the lake, it was found that the average size of the bottom material first decreased with increasing distance from shore and depth of water, then increased markedly. The coarsest bottom sediment, which was coarser than the beach sand, occurred about five miles offshore. Beyond the zone of coarse sand the average size of the bottom material rapidly dropped into the silt range, then slowly graded into the clay range. In most cases the sand-silt boundary occurred at the edge of a subaqueous terrace.

A detailed examination of the lake bottom in the vicinity of Chicago, where the sand-gravel zone is widest, showed that the gravel is a thin veneer occurring on undisturbed glacial till, and that it is a lag concentrate of the coarser constituents of the latter. The relations of the sand and gravel bottoms to topography are rather unusual. The gravel-veneered till is in the hollows, while sand forms the low ridges which are a characteristic feature of the area. Since these ridges are discontinuous and are not parallel with the shore, and occur in as much as 50 feet of water, their existence can best be ascribed to current action on the bottom.

<sup>1</sup>The full paper has been published in the *Journal of Sedimentary Petrology*, vol. 5, No. 2 (1935), pp. 57-80.

## A New Medium for Teaching Geology in the Middle West

G. Frederick Shepherd

*Technical Assistant in Geology, The Museum of Science and Industry,  
Chicago, Illinois*

The Museum of Science and Industry is located at the north end of Jackson Park, Chicago, and occupies the former Fine Arts Building of the 1893 Columbian Exposition. The exterior, originally of plaster, has been entirely refaced with limestone and granite; and through the benevolence of the late Julius Rosenwald, this building will stand as a memorial to the achievements in the arts, sciences, and industries of the past and present.

The exhibits will be arranged in ten departments or sequences, covering a wide scope of scientific and industrial thought. Important among these is the Department of Geology and the Mineral Industries which will occupy sixty-one thousand square feet of floor space. Fundamental laws and processes of geology will be shown to prepare the way for an understanding of geology's applications to engineering, mining, metallurgy, etc. A large portion of the building that is now open is occupied by exhibits of this sequence which will serve to illustrate the methods by which technical subjects are to be presented for non-technical consumption.

The outstanding exhibit of this group is the full-sized coal mine (described in the Museum's "The Story of Coal"). This mine represents a completely mechanized coal mine of the Illinois type. The visitors are taken on a tour, not as through a "museum exhibit", but as through a real coal mine where real mining machines are being used and where experienced miners may be seen at their regular duties. The visitors are lowered in a cage operated by an electric hoist and soon they are aboard the "man trip" on their way to the working face. Here the most up-to-date machinery is at work while the miners stand by to explain to the novice how coal is taken from nature and prepared for the market.

Other exhibits which are indicative of the future Geology and Mineral Industries Sequence are those depicting the story of oil and an operating model of a steel rolling mill. In the latter, small lead bars are actually rolled into long thin strips while the visitors are told how, on a larger scale, ingots are rolled out into strip steel.

The exhibits just described give but a brief conception of the magnitude of the entire sequence. Geology will be represented not only through its economic aspects, but the basic principles of geology likewise are to be portrayed in dynamic, pictorial, and three-dimensional exhibits. The origin and growth of our planet; the processes and phenomena of weathering, erosion, sedimentation; the theories pertaining to seismology, volcanism, and orogeny; the behavior of glaciers; the formation of caverns, and many other geologic features are to be treated in this popular fashion. Other exhibits showing geology's application will include important methods of metal mining and quarrying, to be shown in full size; diamond mining, metallurgy, ore dressing, metal working, and various machine arts will then complete the long story of the origin of nature's resources and the uses to which they have been put by man.

# PAPERS IN MEDICINE AND PUBLIC HEALTH

---

## EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN

Of the seven papers on the program of the Medicine and Public Health Section, six were read in full and the following was read by title only:

"The Significance of Iodine in Thyroid Function," by George Curtis, M. D., Ohio State University, Columbus, Ohio.

The following two articles were not presented for publication:

"Significance of Occupational Diseases," by C. O. Sappington, M. D., Consulting Industrial Hygienist, Chicago.

"Efforts to Control Quality of Foods in the United States," by Fred W. Tanner, Head of the Department of Bacteriology, University of Illinois, Urbana.

Attendance at the meeting averaged about twenty-five.

Dr. Fred W. Tanner, University of Illinois, Urbana, was elected chairman of the section for 1935-36.

(Signed) B. F. WHITMORE, *Chairman*



## Rickets—Its Cause, Effect, and Prevention

J. Howard Beard, M. D.

*University of Illinois, Urbana, Illinois*

Rickets or rachitis is a constitutional disease of childhood in which the bones become soft and flexible from delayed ossification, due to deficiency of calcium, phosphorus, vitamin D or sunshine, or possibly metabolic disturbances not at present thoroughly understood. The disease is characterized by bending and distortion of the bones under muscular action, by the formation of nodular enlargements on their ends and sides, by delayed closure of the fontanelles, pain in the muscles, sweating of the head, and degeneration of the liver and spleen.

There is often nervous affections, feverishness, convulsions, constipation, and anemia. Dentition may be retarded and irregular, the enamel defective in both the temporary and permanent sets of teeth, and an early tendency to decay be present. Adenoids, enlargement of the lymph glands of the neck, and hypertrophy of the tonsils are common. Inflammations of the respiratory and gastro-intestinal tracts are frequent occurrences.

**Historical.**—Rickets is in no sense a new disease. Soranus of Ephesus in the second century of the Christian Era observed that the legs of children often became bent at the thighs, and he raised the question as to "why so many Roman children were deformed." Galen, who lived between 130-210 A. D., described the condition with remarkable accuracy.

In 1582 Jerome Reusner of Basle published a thesis upon rachitis. Nearly one hundred years later (1645) Daniel Whistler gave a classic description of rickets, and in 1885 Palmer presented its pathology so clearly and thoroughly as to leave little to be added to it since.

In 1918 Mellanby stated that rickets was "a deficiency disease due to the absence of an accessory food factor," and Huldschinsky in Germany, a year later, demonstrated he could cure the disease by exposing children to artificial sunlight.

In 1924 Hess showed that vegetable fats, normally inactive against rickets, could be rendered antirachitic by exposure to ultra-violet rays and in living animals, vitamin D could be produced directly by the action of the same rays on a sterol under the skin. The whole problem of rickets is intimately associated with how far unfiltered sunlight rich in ultra-violet rays is permitted to act on the sterol of the food or on the sterol of the animal itself.

**Prevalence.**—Rickets is prevalent throughout the world. Years ago Palm observed the disease "was common where sunshine was scarce and rare where sunshine was abundant." It is less common in subtropical and tropical climates due, it is believed, to the increased efficiency of the sun in warmer climates and to the fact that its action is facilitated by lighter clothing and more bodily exposure.

Rachitis is especially frequent in northern temperate climates. It is more prevalent in Europe than America. In the United States it shows particular prevalence in Negro children and is quite common among those of Italians. It is widespread among the undernourished of our large cities, and its incidence tends to rise with the urbanization of the population.

Season apparently plays an important part in the occurrence of rickets because of its influence on the amount and the efficiency of sunlight. With the coming of colder weather the pollution of the air with soot further decreases the amount of ultra-violet light reaching the earth and renders conditions more favorable for the development of rickets. Symptoms of the disease are more frequent and more marked in winter than summer.

Rachitis usually occurs between the sixth and the eighteenth month. Its onset is insidious and the exact determination of the age at which it begins is usually impossible. It rarely begins after the age of three years and seldom before three months. It shows little if any relation to sex.

**Cause.**—Rickets seems to be due to a deficiency of a specific accessory food constituent called vitamin D, but our knowledge is incomplete as to how abnormal mineral metabolism is correlated with hyperplasia of cartilage. Antirachitic vitamin D is concerned with the regulation of the concentrations of phosphorus and calcium in the blood and with the calcification in bones and teeth.

Vitamin D was first noted by McCollom in 1923 and has been shown to be produced when foods or the human skin containing the unsaturated sterol, ergosterol, is subjected to ultra-violet rays. Crystalline products have been obtained which are highly antirachitic and to which have been given the formula  $C_{27}H_{42}O$ .

Rickets is less frequent and less severe in breast-fed than in artificially nourished children. The diet of artificially nourished children who develop rickets is frequently deficient in fat and rich in carbohydrates. The significance of this defect in diet is readily seen when it is noted that notwithstanding Eskimo children live in darkness or decreased sunlight during the greater part of the year, rickets is relatively rare among them, due to the fact that their food consists of fats, oils, and fish livers.

#### Prevention

##### (1) *Prenatal*

- (a) The mother's food should contain an abundance of eggs, butter, and milk.
- (b) Her diet may be supplemented by viosterol, cod liver oil, vitamin D milk, or sunshine.

##### (2) *Breast Feeding*

- (a) Mothers should be provided with adequate amounts of Vitamin D, calcium, and phosphorus.
- (b) Sun baths or ultra-violet radiation of mothers are helpful.
- (c) Infants may be exposed to the sun or rays after thorough protection of their eyes.
- (d) If sunning or irradiation is not practical, vitamin D milk, cod liver oil, or viosterol, should be given.

##### (3) *Rules for Artificial Feeding*

- (a) Avoid excess of carbohydrates.
- (b) Keep fat content above three per cent by use of cream.
- (c) After first two months, use a half or a whole uncooked egg.
- (d) Give vitamin D. milk.
  1. "Metabolized"; 2. "Fortified"; 3. "Irradiated".
- (e) After first six months, feed more concentrated food (eggs, scraped beef, vegetable purees with butter, etc.).
- (f) Cod liver oil (for vitamin D),
- (g) Viosterol (for vitamin D), or
- (h) Halibut liver oil (for vitamin D).
- (i) Expose to sunlight if weather permits.
- (j) Ultra-violet radiation if sunshine is inadequate.

## Studies in Milk Pasteurization

J. M. Brannon and M. J. Prucha

Department of Dairy Husbandry, University of Illinois,  
Urbana, Illinois

Milk is pasteurized primarily to destroy the disease organisms which may be present. It also greatly reduces the number of other organisms and, therefore, not only makes the milk safe but also improves its keeping quality.

There has been much questioning about the effect of pasteurization of milk on its food value. The results of experimental work carried on with white rats indicate that pasteurization of cow's milk does not materially change its food value when the milk is fed liberally as the sole article of the diet. This might not be true of rat's milk and human's milk.

Ellis and Mitchell state "the pasteurization of milk slightly lowers the availability of its calcium for the growing rat, possible by destroying some unknown constituent of the milk that favors its utilization in the animal body." The basal ration they used was designed to be poor in calcium, but otherwise adequate for normal growth. This ration was provided daily with a milk supplement estimated to furnish from 5 to 7.5 m.g. of calcium per gram of gain made. It is difficult to conclude what effect this slight lowering of the intake of calcium would have on infant feeding. Attention should be called to the fact that cow's milk has twice the ash content contained in human milk.

The effect of pasteurization on the food value of cow's milk has been studied in this laboratory for several years. The method followed was to feed raw and pasteurized milk to white rats. The animals were given all the milk they would consume and it was the only article of diet. The mothers were fed milk only and the young were given cow's milk as soon as weaned. They were fed several times daily. The feeding vessels were cleaned daily and the milk supply was kept in a refrigerator to inhibit bacterial development.

An interesting fact about the animals used in this experiment is that most of them were the fourth generation of rats raised on milk as the main article of diet. However, it should be stated that the parents, grandparents and great grandparents of the animals used in the experiment were fed four Harris Yeast tablets per week and a few drops of cod liver oil daily, otherwise their diets consisted of milk only. The experimental rats did not receive yeast nor cod liver oil.

The average weight of the animals was 49 grams at the start of the experiment. Table 1 gives the average weights of the two groups of animals at the end of the experiment (5½ months) and also the average percentage of the calcium and phosphorus in the leg bones.

TABLE 1

Identification	Average weight of animal	Calcium	Phosphorus
	<i>Grams</i>	<i>Per cent*</i>	<i>Per cent*</i>
Group fed on pasteurized milk.....	185	34.36+	17.45+
Group fed on raw milk.....	184	34.25+	17.84+

\* Percentages are based on dry weight of bones.

Incidentally, it should be mentioned that the reproduction in the rats fed milk as the only article of diet was greatly affected. Some females never had young and some litters of young were born dead. The size of the litters which did live varied from two to ten.

The results of another experiment are of more interest from a sanitary point of view than from a nutritional one. In the first experiment the milk used each day was milked from a healthy cow directly into a sterile container. Half of this milk was pasteurized in the laboratory at a temperature of 145° F. for 30 minutes, the rest was left raw. In the second experiment the milk was taken from a mixed lot of milk at the plant. Every two days two quarts of this milk were collected just before it entered the pasteurizer and two quarts of it were collected after pasteurization, the pasteurizing being carried on at 143-145° F. for 30 minutes. The milk was kept in the refrigerator.

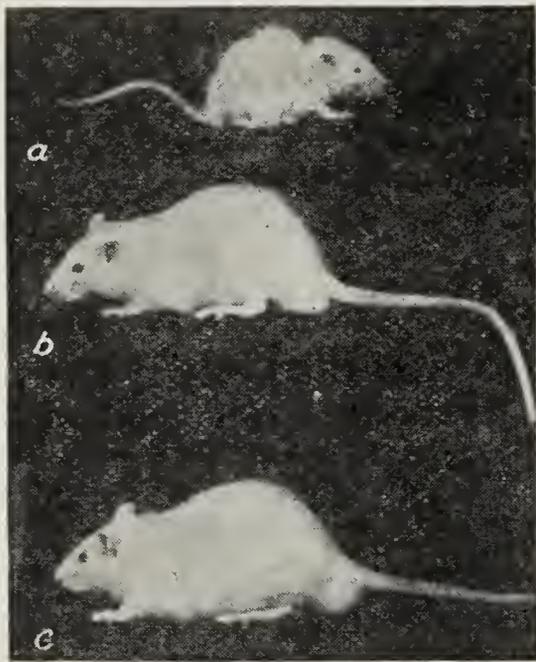


Fig. 1a. This rat was 113 days old and was fed raw milk for 90 days.

b. This rat was 113 days old and was fed pasteurized milk for 90 days.

c. This rat was 113 days old and was fed a mixed diet for 90 days. Previous to that it had been fed mother's milk, the same as the other rats shown here.

During the first month of the experiment the rats fed pasteurized milk and raw milk did equally well. After that time, however, it was noted first that the rats consuming raw milk were not consuming as much milk as they had been and second, it was noted that their coats roughened, and later it was noted that diarrhea had developed. Eventually the animals living on raw milk began to die. Each animal was autopsied. All the organs except the digestive system appeared normal. Both the stomach and intestines were greatly distended due to the presence of gas. A bacteriological study was not made and consequently no exact explanation of this sickness is known.

The animals that consumed the pasteurized milk were normal in growth and health. No doubt the causal agent for the death of the animals fed raw milk was in the raw milk and this was destroyed by pasteurization, since all the animals received the same care in all respects and the milk came from the same general supply.

The picture shows three animals, one from the group fed raw milk, one from the group fed pasteurized and one from a group that was given a mixed diet.

These nutritional studies were carried on for a period of three years, and during this time four experiments were conducted, each one lasting from four to six months. But the animals in the experiment just discussed were the only ones which had any serious illness.

# Implications of Vibro-Tactile Phenomena

Robert H. Gault

*Professor of Psychology, Northwestern University, Evanston*  
*Director General of the American Institute for the Deaf-Blind*

Certain sensory phenomena—vibrational and tactual—have been brought to light during the last decade in the course of experiments with what might be called “listening fingers,” experiments in which spoken language is transmitted through a microphone and a specialized amplifier into a vibrating unit.<sup>1</sup> When one’s fingers are resting upon this unit one discovers it vibrating along with the speaker’s voice. In this situation, the deaf find an approach to the study of the spoken language.

The senses of touch and vibration (herein called the vibro-tactile senses) present many interesting parallels or points of similarity to the sense of hearing. Brought together, they suggest the hypothesis (it is now really better than a mere hypothesis) that when the various forms and characteristics of speech can be brought to the vibro-tactile organs with approximately as great a degree of distinctness as they reach the normal ear in the usual situation, men and women will be found able to make the vibro-tactile senses a substitute for the sense of hearing. The usefulness of these senses will then be enormously increased in relation also to the development and improvement of the speech of the deaf.

In our experimental laboratory situations, the vibro-tactile organs enable one to detect frequencies of vibration at least as high as 8,192 per second,<sup>2</sup> corresponding to the fifth octave above middle C on the piano. The lowest pitch that we have systematically observed corresponds to a rate of 64 vibrations per second, which is the second octave below middle C.

Amplification is required to obtain these results, and it must increase very sharply as we ascend the scale from the lower to the higher limit.<sup>3</sup> The upper limit quoted is considerably higher than is essential for receiving speech by ear.

In differentiating higher and lower pitches, our experiments have been confined to the first octave above middle C—400 vibrations per second.<sup>4</sup> Within this short range, at least, the vibro-tactile organs do as well as the normally hearing but musically untrained observer can do. The vibro-tactile organs also discriminate intensities of stimulation as accurately as the normal ear distinguishes one degree of loudness from another,<sup>5</sup> and by many thousands of observations we have demonstrated that they permit a high degree of accuracy in discovering changes in accent and emphasis and tempo of speech,<sup>6</sup> an accuracy approximating that attainable in hearing.

<sup>1</sup> Goodfellow and Krause: Apparatus for Receiving Speech Through the Sense of Touch. *Rev. of Sci. Instruments*, V, 1934, 44-46.

<sup>2</sup> Goodfellow: The Sensitivity of the Finger-tip to Vibrations at Various Frequency Levels. *Jour. Frank. Inst.*, Vol. 216, No. 3, 387-392.

<sup>3</sup> Goodfellow: *Op. cit.*, 392.

<sup>4</sup> Roberts: A Two-Dimensional Analysis of the Discrimination of Differences in the Frequency of Vibrations by Means of the Sense of Touch. *Jour. Frank. Inst.*, Vol. 213, No. 3, 1932, 283-312.

<sup>5</sup> Knudsen: “Hearing” by the Sense of Touch. *Jour. Gen. Psychol.* I, 2, 1923.

<sup>6</sup> Ilieva: A Comparison of the Sense of Touch Alone and Vision Alone (Lip-reading) and of Both Working Together in Respect to the Detection of Changes in the Tempo of Speech. *Jour. Gen. Psychol.* X, 1934, 100-109.

Thompson: A Comparison of (*Supra*) in Respect to the Detection and Localization of Emphasized Words in Spoken Sentences. *Jour. Gen. Psychol.* XI, 1934, 160-172.

These observations enable us to foresee and to understand the next fact: the functioning of the vibro-tactile organs alone enables one, without great difficulty, to learn to identify each one of a long list of sentences by their total gross pattern. Thus when a lip-reader receives spoken language by means of the eye while at the same time he receives in his vibro-tactile organs the complicated patterns of vibrations that correspond to such language, he interprets more successfully than when he relies upon his eye alone. The increased accuracy amounts to more than 20 per cent.<sup>7</sup>

It is well known that those who have been totally deaf—even very hard of hearing—from birth or early childhood have extraordinary difficulty in mastering speech. At best they hear inadequately both their own and others' voices. Lip-reading cannot make them aware of our changes in accent, emphasis, tempo, rhythm, and pitch that are all involved together in our conventional pattern or melody of spoken language, but these characteristics can be brought to their awareness by bringing the patterns of spoken language to the vibro-tactile organs so they may be felt while the subject is observing the face of the speaker or following with his eye the printed or written page that his teacher is reading aloud. Having felt a sentence or paragraph pronounced in a certain pattern, the pupil becomes more likely to pronounce it in the same pattern, and if he feels it thus repeatedly and attentively we are reasonably assured that he will gradually, almost insensibly perhaps, adopt a pattern of speech that at least approximates that of his teacher.

The psychology of the situation is analogous to that in which the native citizen of Chicago returns from a season visiting in London or in Alabama exhibiting in his own speech some of the characteristics of that of the Londoner or the Alabamian, as the case may be. It is, in technical language, a case of having established certain *ear-vocal conditioned reactions*, and their establishment seems not to be utterly dependent upon an intention to acquire them. For the deaf, it is the establishment of *vibro-tactile-vocal conditioned reactions*.

An important step in this research has been the determination of the difference between the ear and the vibro-tactile organs in the finger in respect to their sensitivity to vibrational stimuli at various frequency levels as follows: 64, 128, 256, 512, 1024, 2048, 4096, and 8192 d. v. sec. The results are in terms of the number of pressure units that are essential for the detection of the stimuli by hearing and by feeling respectively. It is this type of work that is showing us what an amplifier must do if the vibro-tactile organs are to receive the essential pitches involved in speech in the same relations of intensity as they are normally received by the ear. We have now produced an apparatus—the Teletactor—that meets the requirements over a part of the necessary range. Its perfection and completion is an engineering problem.

This research, in its present stage, bristles with possibilities for the improved education and social amelioration of our sorely handicapped young people—the deaf and the doubly afflicted deaf-blind. The American Institute for the Deaf-Blind, incorporated in this State, has a program in which members of the medical profession are interested. The Institute is for the purpose of promoting such research as is aimed at finding the best possible means for educating and training the deaf-blind, the seeing deaf, the hearing blind, and at the protection of vision and hearing in the schools. I hope we may have the encouragement that will come from your being interested in us and in the work we are undertaking.

---

<sup>7</sup>Gault: On the Effect of Simultaneous Tactual-Visual Stimulation in Relation to the Interpretation of Speech. *Trans. Ill. State Acad. Sci.*, vol. 22, 1930, pp. 630, 653.

## Results of Examining Pasteurized and Unpasteurized Milk for *Brucella Abortus*

J. P. Torrey\* and Robert Graham\*\*

*University of Illinois, Urbana, Illinois*

In studies previously reported from the Illinois Agricultural Experiment Station it was shown that *Br. abortus* in milk could be destroyed by carefully controlled pasteurization in the laboratory. The question then arose concerning the effectiveness of pasteurization as it is carried out in commercial plants. Through the cooperation of the Illinois State Department of Public Health and under the immediate supervision of Mr. S. V. Layson, Milk Sanitarian, samples of pasteurized and unpasteurized milk from many different sections of the state were submitted for examination.

The pasteurizers from which the milk samples were obtained for study varied in capacity from 100 to 800 gallons per hour and included coil vat, glass-lined, cylindrical, spray vat and continuous flow types.

Milk samples were collected from 68 different milk stations located in 28 counties. The largest group of samples examined from a single territory came from Sangamon County. The samples were collected immediately before and after pasteurization from the vats of pooled milk of one or more herds. The samples, therefore, represented composites of milk from many cows or herds. Samples were collected in sterile vials containing approximately one per cent boric acid as an inhibiting agent and forwarded to the laboratory in mailing containers. During 1933 and 1934 a total of 233 samples of milk were received for examination. Breakage in transit and spoilage incident to shipment, together with an intercurrent infection in the inoculated guinea pigs, made it impossible to complete the examination of 103 samples. A complete examination was made of guinea pigs injected with 130 samples, including 68 pasteurized and 62 unpasteurized samples. Upon arrival at the laboratory, the milk samples were placed in the ice-box until the cream had risen. Several loops full of cream were then smeared on gentian violet liver agar plates and the plates incubated in CO<sub>2</sub> at 37.5° C. By this technic *Brucella abortus* was not isolated from a single sample of milk. This is what might be expected due to the large number of contaminating organisms found in milk handled as these samples were. While boric acid is used as an inhibiting agent it is not intended to be a preservative and if it were the *abortus* organisms would therefore be destroyed. Two and a half cubic centimeters of the cream and the upper portion of the milk were injected into each of two guinea pigs.

Six weeks following injection, the guinea pigs were autopsied. Blood was collected from each pig for the agglutination test and a search was made for gross pathologic lesions of *Br. abortus* infection. The liver, spleen, lungs, lymph nodes, and testicles or ovaries were smeared on gentian violet

\* Assistant Animal Pathologist, State Department of Agriculture, assigned to the Division of Animal Pathology and Hygiene, University of Illinois, to assist in diagnostic work.

\*\* Chief, Division of Animal Pathology and Hygiene, University of Illinois.

liver agar plates and allowed to incubate at 37° C. for five days in jars containing ten per cent carbon dioxide.

None of the blood samples from the 136 guinea pigs injected with the 68 pasteurized milk samples reacted to the agglutination test. No macroscopic lesions suggestive of *Brucella* infection were found and the organism was not isolated from a single pig. The blood from 45 of the 124 guinea pigs inoculated with the 62 unpasteurized milk samples gave a positive agglutination reaction in dilutions of 1 to 100 or higher and one gave a reaction in a dilution of 1 to 50. Pigs showing positive titres in 1 to 100 or more showed gross lesions in the spleens and livers in 73.3 per cent of the cases and 77.7 per cent yielded positive cultures of *Brucella*.

*Brucella* was isolated from guinea pigs injected with 31 or 50 per cent of the 62 unpasteurized pooled milk samples. All of the isolated *Brucella* strains proved to be of the bovine type when propagated on differential diagnostic media described by Huddleson.

The detection of *abortus* in samples from pooled milk by either direct culture or by the agglutination test are not as reliable as guinea pig inoculation. Direct cultures, even on selective media, are unsatisfactory because of the heavy contamination. The agglutination test is equally inefficient on pooled samples due to the factor of great dilution. Both direct culture and the agglutination test, however, are efficient when samples are drawn from individual quarters of the cow.

The percentage of *Brucella* infection encountered in the samples examined is obviously higher than the incidence of the disease in Illinois herds, and it is assumed that the pooling of milk from several cattle or several small herds which comprise the composite samples accounts for this variation. Obviously if milk from Bang's disease free herds is mixed with milk from infected herds it naturally follows that the organism may be present in the composite milk sample.

The following conclusions may be drawn from the data here presented: *Brucella abortus* is not uncommon in unpasteurized pooled milk from dairy cattle in Illinois and that pasteurization of raw milk as employed in Illinois milk depots from which samples were taken destroys the *Brucella* organisms present.

**Summary.**—(1) *Brucella abortus* was isolated by guinea pig inoculation from 50 per cent of 62 raw milk samples collected at milk depots in 28 widely distributed counties of Illinois.

(2) Pasteurization as employed in milk depots from which samples were collected is effective in destroying *Br. abortus* in milk.

(3) *Brucella abortus*, bovine type, is apparently the most prevalent in milk of Illinois.

## PAPERS IN PHYSICS

---

### EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN

Of the sixteen papers on the Physics program, fourteen were presented at the section meeting. The following was read by title only:

"Some Topics in Physiological Mechanics," by I. M. Freeman.

The following papers were read at the meeting but were not presented for publication:

"The Concept of Oscillations in Present Physical Theory," by Jacob Kunz, University of Illinois.

"Atomic Disintegration or Modern Alchemy," by A. J. Dempster, University of Chicago.

Attendance at the meeting of the Physics Section averaged seventy-five, maximum attendance was eighty-three.

Otis B. Young, Southern Illinois Normal University, Carbondale, was elected chairman of the section for the year 1935-36.

(Signed) LESTER I. BOCKSTAHLER, *Chairman*



# A Convenient Chart for Correcting Barometer Readings

Scott Anderson

*Illinois Wesleyan University, Bloomington, Illinois*

You will all, no doubt, recall sometime or other when you have been doing precision work in the laboratory and have had to stop to perform the irritating task of computing the exact boiling point of water.

Furthermore you probably remember such formulas as:

$$h_0 = h_t \{1 - (d - \beta)t\} = H_r$$

$$H_0 = 760 + 1.9456 \cos 2\lambda + .00004547 h$$

These corrections cannot be done accurately with a slide rule, and the tables in the chemistry and physics handbook are incomplete and involve subtractions and additions besides.

On the other hand, all of the recent editions of such handbooks include very accurate and complete data on the vapor pressure of water. These readings for barometric pressure, however, are sea level measurements taken on the 45° latitude with the scale and mercury at 0° Centigrade. It is necessary for us first of all, to determine what reading in the handbook (standard) will correspond to the pressure at our station. This can be done very simply by the graphic method.

We shall begin by plotting the standard pressures of the handbook against the boiling point of water, with the standard pressures on the X axis and the boiling point on the Y axis—but at the right of the chart.

Now, letting  $H_0$  represent the standard pressure at a given locality we have the formula  $H_0 = 760 + 1.9456 \cos 2\lambda + .00004547h$  where  $\lambda$  is the degree of latitude and  $h$  is the elevation in feet.

In almost every locality there is a government bench-mark giving the altitude of the station. If  $H_r$  represents the barometric pressure on a given day.

$$\frac{H_r}{H_0} - 760 = \lambda_t \text{ (reading in the tables)}$$

This is a straight-line function whose slope is  $H_0/760$ . Using the same figures for standard pressures employed before along the X axis, let  $H_r$  be on the Y axis but to the left of the chart.

Now this  $H_r$  is the true barometric pressure as taken from a barometer at 0° Centigrade. But recalling the formula stated above,  $h_0 = h_t \{1 - (d - \beta)t\}$  we see that for a given value of  $t$  this is a straight-line function. But this  $h_0$  equals  $H_r$ . Now plot a separate curve for various values of  $t$ . This time let the values on the X axis (used before as standard readings) represent the actual barometer reading. It is convenient to draw curves for every two degrees from 16 to 28, depending upon the mean temperature of the room in which the barometer is located.

We now have three charts: one to correct the barometer for temperature, another to transfer the reading to the corresponding reading for sea level at the 45° latitude, and still another to give the boiling point of water.

The process is now very simple. It is only necessary to read the barometer and to record the temperature of the room. Locate this barometer reading on the X axis; find the intersection of the ordinate of this point with the curve for the room temperature; follow the abscissa of this point to the curve correcting for altitude and latitude, then follow the ordinate of this point to the boiling point curve and the abscissa of this point (read from the right) gives the true boiling point of water.

Once completed, this is a very convenient chart for correcting all of these errors with a minimum of time lost. The chart at Wesleyan has a maximum error of  $.001^{\circ}$ .

## On Growing Bismuth Single Crystals

J. A. Boyajian

*Northwestern University, Evanston, Illinois*

In a single crystal, the angles between the crystallographic axis and the axis of the crystalline rod are the same from one end to the other. Single crystals of a metal are generally grown from the melt by allowing the metal to cool very slowly. However, if one wishes to produce a single crystal of a metal with a predetermined orientation, the rod which is to be crystallized must be inoculated with a seed-crystal. When this is done in the proper manner, the orientation of the seed-crystal is carried on throughout the length of the bar as it slowly crystallizes from its molten state.

Bismuth is one of the metals which crystallizes most easily. This is probably due to its low melting point ( $271^{\circ}\text{C}$ ) and because it has fewer crystallization centers than most metals. Bismuth crystallizes in the rhombohedral division of the hexagonal system which approaches very nearly a cube.

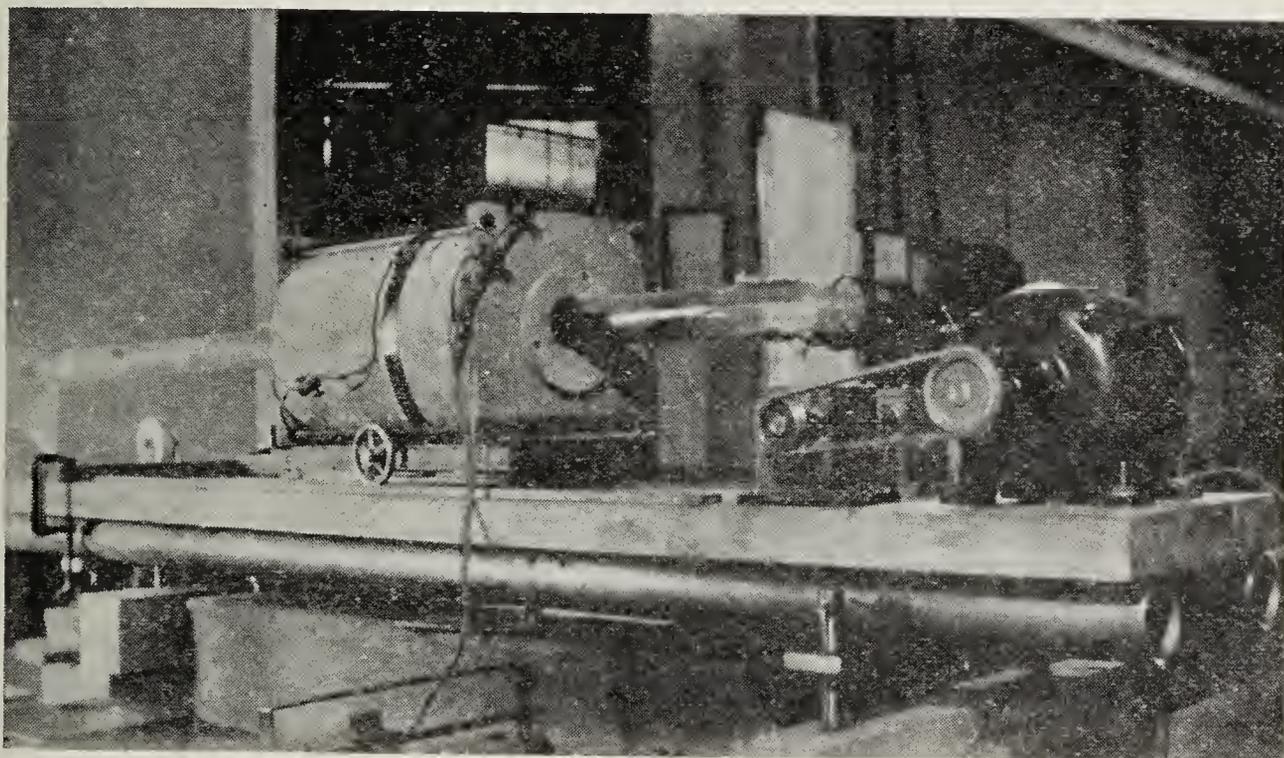


Fig. 1.—Movable furnace used in growing bismuth single crystals.

The apparatus used to grow single crystals of bismuth is easily constructed, and quite simple to operate. It consists of a movable furnace resting on tracks fastened to a very rugged platform (Fig. 1). Motion is given to this furnace by means of a weight fastened to a chain which runs over a pulley, and the other end of the chain is fastened to the furnace. The velocity of the furnace is governed by varying the speed of a DC motor, which runs a set of gear boxes with a ratio of 90,000 to 1. A sprocket chain is fastened to the other end of the furnace and then runs over a driving gear fastened to the shaft of the gear box. Thus as the motor pays out chain, the weight at the other end pulls the furnace along the track at a uniform rate.

The pyrex glass tube used for the growing chamber passes through the center of the furnace, and is supported at either end by means of clamps. The stands holding these clamps rest upon a concrete pier which is independent of the support for the rest of the equipment. This arrangement allows the crystals to be grown free from vibrations set up by the motor, or from other sources. This glass tube is evacuated to enable the crystals to be grown free from oxide coatings.

The production of crystals of the desired shape and size required two types of moulds: a casting mould and a growing or seeding mould. These moulds were made of Acheson graphite because it can be machined easily, and does not react with the metal. The casting mould has a cavity in which the bismuth is placed, and a trough also cut in to give the metal its proper form when the molten metal is poured from the cavity. A cover must be clamped tightly to the casting mould to aid in pouring and to keep the metal from running out. The growing mould must have the same internal dimensions for its trough as the casting mould. One end of the growing mould is cut down to provide a ledge for the seed which may be rotated about the vertical axis to give the desired angle of orientation after it is welded to the polycrystalline bar. The apparatus is, in some respects, similar to that used by M. F. Hasler.<sup>1</sup>

The polycrystalline bars were cast by withdrawing the pyrex tube containing the mould with the molten bismuth in its cavity, and tilting it to pour the metal into the trough of the mould to give the casting the desired shape. These polycrystalline bars were then seeded in the growing mould by allowing the whole bar and half the seed to become melted. At this point, the motion of the furnace is started and the metal is allowed to crystallize by cooling slowly. An important factor influencing crystal growth is that a proper temperature gradient must exist at the zone of crystallization. This was found to be 20° per cm for bismuth.

---

<sup>1</sup>M. F. Hasler, *Rev. Sci. Inst.* 4, 656 (1933).

# The Atomic Beam as a Spectroscopic Source

Benjamin Carpenter

*Northwestern University, Evanston, Illinois*

The first spectroscopic source was sunlight, a continuous radiation with dark lines due to absorption in the sun's atmosphere. As soon as this was understood spectroscopists went to work with flames, arcs, sparks and various discharge tubes, identifying and cataloguing the spectra of the various elements. Next these spectra were analyzed and ascribed to transition of the atom from one energy level to another. As apparatus improved many lines and therefore energy levels were seen to consist of several components, readily explained by the interaction of the electron spins with the azimuthal moments. The twin yellow lines of sodium are a familiar example of such multiplicity.

Hyperfine structure, a still further splitting, can be explained by consideration of the nucleus. Each isotope has its own energy levels and spectrum differing only minutely. Furthermore the isotopes of odd atomic weight have a nuclear moment, which interacts with the resultant of spin and azimuthal moment to give the hyperfine splitting of energy levels and spectral lines.

Unfortunately spectral lines are not perfectly sharp. Doppler broadening, due to the random motion of the atoms, is usually serious. The breadth at half intensity is given by the relation

$$\Delta\nu = (1.67\nu_0/C) \sqrt{2RT/M}.$$

This must be reduced to a minimum to observe hyperfine structure. If we reduce the wave number  $\nu_0$  we are driven towards the ultra-violet and X-rays. An increase of  $M$ , the atomic weight, limits us to the heavier elements. The temperature  $T$  may be lowered with liquid air but this is often insufficient.

An atomic beam is the solution. A stream of radiating particles moving at right angles to the observer would have no Doppler effect. An atomic beam can easily be produced in a vacuum with an oven and two collimating slits but such a beam is invisible and must be excited.

Felix Esclangon<sup>1</sup> sent an atomic beam into an atmosphere of argon excited with a high frequency electrodeless discharge. The beam showed up brightly against the fainter illumination of the background. The spectrum was not limited to the resonance lines.

Under the direction of Dr. Russell Fisher I have been developing such a source for use with the lighter elements. Each of the sodium D lines is easily resolved into two components due to the splitting of the lower level. Jackson and Kuhn,<sup>2</sup> in absorption with an atomic beam, found the separations of the  $D_1$  and  $D_2$  doublets to be  $0.061 \text{ cm}^{-1}$  and  $0.056 \text{ cm}^{-1}$  respectively. This difference indicates a splitting of the upper levels. Since the nuclear mechanical moment is  $3/2$ ,  $D_1$  should actually have four components,  $D_2$  six. We are at present endeavoring to resolve some of these. The breadth of our lines is but  $0.009 \text{ cm}^{-1}$ ; that of Jackson's and others' about three times as great.

<sup>1</sup> F. Esclangon, *Annales de Physique*, Series 11, Vol. 1, 401 (1934).

<sup>2</sup> D. A. Jackson and H. Kuhn, *Proc. Roy. Soc.*, v. 148, 335 (1935).

An interesting field for study is the collision of the argon with the sodium atom. Some of the argon is ionized; a larger portion is metastable, the possessor of excitation energy which it can release only in collision; all of it is in random motion. Upon collision the sodium loses an electron and there is an exchange of momentum. The sodium lines must be broadened by the resulting motion but the amount is evidently small. (N. B. Subsequent work has shown that the excitation of the sodium is almost wholly due to impact of the high speed electrons formed when the argon is ionized.)

Our apparatus consists of a 52 mm. Pyrex tube 50 cm. long; at the top is a liquid-air-cooled target. A ground joint supports a nickle crucible with its heating wires and thermocouple. The lower "slit" is an 0.8 mm. diameter hole in the crucible cover. A tight fitting aluminium spinning is drilled 1.5 mm. to form an upper slit 2.5 cm. above the other. Argon is introduced just above the upper slit and pumped off with a mercury pump from the lower chamber. The pressure is adjusted to the lowest value that will sustain a discharge. High pressures visibly broaden and shorten the beam and hyperfine structure fades out of the interferometer. The pressure between slits is perhaps one third of that above, depending upon the fit of the aluminium spinning. This reduces undesired collisions and increases the mean free path of the sodium which either flies through the upper slit or hits the aluminium either to stay or to fly off again to condense finally on the water cooled walls of the tube. The intensity of the discharge is in direct proportion to the amount of sodium in it and to the vapor pressure in the oven. The useful value is limited by a reduction in the mean free path of the sodium issuing from the crucible. The effect is as if the sodium were issuing from a source midway between slits and the beam is consequently broadened. We have found 350° C a satisfactory temperature.

Argon is stored in a 300 cc tube. Its pressure may be controlled by displacement with mercury. The argon leaks through a capillary into the discharge tube. Contamination by mercury or stopcock grease is avoided by a liquid air trap. This is important in subduing the background and emphasizing the atomic beam.

The oscillator is push pull, tuned plate, tuned grid, using two No. 852 de Forest, 100 watt tubes at 30 megacycles. The inductance is four turns 5/16-inch copper tube spaced 1/4-inch and 4 inches diameter.

The optical system comprises a Fabry Perot etalon with 11 cm. spacer and a spectrograph. Admitting a probable resolution of one tenth of an order we have a resolving power of 37 million or an ability to distinguish two lines separated 0.0045 cm<sup>-1</sup>. Ruling the interferometer as described by Mr. Machler<sup>3</sup> in the next paper greatly increases the brightness of the pattern. An interferometer with such a large spacer can best be adjusted by the light of the atomic beam itself. Rings can be seen with a mercury arc for about thirty seconds; then the vapor gets hot and the rings merge.

---

<sup>3</sup> R. Machler and R. Fisher, *Jour. Opt. Soc. Am.* Sept. (1935).

# An Appraisal of the Definitive System of Units

Henry Crew

*Professor of Physics Emeritus, Northwestern University, Evanston, Illinois*

## HISTORICAL BACKGROUND

For the sake of perspective may I first call your attention to a few facts which are quite as well known to the members of this section as to me? Among them I shall mention first the marked difference between a haphazard set of units, such as a mile of 1,760 yards, a yard of 3 feet, a foot of 12 inches, a gallon of 231 cubic inches, another of  $277\frac{1}{4}$  cubic inches, an area of one square mile containing 640 acres, etc., and, on the other hand, a coherent system of units such as that introduced by the French people about 1795, in which length, area, volume, mass, and force are all tied together in a natural, simple and decimal manner. The distinct economy of thought secured by a system of simply related units is too patent to call for discussion.

Secondly, I remind you of the long search which was made to find a standard of length and a standard of mass which should be natural and universal and hence capable of being determined, or tested, by any independent and accurate observer, just as the second or mean-solar-day now is. The two principal competitors for the first of these standards were the length of the seconds-pendulum and a definite fraction of the earth's meridian. The decision was made on the 10th of December, 1799, in favor of one ten-millionth of the earth's quadrant; and, on the same day, the kilogram was defined as the mass of a litre of water.

Thirdly, I recall that when the International Commission on Weights and Measures met in Paris in 1872, it completely abandoned the idea of natural standards and arbitrarily defined the metre as the distance between two rulings on a certain bar of metal in Paris, and the standard kilogram was, in like manner, arbitrarily fixed as the mass of a certain piece of platinum-iridium alloy in Paris.

Accordingly, at the present moment, two of the three fundamental mechanical units are entirely arbitrary while the remaining one, the *second*, is eminently natural. The prospect, however, is that the standard of length may shortly become a wavelength of light and that, if the irregularities in the rotation period of the earth, now suspected, are established, our standard of time may become the vibration period of an arbitrarily chosen quartz crystal; in which event, the *metre* and the *second* would just interchange their arbitrary and natural qualities.

## EARLY ELECTRICAL AND MAGNETIC UNITS

Nothing can be more patent than the fact that electrical units are needed the moment that electrical measurements are begun. The quantitative work in electrostatics by Cavendish, Coulomb, and their contemporaries was done with units of their own individual choice. They used their own bodies, indeed, as voltmeters.

As the number of investigators increased and as new phenomena were discovered, the difficulty of accurate description and of comprehension increased. From the invention of the voltaic cell, in 1800, to the discovery of electromagnetism in 1820, there was an urgent demand for a current-meter, but practically no supply.

The eleven years between 1820 and 1831 were, however, so rich in discovery that they practically created a crisis, which was first met by Gauss

TABLE 1

1820.	21 July. Oersted's Discovery.
1820.	Schweigger's "Multiplier".
1820.	Biot and Savart's Law. $H = Ki/r$ .
1821.	Seebeck's discovery of thermo-electricity.
1822.	Fourier's <i>Theorie Analytique</i> .
1823.	Barlow's "Stellate wheel".
1825.	Sturgeon's Electromagnet.
1826.	Ampere's <i>Theo. Math. Phenom.</i> <i>Electrodynamique</i>
1828.	Ohm's Law.
1831.	Faraday's discovery of Induced currents.

in 1833. In this year he reported his two experiments upon the behavior of a magnet in the earth's field. One of these experiments, as you know, gave him the ratio of the magnetic moment of the magnet to the earth's field; the other gave him the product of these two quantities,  $M$  and  $H$ . By elimination between these two equations he obtained for the first time an expression for the intensity of the earth's magnetic field in terms of mechanical units.

By use of the tangent galvanometer, invented by Pouillet in 1837, it became immediately possible to measure electric currents in absolute units. Magnetic flux was, from now on, easily expressible as a surface-integral of a magnetic field; and hence (through Neumann's description of Faraday's

discovery,  $E = - \frac{N}{t}$ , electromotive forces were determined in absolute measure. Units were now needed for all three of the quantities appearing in Ohm's law, in addition to those employed in magnetic work.

## EXTENSION OF OHM'S LAW

In the meantime, however, the original expressions of Ohm's law (which was, indeed, only an adaptation of Fourier's law of heat-conduction enunciated in 1822) had been undergoing rapid expansion so as to include circuits involving both capacitance and inductance, distributed as well as local. This development will be sufficiently clear from Table 2 without going into details as to nomenclature.

TABLE 2

*Ohm's Law*

$$Ri = E$$

$$L \frac{\delta i}{\delta t} + Ri = E$$

$$L \frac{\delta i}{\delta t} + Ri + \frac{Q}{C} = E$$

$$L \frac{\delta^2 Q}{\delta t^2} + R \frac{\delta Q}{\delta t} + \frac{Q}{C} = E \sin pt$$

$$C_1 L_1 \frac{\delta^2 i}{\delta t^2} + C_1 R_1 \frac{\delta i}{\delta t} = \frac{\delta^2 i}{\delta x^2}$$

By the time that the first Atlantic cable was laid, certain arbitrary units had come into vogue, such as Jacobi's resistance, Daniell's cell for E.M.F. and Siemen's mercury unit for resistance.

Latimer Clark and his brother and Sir Charles Bright became interested in the cause of numerous failures in marine cables and through these men the matter was first brought to the attention of the British Association for the Advancement of Science in 1861.

### CREATION OF THE INTERNATIONAL SYSTEM

In 1863 Clerk Maxwell and Fleeming Jenkin reported to the British Association what is essentially our present system of *electrostatic*, *electromagnetic*, and *practical* systems of units. Through the fifty years following this report, this triple system has been extended and modified in nomenclature, in precision and in standardization, through the efforts of many individuals, cooperating institutions, and international conferences, culminating, one might almost say, in the "international system" defined by the London conference of 1908.

Table 3 illustrates, very roughly indeed, the steps of this development.

TABLE 3

- 1863. E.S. and E.M. systems reported to British Association by Maxwell and Jenkin.
- 1873. *Ohm* and *Volt* adopted in England at Bradford Mtg. British Association.
- 1881. First Elec. Congress (Paris) adopts *Ohm*, *Volt*, *Ampere*, *Farad* & *Coulomb*.
- 1889. Second Elec. Congress (Paris) adopts *Joule* and *Watt*.
- 1891. Third Elec. Cong. (Frankfort) recommends *Gauss* and *Weber* for H and B.
- 1893. Fourth Elec. Cong. (Chicago) adopts *Henry*, as unit of inductance.
- 1900. Fifth Elec. Cong. (Paris) recommends *Gauss* and *Maxwell* for H and  $\phi$ .
- 1908. "International" units adopted at London.

The fundamental facts here are the adoption of the *ohm* as being the nearest practicable representative of the Siemen's mercury unit; the *volt* representing as nearly as possible the E.M.F. of the Daniell cell; and the *watt* as the only unit of power consistent with the ampere and the volt. The London conference, in 1908, adopted values for the *ohm* and *ampere* which were to a slight extent arbitrary, and thus made them play the rôle of "fundamental" units for other electrical and magnetic quantities. They are now known as "international" units.

When, as an undergraduate at Princeton, I first met these two great systems of units, electrostatic and electromagnetic, they impressed me as so complete and perfect that I felt sure that Moses had brought them down out of the mountain along with the ten commandments. But I was soon disillusioned; for within a year or two, I learned that the currents we had been measuring in the laboratory in terms of *webers* were now measured in terms of *amperes*: also that such eminent authorities as Clausius, Helmholtz, Rucker and others were differing among themselves as to the "dimensions" of the magnetic units.

Table 4 shows the principal adoptions of recent years, in the way of practical units. I refer to those made by the International Electrical Commission meeting at Oslo in 1930.

TABLE 4

## C. G. S. Magnetic Units

Quantity	Symbol	Name	Date
1. Magnetomotive force	F	Gilbert	1930
2. Magnetising force	H	Oersted	1930
3. Magnetic flux	$\phi$	Maxwell	1900 & 1930
4. Magnetic flux density	B	Gauss	1930

So much for the evolution of the three earliest and most widely used of the various systems now in practice.

## THE SCIENTIFIC BASES OF SOME OF THESE SYSTEMS

For the sake of clearness in what is to follow, it will be well for a moment to consider the conventions—that is, the postulates and definitions—which underlie some five or six of the systems which have received wide acceptance.

(1) **Electrostatic C. G. S. system.**—The Committee of the British Association, in 1862, created this system by adopting, as their four fundamental units, the following quantities; the *centimeter*, the *gram*, the *second*, and the *specific inductive capacity of space*. Then followed the definition of *electrical quantity* from Coulomb's law, *current* from  $i = Q/t$ , etc., in the well known manner.

(2) **Electromagnetic system.**—Here the four fundamental units are different from the preceding, being the *centimeter*, the *gram*, the *second*, and the *magnetic permeability of space*. Again Coulomb's law is employed; this time to define the unit *magnetic pole*, and hence the unit of *current* by Biot and Savart's law, or by its equivalent.

(3) **Practical or Q. E. S. System.**—This system, used "everywhere, always, and by everyone," is explained by Maxwell (in Section 629 of his great treatise on *Electricity and Magnetism*), as based upon the following four fundamental units;  $10^9$  *centimeters*,  $10^{-11}$  *gram*, the *second*, and the *magnetic permeability of space*. These four fundamental units are identical, *in kind*, with those of the electromagnetic system, but their size is so chosen that they yield at once the *ohm*, the *ampere*, and the other six practical units. Thus, for example, the unit magnet pole,  $m$ , is defined by the following equation where  $r$  is the distance separating two equal poles and  $F$  is the force exerted by one on the other.

$$m = r \sqrt{F} = 10^9 \sqrt{F} = 10^9 \frac{\sqrt{10^{-11} \times 10^9}}{1} = 10^9 \times 10^{-1} = 10^8 \text{ c. g. s. units.}$$

In like manner, the unit of magnetic field,  $H$ , is defined as follows:

$$H = F/m = 10^{-2}/10^8 = 10^{-10} \text{ c. g. s. units.}$$

Unit magnetic induction =  $H \times$  unit area =  $10^{-10} \times 10^{18} = 10^8$  c. g. s. units.

$$\text{Hence unit E. M. F.} = - \frac{\delta N}{\delta t} = \frac{10^8}{1} = 10^8 \text{ c. g. s. units, which is one volt.}$$

(4) **Heaviside-Lorentz System.**—Since the Gaussian system is identical with that of Heaviside and Lorentz, save for a shift of  $4\pi$  from one equation to another, we shall consider only the latter. Heaviside starts from the two following expressions for the inverse square law:

$$F = \frac{qq'}{4\pi r^2} \text{ and } F = \frac{mm'}{4\pi r^2}$$

This rationalizes certain equations and makes the total flux from unit pole equal to unity.

Since  $\epsilon_0$  and  $\mu_0$  are each taken as unit, in their own fields, the dimensions of any quantity are the same in the electrostatic as in the electro-

magnetic system; but a constant,  $c$ , the ratio of the sizes of the units in these two systems, is introduced whenever an electric and a magnetic quantity appear in the same equation.

(5) **International System.**—Here the four fundamental units are the *centimeter*, the *second*, the *ohm*, and the *ampere*, as indicated in Table No. 5. The dimensions of the electrical units are greatly simplified in this system, but those in the field of dynamics are correspondingly complex. The scheme is of special interest to those laboratories which are charged with the preservation and testing of electrical standards.

TABLE 5

*The International System*

Quantity	Symbol	Unit	Defining Equation
1. Length	L	Centimeter	} Fundamental
2. Time	T	Second	
3. Resistance	R	Ohm	
4. Current	I	Ampere	
5. E. M. F.	E	Volt	$E = RI$
6. Quan. Elec.	Q	Coulomb	$Q = Idt.$
7. Capacity	C	Farad	$C = Q/E$
8. Dielec. Const.			$K = \frac{4\pi LC}{S}$
9. Elec. field		Volt/cm	$E = \frac{dE}{dL}$
10. Self inductance		Henry	$L = E / \frac{dI}{dt}$
etc.	etc.	etc.	etc.

(6) **Definitive or M. K̄. S. Ω. System.**—Thirty-one years ago this coming summer, an International Congress of Arts and Science, and also an International Congress of Electricians, met at the World's Fair in St. Louis. The proceedings of the first of these congresses fill eight large octavo volumes and constitute a cross-section of human knowledge in the year of grace 1904. The proceedings of the electrical congress occupy three octavo volumes, which contain little on the subject of electrical standards or units. Two of these latter communications, however, made a distinct impression; one is by Dr. Frank A. Wolff of our own Bureau of Standards, who points out a number of really serious defects in the definitions then employed in our system of electrical and magnetic units. The other paper is one by Professor G. Giorgi of the University of Rome, presented, in his absence, by the Italian Delegate, Mr. Ascoli.

Professor Giorgi's proposal is to embrace in a single, coherent, consistent and comprehensive system all of our present dynamical, electrical and magnetic units, in such a way as not to disturb any one of the eight practical units upon which the five previous international conferences have agreed. A simplification so tremendous as this is not to be expected without some cost. My sole purpose in addressing you this afternoon is to present both sides of Giorgi's proposition in an unbiased way. During these thirty-one intervening years, this plan from Italy has been impressing itself upon electrical men. It has come up for discussion in the *London Electrician*, in the *Encyclopedia Britannica*, in the *Bulletin* of the Bureau of Standards, in the American Physical Society, in the A. I. E. E., and in 1933 was the prin-

cial topic discussed in the American Section of the International Union of Pure and Applied Physics, meeting in Chicago.

A few words now concerning the system itself; and then finally a few more concerning its merits and demerits.

Like the five preceding systems, it is based upon four fundamental units, namely, the *meter*, the *kilogram*, the *second*, and the international *ohm*. The "international ohm", it will be recalled is the resistance of a thread of mercury, of prescribed mass, having a length of 106.3 mm, a value which has long been known to be about 1/20 of one per cent larger than the c. g. s. absolute ohm.

The easiest approach to the "definitive" system is perhaps to follow through the logical sequence of the derived units for dynamics, as well as for electricity, in the manner employed by Dr. George A. Campbell of the American Telegraph and Telephone Co.; for he is the clearest and ablest expositor which the system has found this side the Atlantic.

In Table 6, each derived unit is clearly defined in terms of those which precede.

TABLE 6

*The Definitive System of Dynamical, Electric and  
Magnetic Units*

Quantity	Defining Equation	Name
1. Length	L	Meter
2. Time	T	Second
3. Mass	M	Kilogram
4. Resistance	R	Ohm
5. Area	$S = L_1 L_2$	Square meter
6. Volume	$V = SL$	Stere
7. Density	$d = MV^{-1}$	Kg/stere
8. Speed	$v = LT^{-1}$	Meter/second
9. Acceleration	$a = vT^{-1}$	Meter/second <sup>2</sup>
10. Force	$F = Ma$	_____?
11. Energy	$W = FL$	Joule
12. Power	$P = WT^{-1}$	Watt
13. Torque	$t = F \times L$	_____?
14. Elec. current	$I = \sqrt{PR}^{-1}$	Ampere
15. Elec. quantity	$Q = IT$	Coulomb
16. Elec. potential	$E = WQ^{-1}$	Volt
17. Elec. field	$E = EL^{-1}$	Volt/meter
18. Elec. capacity	$C = QE^{-1}$	Farad
19. Elec. capacitvity	$\kappa = CL^{-1}$	Farad/meter
20. Elec. resistivity	$\rho = RL$	Meter—ohm
21. Elec. displacement	$D = \kappa E$	Coulomb/meter <sup>2</sup>
22. Elec. Inductance	$L = RT$	Henry
23. Magneto motive force	$F' = NI$	Ampere-turns
24. Magnetic field	$H = FL^{-1}$	Ampere-turns/meter
25. Magnetic pole	$m = FH^{-1}$	Volt-second/turn
26. Magnetic moment	$\mathbf{m} = mL$	(Volt-second turn) meter
27. Magnetic flux	$\phi = ETN^{-1}$	Volt-second/turn
28. Magnetic reluctance	$R = \phi^{-1}F'$	Henry <sup>-1</sup> -turn <sup>2</sup>
29. Magnetic permeance	$P = \phi F'^{-1}$	Henry/turn <sup>2</sup>
30. Permeability	$\nu = P'L^{-1}$	(Henry/turn <sup>2</sup> )/meter
31. Mag Flux den.	$B = \phi S^{-1}$	(Volt-second/turn) per square meter

In the complete system there are, of course, many more quantities than the 31 here listed, but these include the most important ones and are sufficient to illustrate the whole.

## THE DEBITS AND CREDITS OF THE DEFINITIVE SYSTEM

Among the features of this comprehensive system which may give rise to unfavorable comment are:

(1) The fact that the numerical value of any density determined in the c. g. s. system would be multiplied by one thousand.

(2) The fact that the new unit of force, which would do one *Joule* of work when exerted through one *meter*, is very large compared with the dyne, and would call for a new name.

(3) The fact that the dielectric constant of space,  $\kappa_0$  would no longer have the value unity, but  $8.86 \times 10^{-12}$  farads per meter; and, in a similar manner,  $\nu_0 = 1.257 \times 10^{-6}$  henries per turn<sup>2</sup> per meter.

(4) The lack of symmetry in Maxwell's field equations.

On the other side of the account, one has a large number of advantages, which have already been set forth by Dr. George A. Campbell and Professor Giorgi. Among these, I may mention the following:

(1) Complete uniformity, in both units and equations, in the shop, market place, test room, laboratory, and study.

(2) Students would have to learn only one simple, comprehensive, coherent, and universal system of units.

(3) All fundamental units would have material standards, with every possible provision for ensuring continued preservation of constant values.

(4) The old wall of partition between electric and magnetic quantities which existed up to the year 1820 and which has been out of place ever since Oersted's great discovery, would disappear.

(5) All eight of the named practical units would be included except for very slight adjustments, using the familiar defining equations.

(6) The calibration of ammeters, voltmeters, wattmeters, and resistance coils would remain unchanged since the adjustments required are too small to affect even the precision instruments of commerce.

(7) The equations of the system are effectually rationalized, due to the choice of the ampere-turn as the unit of magnetomotive force.

Other advantages might be mentioned; but these are ample to emphasize the simplicity and clarity of the proposed system.

Coming generations of students, engineers, and men of science will realize the benefits conferred by a single, universal system of units, backed up by a single sequence of equations, and will, it is my belief, thank the generation that shall have the courage to introduce it.

## Ripple Tank Experiments

S. E. Boomer

*Southern Illinois State Normal University, Carbondale, Illinois*

Visual education has been growing rapidly in elementary and secondary schools with gratifying results as shown by scientifically conducted tests. It is quite as effective for college students. Teachers of physics have been pioneers in visual education for they have long used demonstration experiments, but when we have performed the same simple experiments before many classes we are likely to discard them, forgetting that to our students they are new and effective.

Waves fill incomparably more space than matter (and possibly matter itself is a wave phenomenon) and transmits vastly more energy than all other methods combined. Most of these we cannot see but the ripple tank helps to illustrate many wave phenomena, simple demonstrations of which are helpful to college students.

A series of closely spaced  $\frac{3}{4}$ -inch holes in a board illustrates Huygens' Principle. A sharp edge made by the intersection of a plane and a curved surface shows diffraction. Grating spaces should be about  $2\frac{1}{2}$  or 3 inches long, separated by the same distances. To show the advantage of a parabolic reflector for head lights and a spherical reflector for lighting a room, cut a parabola and the arc of a circle from boards or shape them from sheet metal. Slight shifts in the disturbance are instructive. Cut out an ellipse and show that the sum of the distances from a point on the ellipse to the foci is constant. With rubber tube, form shapes of various halls and auditoriums. Reverberation can be shown, good and bad areas identified. If the board used to show Huygens' Principle be placed near one wall of tank, rough surfaces are shown to be poor reflectors.

Outside stone steps leading to the second floor of our main building forms the best eschelon grating I have observed. Blocks cut from a 2" x 4" built into stairway lying on its side show successive reflections of a single impulse which explains the high pitched tone.

Recently Mr. Lowell Davis gave a special report on echoes in my class in sound. To illustrate the whispering gallery under the dome of St. Paul's Cathedral he made a circle about 16 inches in diameter of rubber tubing, allowing the ends to overlap about three inches. In the small space between ends of tube he produced ripples which crept around the inner edge of the tube much as Rayleigh explained the phenomenon in St. Paul's. This sheet metal ring is substituted for the tubing. The whisperer directs sound along wall and the trap does the same with ripples. Mr. Davis' experiment is responsible for my presenting these simple demonstrations today.

# Rotating Magnetic Fields

Leonard R. Crow

*Research Director, Educational Electric Manufacturing Company*

Many attempts have been made to produce a device for effective demonstration of rotating magnetic field phenomena which would be both instructive and impressive to the student. Very little has been accomplished in this direction.

A demonstration to be of the greatest value for instruction must be impressive or forceful and as simple as possible. In other words, because a certain demonstration or experiment is performed means little or nothing

at all, but the manner in which it is performed gives it value. It was with this idea in view that the writer developed the special apparatus here described for demonstration of rotating magnetic field phenomena. The apparatus is well adapted to attract attention in many types of display or exhibition work and lectures, and the student's curiosity can be raised to a high pitch, producing an interest and state of mind most receptive for the principles involved.

The device provides for creating a rotary magnetic field especially adapted to actuate conductive elements in close proximity to or isolated from the stator. The conductive elements may be in the form of balls, cylinders, discs, cubes, rings, etc.,

and in most cases are to be confined in a shallow transparent receptacle isolated from the stator.

Although means is known for producing a rotary magnetic field and for utilizing such a field in spinning small metallic objects, this device embodies improvements over prior apparatus in that the field is so directed that it can be more effectively employed for the purposes desired. Thus, in lieu of a Gramme ring, the magnetic flux of which tends to travel within the ring itself in the plane of the ring, the writer utilizes, preferably, a set of four coils (Fig. 1) provided with laminated cores, one pair of coils being connected in series with a unit for retarding the flow of current to throw the same out of phase with the remaining coils, or the two pairs of coils may be connected to the wires of a two-phase current, and by the adoption of six poles a three-phase current could be used. Any of these set-ups can be employed to produce a rotating magnetic field, the lines of force of which arch across between diagonal poles of the pairs of magnets at the upper end of the apparatus and the effective strength of the rotating field is thus readily available for the purposes desired.

Another object of the device, therefore, relates to improvements in means of producing a rotary magnetic field, so localized as to be accessible without substantial interference by the apparatus creating the field.

Many uses will suggest themselves from a consideration of the accompanying illustrations and drawings, wherein:

Figure 1 is a diagrammatic view showing the coil circuits and the preferred construction of the cores.

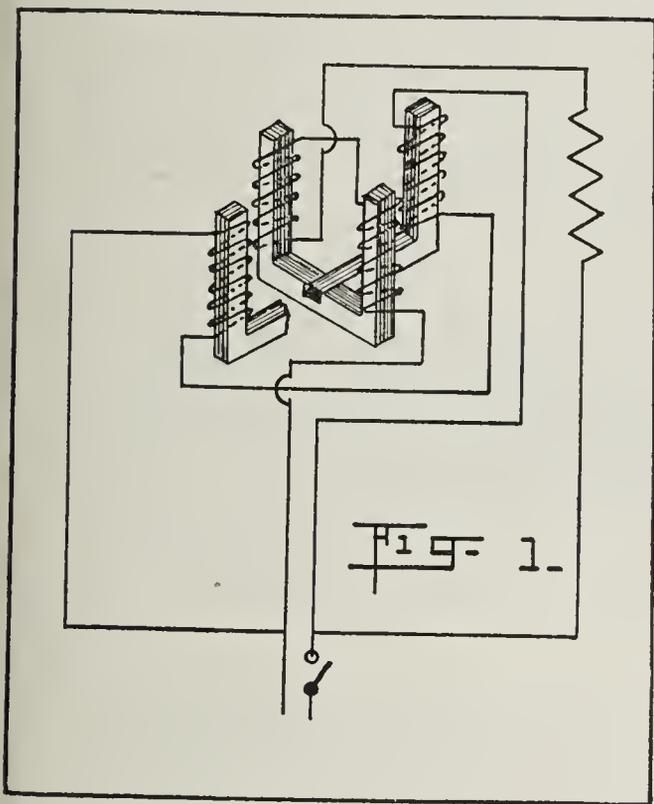
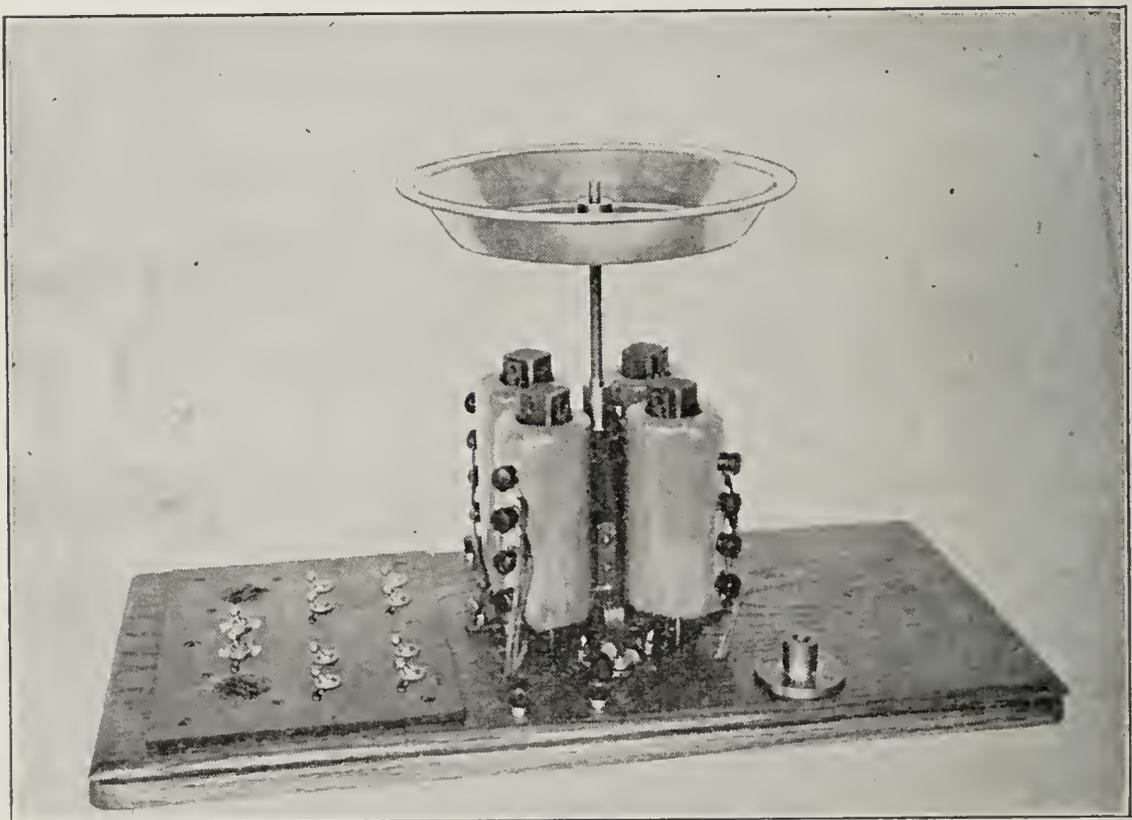
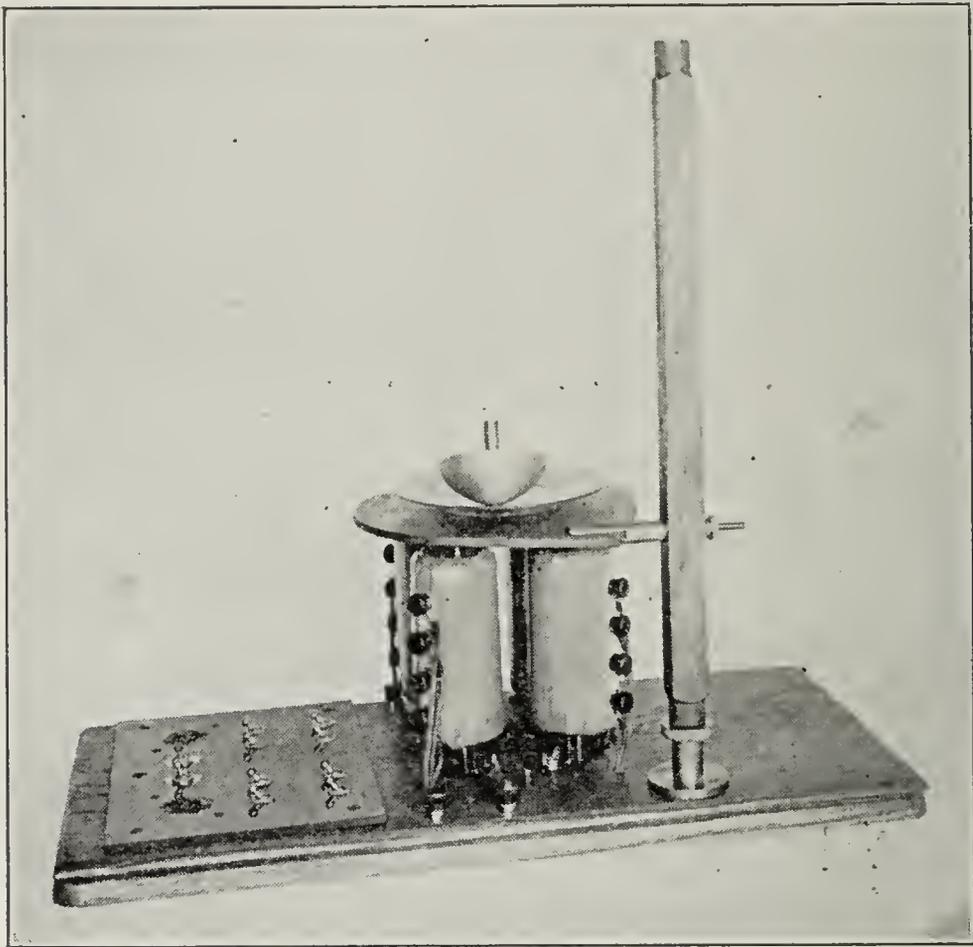


Figure 2 is an illustration showing an aluminum top which will spin in a glass dish placed upon a wood platform above the poles of the device.

Figure 3 is an illustration showing an aluminum pan which will rotate 4 or 5 inches above the poles of the stator.



Instead of the top illustrated in Figure 2, conductive balls, cylinders, discs, cubes or rings could be substituted.

A small commercial squirrel cage rotor could be substituted for the aluminum pan in Figure 3. Thus many other varied experiments and demonstrations can be performed in an amusing, impressive and highly educational manner with this type of demonstration device.

# A Polyphase Electric Gun

Leonard R. Crow

Research Director, Educational Electric Manufacturing Company

For many years engineers and other scientists have given serious thought to the design and development of a practical gun capable of discharging projectiles by the use of electricity instead of some type of explosive. All such guns so far devised have had some type of contactor system whereby the movement of the projectile, as it passed through the gun barrel, opened and closed contacts to effect its discharge.

The demand for an enormous amount of power delivered over a short interval of time as required to effectively discharge a projectile is a factor in itself sufficient, in most cases at least, to make the use of electricity impractical as a power for shooting projectiles.

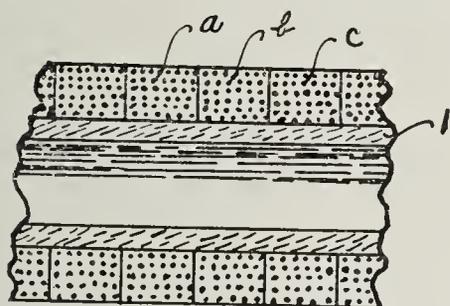


FIG. 1.

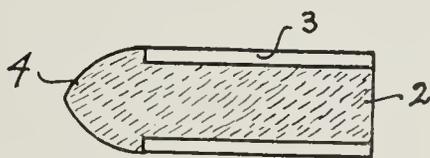


FIG. 3.

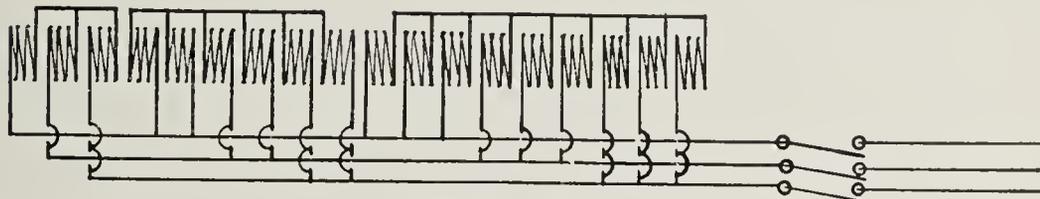


FIG. 2.

The type of electric gun here described is a great improvement over other electric guns, although the description is presented not with the thought of practicability but from an educational point of view.

One of my chief objects is to provide a simple and efficient construction for discharging the projectile which consists in generating traveling magnetic fields, annular in form, propagated in the direction of the desired line of flight of the projectile by means of polyphase electric current.

As illustrated in figure 1, the gun barrel preferably consists of an inert tubular member 1 provided with a clear unobstructed bore open at both ends, which constitutes the guideway for the projectile. This inner member should have high resistance to electric currents, which provides a substantially equal distribution of flux around the gun and prevents any possible tendency to shoot member 1 and energy loss due to eddy currents.

Surrounding the tubular member *1* is a series of annular coils *a*, *b*, *c*, arranged in successive groups and extending from the breech to the muzzle of the gun. The several sets of annular coils constitute means for producing traveling magnetic fields, which are propagated longitudinally of the gun barrel from the breech toward the muzzle and which, when a projectile of appropriate material is placed in the bore of the gun at the breech, induce currents in the projectile, thereby setting up a force tending to move the projectile through the gun toward the muzzle.

As illustrated, the coils are supplied with current of the alternating three-phase type, but current of any other polyphase type might be employed by proper arrangement of the coils.

The muzzle velocity of the projectile should be as high as possible, but it cannot exceed that of the traveling field which must therefore be maintained as high as practicable. The velocity of the traveling field is proportional to the pole pitch and the frequency of the inducing current so that by varying either one or both of these factors, the velocity of the traveling field may be correspondingly varied. One way of varying the pole pitch is shown in figure 2; the first three coils are connected to the polyphase system to form one pole, the following six coils are connected to the same system to form a pole of twice the length of the first pole, the following nine coils are connected to the same system to form a pole three times the length of the first pole. In this manner the pole pitch may be increased indefinitely.

When the frequency of the current in the gun coils is constant, the frequency of the current induced in the projectile is highest at the breech and gradually decreases toward the muzzle as the velocity of the projectile increases. The forces acting on the part carrying the induced currents are a maximum for a certain frequency of induced currents, and if the frequency is decreased, the forces fall off quickly, and if increased, the forces decrease slowly from said maximum. Therefore, it is decidedly advantageous to maintain the frequency of the induced currents in the projectile constant, and of such value as will maintain the forces at a maximum. This result can be approximated for practical purposes by making the velocity of the traveling magnetic field comparatively low at the breech and gradually increasing toward the muzzle of the gun. If the frequency of the current in the gun coils is constant, the result can be attained by varying the pole pitch, making it small at the breech and gradually increasing toward the muzzle. The same result may be effected by increasing the frequency of the impressed current during the time the projectile is traveling from the breech to the muzzle of the gun, or by connecting the successive sets of coils on the gun to current sources of different frequencies, which vary from a relatively low frequency near the breech to a maximum frequency at the muzzle. Obviously, either of these two last methods may be used in conjunction with the variation of pole pitch.

The projectile consists of either a solid or a hollow body of metal which may be of an appropriate shape, common to shot or shell. Figure 3 shows a projectile with a soft iron core (2) surrounded by a copper or aluminum conductive cylinder (3). The nose (4) may be of any suitable material.

When the inducing current is of very high frequency the magnetic circuit is not especially provided for, but the good electrical conductivity of the projectile is of great importance regardless of any frequency employed.

In order to increase the efficiency of the projectile as an element of the electrical system which effects its discharge from the gun, the walls of the shell should ordinarily be as thick as possible, and the material of which the conductive element of the shell is formed should possess high electrical conductivity.

## Some Topics in Physiological Mechanics

Ira M. Freeman

*Central Y. M. C. A. College, Chicago, Illinois*

Physiological mechanics examines the living body from the viewpoint of the engineer. If we begin by considering the human skeletal system, we find that the physical and chemical properties of the bone materials are important factors in determining its mechanical characteristics. The rigidity of the bones is attributable mainly to calcium salts. A 5 mm. cube cut from the tibia of a cow will carry a load of 426 kg. when fresh, but withstands a stress of but 68 kg. after the calcium has been extracted chemically, a decrease of about 84 per cent in ultimate strength.

When an engineer wishes to exhibit the elastic behavior of a structural material, he usually records the data in the form of a stress-strain diagram. Such curves have been obtained for bone materials. The curve for compact bone is similar to that for wood. The average tensile strength of human bones is about 10 kg./mm.<sup>2</sup> or 1,420 lb./in.<sup>2</sup> According to Fessler, the humerus of the cadaver of a 25 year old male has a tensile strength of 800 kg.

The distribution of stress in an engineering test specimen may be represented by drawing the so-called lines of stress, and the object itself may then be considered, for purposes of elastic theory, to be replaced by fibers following the lines of stress. One set of these fibers will be in a state of compression, the other in a state of tension. Culmann computed the stress distribution for several members of the human skeletal system and found a striking similarity in appearance between the cellular structure observed in bone sections and the theoretical stress line diagrams. Even in the case of the knitting of a broken bone or in ankylosis, i. e. growing together of bones at a joint, the new bone structure develops in accordance with the new stress requirements. Wolf's observations correspond well with calculations made by Roux for curved beams. The fact that the cellular structure follows the lines of stress means that the bones are made of the minimum amount of material necessary for the fulfilment of their structural requirements, a most remarkable instance of adaptation.

The connective tissues of the body present mechanical problems which are even more interesting. Aschoff showed that the pathological changes accompanying arteriosclerosis are due to loss of resiliency of the walls of the vessels because of atrophy of the elastic fibers.

Even the simplest considerations of tissue elasticity have important clinical applications. Alterations in the colloidal state of the connective tissues manifest themselves as changes in hardness, resiliency and rigidity, and are clinically observable in the form of constitutional abnormalities or as local symptoms like the edema accompanying certain heart and kidney diseases. Special instruments have been devised to make quantitative measurements of tissue resiliency.

The extensibility of the muscles is, from the very nature of these organs, a question of importance. It is found that under the influence of applied forces an extension of about one per cent is produced by a unit stress of 4 gm./mm.<sup>2</sup>, which is equivalent to 5.68 lb./in.<sup>2</sup> The stress-strain relations

for a muscle are represented not by a straight line but by a curve which approaches an asymptotic value of the extension.

The maximum force exerted by the human calf muscle is about 6 kg./cm.<sup>2</sup> and that developed by the biceps is 10 kg./cm.<sup>2</sup> The greatest contraction in length of human muscles is 60 to 80 per cent of their natural length. Certain muscles of the frog are capable of over 80 per cent contraction, while insects possess muscles which are able to shorten by 97 per cent of the natural length.

In dealing with the statics of the body as a whole we come upon such problems as the determination of the position of the center of gravity. For the extended position with arms at the sides the center of gravity is in the median plane about 4 cm. above the line joining the hip joints. Knowing the relative weights of the various portions of the body and the position of the center of gravity of each, the location of the center of gravity of the entire body in any position may be computed in the usual manner. O. Fischer has devised an interesting linkage mechanism for experimentally locating the center of gravity without resorting to the rather troublesome calculations.

Kinematics finds a most interesting application in studies on the locomotion of the body. The act of walking has been referred to as a kind of repeatedly arrested falling process, but it is more accurate to analyze this activity by considering the cycle divided into three distinct phases:

In the first of these, the leg swings forward preparatory to assuming the weight of the body, whose momentum carries it forward and upward. Extension of the leg by flexure of the knee joint raises the center of gravity an additional amount. Work is done by the muscles during this time.

During the second phase, the foot reacts on the ground with a rolling motion from ankle to toe. In the third phase, the other leg is swung forward by the action of the hip muscles. This is accompanied by bending of the knee and dorsal flexure of the foot. This completes the cycle.

Running differs fundamentally from walking in that one foot leaves the ground before the other makes contact. In addition, contact of the heel with the ground is normally absent.

Energy changes accompanying vital processes in the body were, from earliest times, suggestive of an analogy between the living body and a thermal engine. The maximum mechanical efficiency of the human system is about 34 per cent. The rest of the energy appears as heat. Of this part, 60 per cent is lost by radiation, 25 per cent by vaporization of water and 15 per cent by convection. The maximum mechanical efficiency is attained, however, only in certain types of activity, e. g. walking. If the energy is expended in turning a crank the efficiency is only about 20 per cent, while for work done in raising weights the figure is a little over 8 per cent. The results are functions of the subject's diet and his practice and training in the activity under consideration.

It may be said that the contemplation of the human body from the mechanical point of view has led to a functional orthopedic science. These studies are of value not only in clinical medicine but also in such applications as the improvement of human efficiency in industry.

# The Temperature of the Gas in an Interrupted Carbon Arc

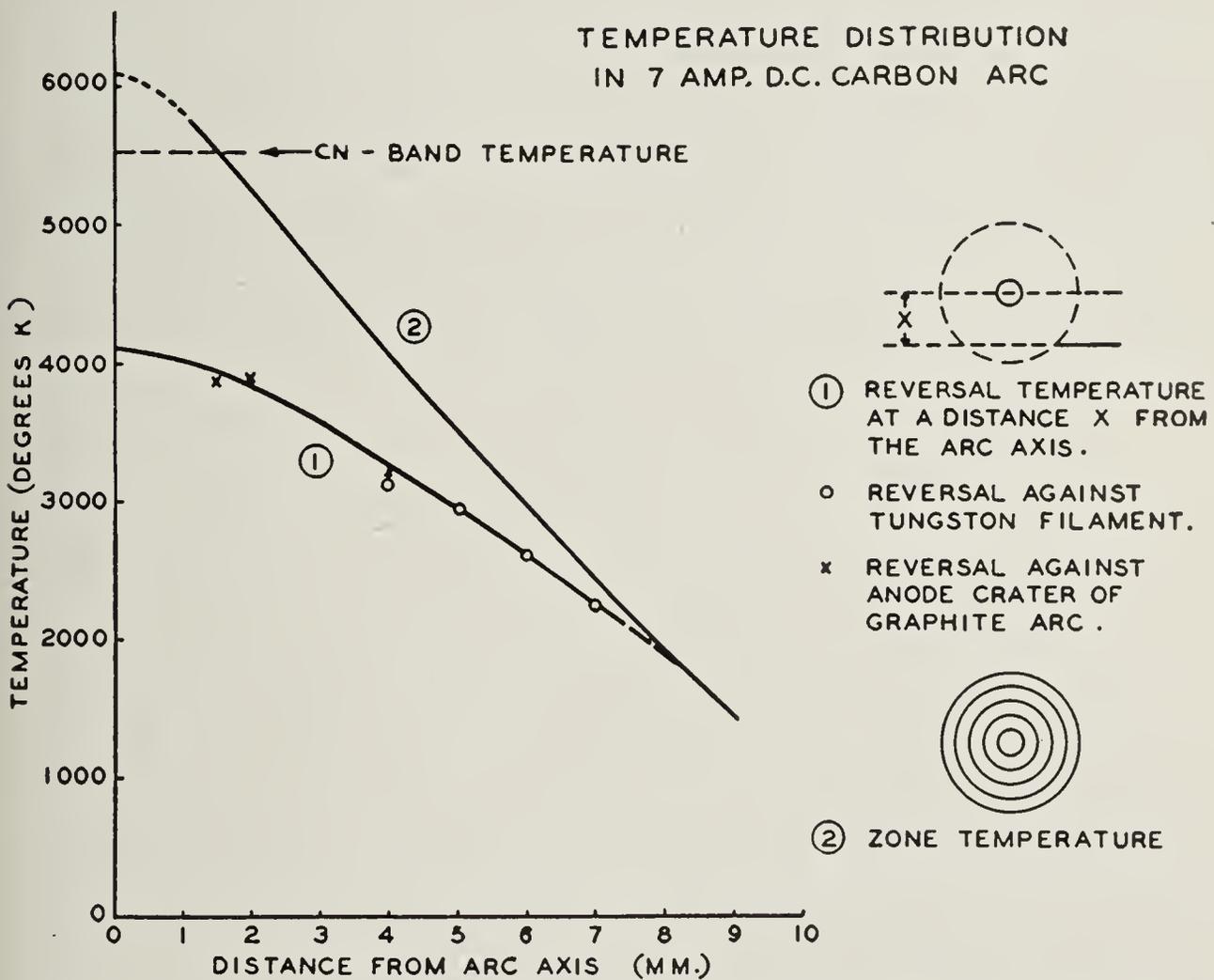
William T. Gray

Northwestern University, Evanston, Illinois

The temperature of the gas space in the electric arc has been the subject of many recent investigations. Knowledge of this temperature is of importance in studying the mechanism of the electric arc, and as a means of determining the temperature variation of gas-kinetic constants.

In the research problem upon which I have been working with Prof. W. S. Huxford, we have applied an established method of temperature measurement to the arc gas, namely the method of spectral line reversal. As is well known, when radiation from a black body is passed through a cooler gas containing a metal vapor the resonance lines of the metal appear as absorption lines. Conversely if the gas is hotter than the black body source, the lines appear bright. But if the temperature of the gas is the same as that of the black body, the lines disappear against the continuous background.

TEMPERATURE DISTRIBUTION  
IN 7 AMP. D.C. CARBON ARC



In our application a spiral tungsten lamp filament was imaged in the gas space of a 4 mm. D. C. arc between two "National Projector" carbons. This filament image and the arc were in turn imaged upon the slit of a spectrometer, in which the reversal of the Na-D lines was observed. The

black temperature of the lamp was determined by viewing with an optical pyrometer through a lens identical with that forming the filament image at the arc.

Reversal temperatures taken at various distances from the arc axis are shown in the figure. The range of the temperature measurements was extended by using the anode crater of a graphite arc as a black body source. For further analysis the arc was divided into concentric zones of uniform temperature. The reversal temperature at each distance is that corresponding to the intensity of radiation coming from all zones intersecting the light path, each zone being weighted by the product of the path length and the sodium density in that zone. Assuming that the sodium density is a constant fraction of the total gas density throughout the arc, the sodium concentration is inversely proportional to the temperature. The zone temperatures shown were calculated upon this assumption. The average temperature within a cylinder of 2 mm. radius about the axis is  $5750^{\circ}\text{K}$ . This cylinder coincides with the violet kernel of the arc, from which the CN bands are emitted. From the relative intensities of the rotational lines in these bands in the same arc, we have computed the rotational temperature of the CN molecules as  $5500^{\circ}\text{K}$ . The difference between these results is well within the limit of experimental error.

Thus far the existence of temperature equilibrium at each point in the gas space has been assumed. However the electric field, because of its acceleration of the ions and electrons, may disturb the Maxwellian velocity distribution. In order to eliminate this possibility we have turned to an interrupted arc, in which we observe the Na-D lines in the absence of a field. A synchronous commutator shunted across the arc short-circuits it for  $1/240$ th of a second, then allows it to burn for  $1/240$ th of a second. A disc provided with slits and run in synchronism with the commutator allows light to pass into the spectrometer only at a definite instant of the cycle. By rotating the stator of the disc-motor the phase of observation can be shifted. Reversal temperatures were taken through the center of the interrupted arc as a function of the phase. The curve of these temperatures, extended backward in time, intersects the point of cut-off at about  $4000^{\circ}\text{K}$ . This agrees very well with the central reversal temperature in the D. C. arc. Thus we have shown that the reversal temperatures upon which the distribution curve depends are not affected by the electric field in the arc.

# A Modified Form of Fabry-Perot Interferometer

R. C. Machler

*Northwestern University, Evanston, Illinois*

Because of the vanishingly small transmission coefficient of silver films for which the reflection coefficient is above 90 per cent in the visible spectrum, Professor R. A. Fisher and the writer have found it of considerable advantage to rule the first of the interferometer films with parallel slits.

By properly choosing the separation of the slits and the width of each slit one can modify the Fabry-Perot interferometer so as to give the same resolving power with considerably greater intensity in the fringes. The increased photographic speed minimizes the effects of change in temperature and atmospheric pressure on the fringes. [Time of exposure was reduced from 4 hrs. to a few minutes in certain cases.]

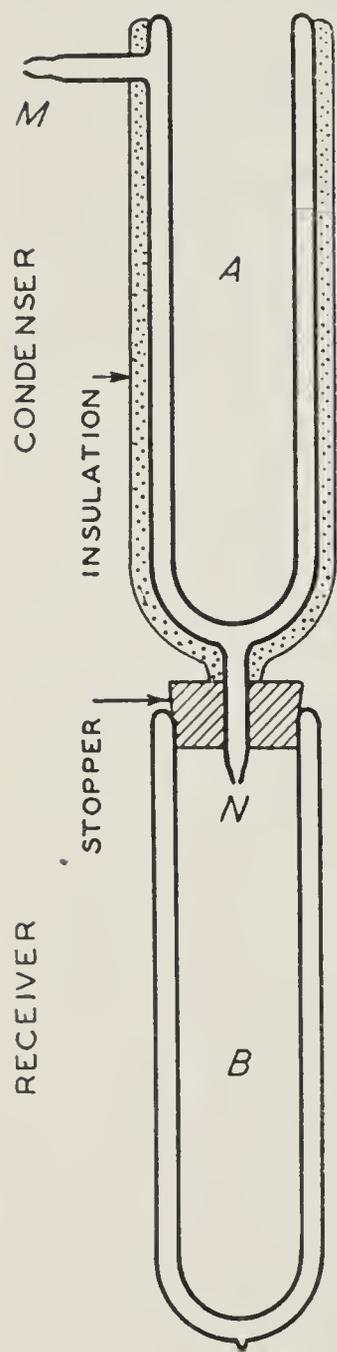
An ivory stylus mounted in a dividing engine head serves as a convenient and safe means of ruling the film.

## An Easily Constructed Oxygen Liquefier

Chas. R. Marsh

*Todd School for Boys, Woodstock, Illinois*

The most attractive feature of this liquefier is its extreme simplicity. It consists essentially of two test tube shaped thermos bottles, one placed above the other (Fig. 1). Both are unsilvered. The upper bottle is modified by the addition of two short tubes or nipples attached to the outer wall and opening into the space between the walls. One nipple is placed near the top. The other is attached at the bottom and in line with the axis of the thermos bottle as shown in the figure. This lower nipple passes through a rubber stopper firmly inserted in the mouth of the lower thermos bottle. The upper bottle is insulated by a layer of hair felt.



The upper vessel may be styled the condenser. The lower is to receive and store the liquefied gas, in this case, the liquid oxygen. To operate, it is only necessary to fill A with liquid air. Then connect the nipple M through a pressure tube to a steel tank containing the gas oxygen. A pressure gauge (Hoke gauge) or an open-end mercury manometer must be included. Everything is now in readiness for the operation of the liquefier. The valve of the gas cylinder is opened carefully, allowing the pressure in the liquefier to rise until the gauge records, say, two atmospheres absolute. In a few moments liquid oxygen will begin to trickle down through the nipple N and collect in the thermos bottle B. The mechanism within A is simply that of condensation under pressure of the gas oxygen. This condensation takes place on the chilled wall of the condenser that is in contact with the liquid air. The condenser, of course, should be kept filled (or nearly so) with liquid air. Under these conditions, the liquefaction of the gas oxygen proceeds quite rapidly. An idea of the speed and efficiency may be gained from the following results of a test run. With the gas oxygen under 20 pounds pressure, absolute, and the liquid air about 6 hours old (its temperature being about  $-190^{\circ}\text{C}$ ) 100 cc of liquid air cooled the apparatus from room temperature and in 8 minutes produced some 20 cc of liquid oxygen.

The apparatus was actually constructed from four pyrex test tubes of 15 cm length, 25 and 32 cm diameter respectively.

This liquefier may be used in the liquefaction of other gases as well, the only requirements being that the cooling agent be colder than the resulting liquefied gas.

# Design of Some Elementary Physics Laboratory Apparatus

Clarence J. Overbeck

Northwestern University, Evanston, Illinois

The apparatus of any laboratory is a silent but forceful teacher of the subject. In physics especially its design plays a considerable part in helping the student to learn what the laboratory work aims to teach him. In a course which introduces the subject to him the prime requisites for the apparatus are simplicity, ruggedness and a fair degree of accuracy of results.

The four pieces of apparatus shown, rather schematically, in the diagrams have proved helpful in our freshman laboratory at Northwestern.

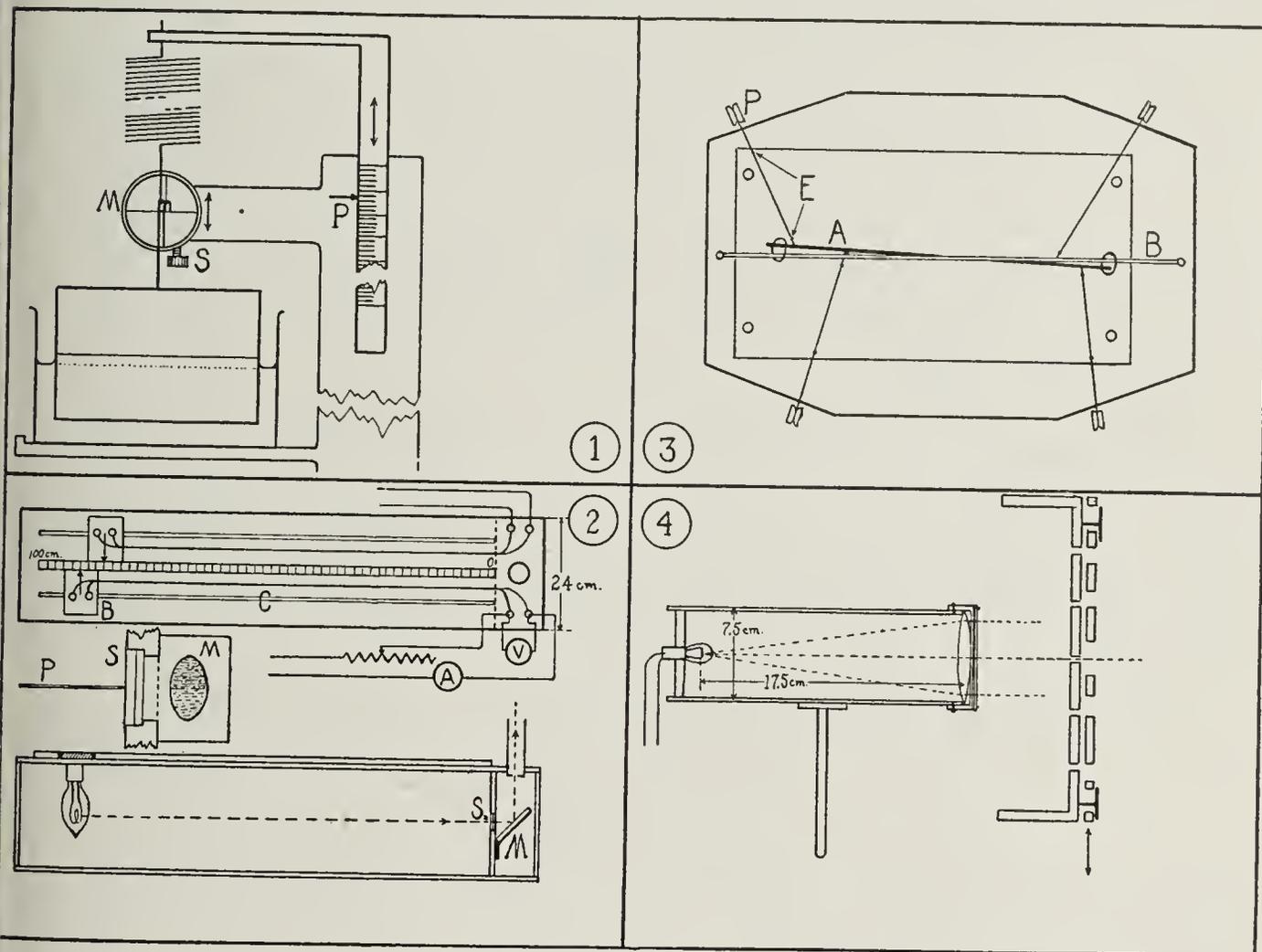


Figure 1. In the direct measurement of surface tension the force required to draw a horizontal wire from the liquid surface is measured. To obtain good results this wire must be of very small diameter and preferably rather long. To also have the stability necessary for repeated handling by first year students, a frame was made of nickel wire (0.76 mm. dia.), and fine tungsten wire (0.12 mm. dia.) used for the measurement was spot-welded across its face. This frame attached to a Jolly Balance (described in the "American Physics Teacher" Feb. 1935) is slowly drawn from the liquid keeping the spring index and its image always on the hair-line of the mirror M. A screw S is used to raise and adjust the mirror as the frame lifts from the liquid. The scale reading P is made when the film breaks. Then the

spring frame is lowered to the same cross-hair setting without the film and a second reading made. The difference between the two readings gives accurately the spring elongation, due to the film. The student then calibrates the spring, using known masses, and measures the length of the tungsten wire.

Figure 2. A measurement of the luminous efficiency of carbon filament and Mazda lamps is made the connecting experiment between electricity and light. A daylight type of photometer box was designed for this purpose. The upper drawing shows the top view of the box cover, and the lower drawing the inside side view. The middle drawing is an enlarged top view of the comparison screen *S* and mirror *M*. The standard lamp and lamp to be tested are separated by a black sheet metal partition *P*. In making a reading the bases *B*, to which the lamps are attached through slits *C*, are slid back and forth until the two halves of the circular screen at *S* (dia. 2 cm.) are equally illuminated as seen in the mirror. Since tests are run on different lamps operated at different voltages the color trouble tends to make comparison difficult. This is practically avoided by placing glass Corning Filters Nos. 349 and 430 over the fine tracing paper of the screen. These filters permit a comparison for a quite narrow band with a maximum at approximately 5700 Å and give results which are in fair agreement with those obtained using a flicker photometer.

Figure 3. The "Equilibrium of Forces and Torques Board" consists of a light brass rod *A* with four cords running over the pulleys *P*. The cords are loaded so that the rod clears its rings from the check rod *B*. Rod *B* is fastened to the board. After obtaining an equilibrium condition the student places a sheet of paper under the cords and locates the positions of the points *E* under each cord. This with a record of the loads is sufficient data to show that there is a balance of forces (graphically) and a balance of torques (mathematically). This apparatus is very instructive and may be built at small cost.

Figure 4. The Hartl Optical Disc method adds greatly to the understanding of the usual refraction of light experiment. Light sources for this experiment were constructed as shown, using a Mazda G. E. 1141 21c 12-16v lamp as a source. This lamp is found most satisfactory since it has a single straight filament which when set in line with the slits gives efficiently very narrow beams of light. The variable slit system shown in the enlarged cross-section view permits a rapid selection of any one of four different slit combinations.

The single center slit is used in the plate and prism study, the others being used in a study of lenses.

# Protection of Multiple-Scale Voltmeters in the Laboratory

O. L. Railsback

*Eastern Illinois State Teachers College, Charleston, Illinois*

In the experience of the writer, the instruments most likely to be damaged in the general physics laboratory are the ammeters and voltmeters. In most cases, the ammeters can be fairly well protected by the use of fuses. The following method has been employed with marked success to give protection to the D. C. voltmeters:

The voltmeter is enclosed in a close-fitting box of panel board on which is mounted a series of switch points and switch, as shown in the accompanying diagram. The binding-posts are permanently connected in the order shown. A series resistance is connected to the first "on" position. The value of this resistance is about ten times that of the high resistance of the voltmeter. An ordinary radio resistance is used since its value is not critical.

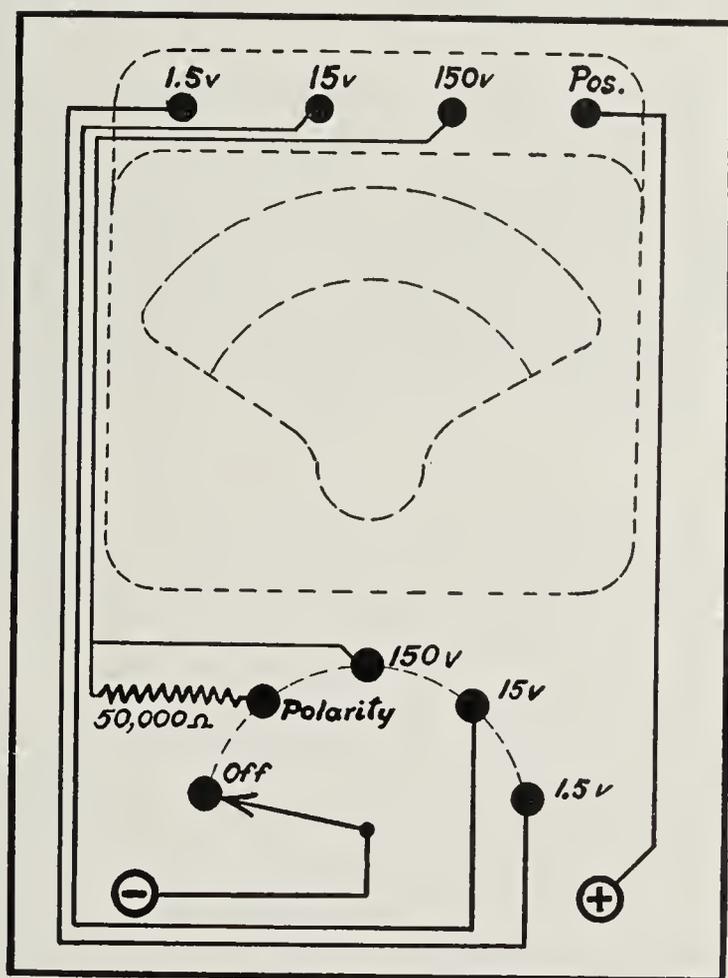


Fig. 1.—Wiring diagram.

Its purpose is to protect the voltmeter needle from a hard blow in case the voltmeter is connected backwards to the circuit. When these instruments are first placed in the hands of beginning students, the following precautions are emphasized:

(1) Always have the switch in the "off" position when connecting to a circuit, or when changing connections of the circuit.

(2) Watch the voltmeter hand as the switch is moved forward. If the deflection is backwards in the first "on" position, do not advance the switch, but reverse the connections on the voltmeter.

(3) Never advance the switch to the next point without making sure the voltage is less than the maximum scale-reading for the next contact point.

These rules of procedure are more easily understood, and carried out by the beginning student than if he is using the ordinary type of multiple-scale voltmeter with several binding-posts.

The use of this instrument offers the following advantages:

(1) A reversed connection may be detected without throwing the full voltage of the circuit on the instrument, because of the high protective resistance.

(2) The setting to the proper scale is always made from the high scale down.

(3) The student may change from one scale to another easily and quickly, thus avoiding the usual temptation to "guess" the proper scale without starting at the highest.

(4) There are only two binding posts exposed, clearly marked plus and minus, respectively, thus reducing the chances of wrong connections.

Thus it is possible to considerably increase the protection afforded the instrument, and at the same time actually to make its use much more convenient and rapid. The writer has tried placing unprotected voltmeters among the protected ones, from which the students might select their instruments. Invariably the protected ones are chosen because they are easier to use.

Before the adoption of this method of protection, the largest cost for repair in the general elementary laboratory was for voltmeters. Since its adoption, damage to voltmeters has become very rare.

The Weston Type 280 voltmeters were used because of their small size. The method could, of course, be adapted to any voltmeter. The cost of protecting a voltmeter is approximately two dollars.

This method of protecting multiple-scale voltmeters was planned and executed jointly by Samuel P. Mitchell and the writer.

## Models of Thermodynamic Surfaces

Frank L. Verwiebe

*Eastern Illinois State Teachers College, Charleston, Illinois*

The photographs show models of thermodynamic surfaces showing the P-V-T relations for two typical substances, water and carbon dioxide, including the solid phase as well as the liquid, vapor, and gas phases.

The models are of course dimensionally quite diagrammatic in order that the volume changes of the liquid and solid phases be visible. They are nevertheless very useful in clarifying the P-V-T relations. The graphs are easily traced on the models themselves and are readily explained when the models are at hand. They show in a clear-cut fashion a few of the more elementary but interesting P-V-T characteristics, which Bridgman discusses exhaustively in 'The Physics of High Pressure'<sup>1</sup> and elsewhere.<sup>2</sup>

Water is one of the few substances that shows a diminution of volume during fusion; the others are cast iron, gallium and bismuth, the latter two of which have been examined in the physicist's laboratory, along with water. This diminution of volume is thermo-dynamically associated with a negative

$\left. \begin{array}{l} \delta p \\ \delta t \end{array} \right)_v$  according to Clapeyron's equation, that is to say, the melting temperature falls as the pressure is increased. Water and bismuth,<sup>3</sup> however, revert to the more common type of behavior at sufficiently high pressures, water at 2200 kg/cm.<sup>2</sup> and bismuth at 25000 kg/cm.<sup>2</sup>

Of the six forms of ice known, only Ice<sub>I</sub> is abnormal. The first graph shows the transition from Ice<sub>I</sub> to Ice<sub>II</sub> and the melting curve between water and Ice<sub>II</sub>, which curve has a positive  $\left. \begin{array}{l} \delta p \\ \delta t \end{array} \right)_v$ . There is a change of approximately 20 per cent<sup>4</sup> in going from Ice<sub>II</sub> to Ice<sub>I</sub> as compared with the 8 per cent change for Ice<sub>I</sub> to water, an increase in the first case and a decrease in the latter. These changes are clearly shown on the model.

All substances so far tested show P-T melting curves concave toward the P axis. As to the ultimate behavior of the melting curve four theories have been advanced, a critical point as in the case of liquid-vapor, a maximum temperature, an asymptotic temperature, and an indefinite rise, the last by Bridgman.<sup>5</sup> The first two have not been realized in the experimental pressure range, and the last two depend on extrapolation, so that the problem is not definitely answered at the present time.

The P-T curves are not strictly isovolumic curves; they are rather the important lines seen in a side-view toward the P-T plane. The triple point is a point for P and T; it is a triple point line for V.

These surfaces were first modeled in clay, negative plaster casts made from the clay models, and positives cast from the negatives. A little paint preserves the surfaces and makes them more distinct.

<sup>1</sup> P. W. Bridgman, *The Physics of High Pressure*, (Macmillan, N. Y., 1931).

<sup>2</sup> P. W. Bridgman, *Reviews of Modern Physics* 7, (1935).

<sup>3</sup> P. W. Bridgman, *Phys. Rev.* 45, 844 (1934).

<sup>4</sup> P. W. Bridgman, *The Physics of High Pressure*, page 242.

<sup>5</sup> P. W. Bridgman, *Phys. Rev.* 46, 930 (1934).

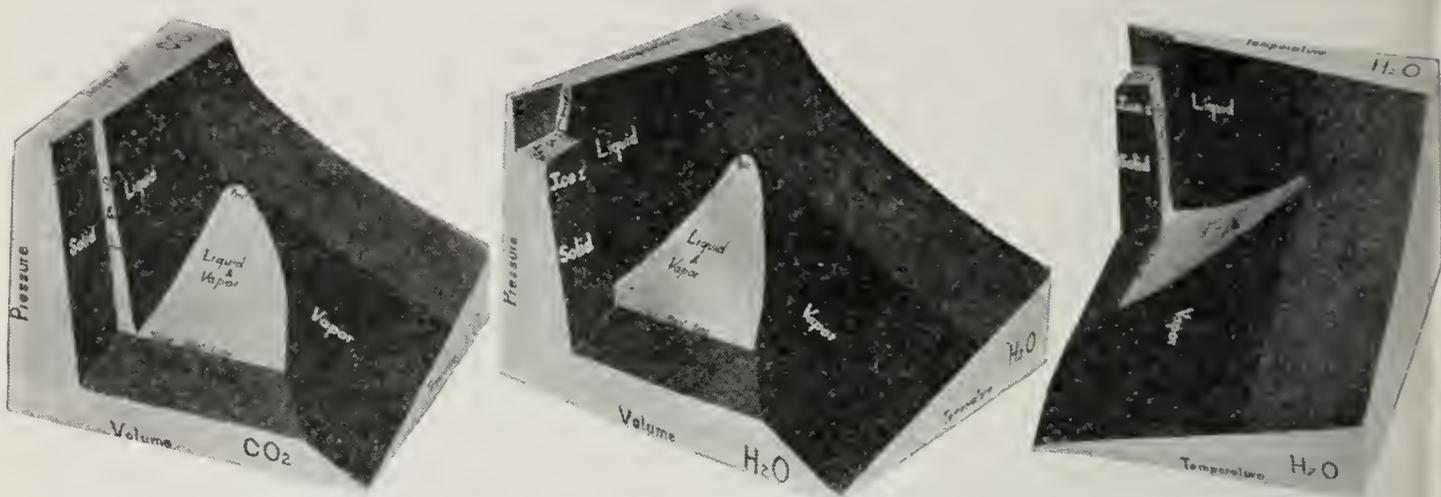


Fig. 1.—Models of thermodynamic surfaces showing the P-V-T relationships for carbon dioxide and water.

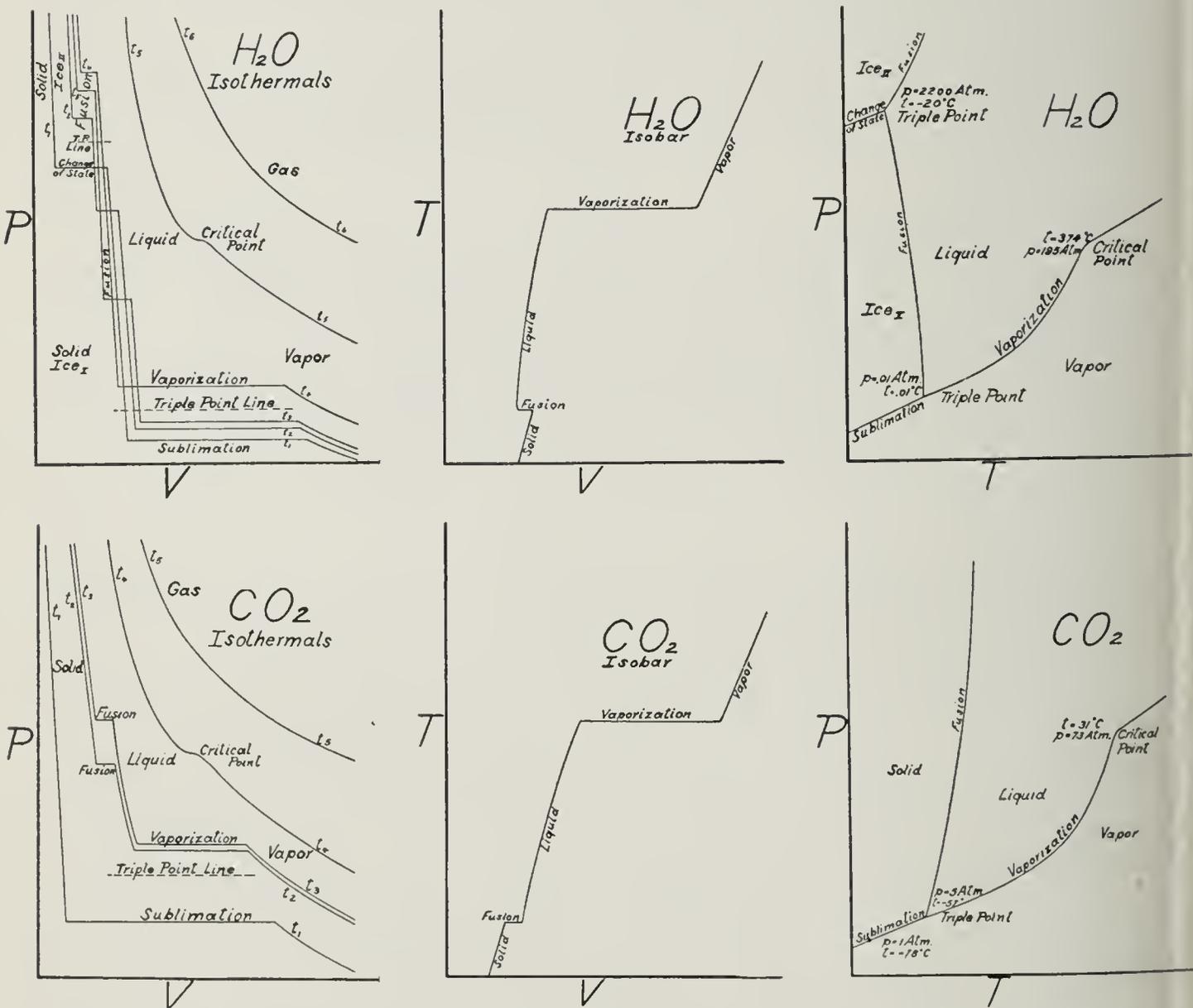


Fig. 2.—Graphs showing the same P-V-T relationships that can be traced on the models.

## PAPERS IN ZOOLOGY

---

### EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN

The program of the Zoology Section consisted of nineteen papers, six of which were not presented at the meeting and one of which was read by title only.

The following was read by title: "Studies on the Biology of the Crayfish, *Cambarus propinquus Girard*," by William C. Van Deventer, Rochester, New York.

The following, although read at the meeting, was not presented for publication: "The Family Life of the Blackbellied Tern," by Charles K. Carpenter, Chicago.

Attendance at the meeting averaged thirty; maximum attendance was forty-two.

No election of chairman was held.

(Signed) L. A. ADAMS, *Acting Chairman*.



## Dental Variations of the Dog, *Canis domesticus*

L. A. Adams

*Department of Zoology, University of Illinois, Urbana, Illinois*

The following notes on the anomalies of the dog dentition were obtained from the observation of over a hundred skulls that were prepared for the use of university classes in vertebrate zoology. The dogs were supplied by a department that uses many animals, and the source was the pounds of the surrounding cities. The collection was quite representative, consisting of animals of all sizes, and short-headed, long-headed, and intermediates. The dentition was surprisingly good for animals that had to depend upon themselves for a balanced dog diet.

The dental formula of the dog has been fixed since the upper Miocene  

$$3-1-4-2$$
and it is to be expected that the formula  $\frac{\quad}{3-1-4-3}$  should be quite stable.

Earlier in carnivore history there was a shifting forward of the shears and we find that in *Hyaenodon* the shears were on  $M^2$ , in *Oxyaena* on  $M^1$ , while  

$$M^3 \qquad M^2$$

in modern canines it is on  $Pm^4$ . The dental formula was quite stable in the  

$$M^1$$

series examined with little deviation except in the last molar and in the first premolars. The skulls were examined for the following anomalies; missing teeth; duplication of teeth; decayed and abscessed teeth; and irregular alignment. In no case was there any irregularity in incisors or canines.

### Missing teeth:

First premolar missing bilaterally on skull.

First premolar missing unilaterally on three mandibles.

Second premolar missing unilaterally on three mandibles.

Third premolar missing bilaterally on one mandible.

Fourth premolar missing bilaterally on two pairs of mandibles.

Fourth premolar missing unilaterally on one mandible.

(Molars 1 and 2 were always present.)

Third molar missing bilaterally in four cases.

Third molar missing unilaterally in three cases (mandible).

### Duplication of teeth (confined entirely to first premolar).

First premolar with bilateral duplication on two pairs of mandibles.

First premolar duplicated unilaterally on one mandible.

First premolar duplicated unilaterally on one skull.

First premolar duplicated bilaterally on one skull.

First premolar incompletely doubled on two mandibles (unilateral).

### Decayed teeth:

Dental caries were found in but one skull and in two pairs of mandibles.

### Abscessed teeth:

Abscessed teeth were found in three specimens only.

Third premolar of mandible with large abscessed area.

Fourth premolar with a large abscess around its roots (mandible).

One mandible with a pair of abscesses under the first and second molars of both rami of the mandibles.

### Teeth out of alignment:

Four cases were found in which there was a crowding of the teeth so that they were out of alignment. This was in the short-headed animals. The premolars were concerned in this crowding.

It appears that for the most part, dogs have very little trouble with their teeth. The greatest danger appears to lie in abscessed teeth, although this was found in but three cases. It seems probable that these abscesses are caused by spikes of bone that are driven down into the bone and jaw, while crushing bones eaten as food. These abscesses were always associated with the posterior premolars, or with the molars. The few cases of decayed teeth indicate that it occurs rather infrequently, and probably always associated with some chipping or accidental break in the tooth. The crowding of teeth in some specimens was such as to make the occlusion of the teeth rather poor and the dogs with the mixed heredity appear to suffer somewhat from dental failures.

# Rearing Codling Moth Larvae for Testing Insecticides

M. D. Farrar\* and E. R. McGovran†

*State Natural History Survey and University of Illinois Agricultural Experiment Station*

**Introduction.**—The codling moth, *Cydia (Carpocapsa) pomonella* L. is an insect extensively and intensively studied by many research workers. Actually thousands of articles are printed dealing with the codling moth, mostly in scientific publications. It is a serious pest of apples and other fruits in all parts of the world. The majority of investigations have been made to improve the control. In addition to work on control, research has been done dealing with the development, habits, parasites, tropisms, metabolism, digestion and ecology. The effect of temperature on this insect was exhaustively studied and more recently the variations in resistance to poison of strains of codling moth from different sections of the United States are being investigated.

The life cycle of the codling moth may be one, two or three brooded, depending entirely on temperature relations and length of season. Three full broods occur in southern Illinois while one and a partial second is normal for extreme northern sections of the State. In all cases it overwinters in the larval stage. Larvae spin into cocoons, usually on the trunk of the tree. With favorable spring temperatures, pupation occurs and development proceeds more rapidly.

Generally between May 10–30, first summer generation larvae will be entering apples. As much as three weeks variation in season may occur between southern and northern Illinois.

In Table I, life history data collected by Glenn (1922) at Olney, Illinois, illustrates seasonal history typical of the insect in most sections. Each generation is considered to start with the egg stage and end with the adult moth.

\* Research Entomologist, State Natural History Survey.

† Research Assistant in Entomology, State Natural History Survey and University of Illinois Agricultural Experiment Station.

TABLE 1—DAYS FOR CODLING MOTH TO DEVELOP

Stage of development	Hibernating generations			Summer generations		
	Minimum	Maximum	Average	Minimum	Maximum	Average
Egg.....	5	15	7	6	13	9
Larva (feeding).....	16	54	29	14	43	25
Larva (total).....	244	305	265	18	47	26
Pupa.....	18	46	31	8	14	11
Adult.....	4	26	12	3	15	7
Total life.....	287	330	315	43	66	53

**Technique.**—In order to secure data on the toxicity of insecticides against codling moth, it is necessary to produce larvae for standardized tests. Farrar and Flint (1930) published an article dealing with the production of larvae out-of-season. Since that time many refinements have been added. Many of them are reported in this paper. The use of equipment for control of temperature and humidity has made possible the production of about 25,000 larvae for the testing of new insecticide mixtures during the winter months. Mature apples have in all cases been sprayed and infested with larvae.

**Collection and Storage of Larvae.**—To rear enough newly hatched larvae for insecticide tests, thousands of hibernating larvae must be secured. The daily emergence of 200-500 adult moths provides a good working basis for tests. During the active season collected larvae will develop to maturity, but after temperatures below 50°F. arrest pupation (about August 15 at Urbana, Illinois) a storage period at low temperature is necessary before development will continue. The most economical collections of larvae for tests are made after normal pupation stops. Corrugated paper bands two to four inches wide placed around the trunks of apple trees bearing a crop of wormy fruit catch many larvae. Scraping the trees free of rough bark will aid materially in inducing the larvae to enter bands. Similar strips of corrugated paper tacked against the walls of bins containing cull apples yield quantities of larvae.

By the latter part of September the bands should be removed and stored, preferably out-of-doors. Protection should be provided against mice and temperatures of lower than 10°F. below zero as either can quickly destroy the collected larvae.

Fall collected larvae if brought indoors January 1st will start to emerge about February 15th. The larvae will pupate more uniformly and in greater numbers if their hibernating cocoons are thoroughly soaked with water before placing them at higher temperatures. Before pupation starts in the spring, unused over-wintering larvae may be placed in cold storage at 40°F. or less. Here they may be safely kept for 6-10 months without undue loss, provided they are not allowed to dry out or mold. Larvae kept in storage past their normal emergence date will emerge in 3 to 4 weeks when exposed to summer temperatures.

**Emergence and Collection of Adults.**—A room 6 x 6 x 6 feet is convenient for an emergence chamber. Such a room will provide ample space for storage of larvae in corrugated paper and for the collection of adults. For maximum production 80°F. and 80-90 per cent relative humidity is desirable. For the convenience of handling adult moths, a window in one side fitted with an oviposition cage will attract at least 50 per cent of the adults without attention. A cheese cloth lining of the interior of the room serves as an excellent background for the collection (by suction) of those moths not attracted to the lighted window. As protection against mice, the larvae are stored in trays with one-fourth inch gravel screen tops and bottoms. The moths emerge from their cocoons in the corrugated paper, crawl through the one-fourth inch screen and fly to the light.

The oviposition cage was designed to save time in handling moths. It is essentially a wooden frame three and one-half inches wide and twelve inches square. To each side is hinged a light frame twelve by twelve inches covered with screen wire. In assembling the cage, the inside of the wooden frame is first lined with perforated cellophane. A twelve by twelve sheet of the same material is then slipped into each side, thus completely lining the cage. Adult moths are collected daily into an oviposition cage. Many moths will enter the cage unhandled if the one side of the cage is lowered and the

cage is fitted into the window of the moth emergence chamber. Additional moths can be added through a hole provided in the top of the cage.

**Oviposition.**—This phase of larval production is the most exacting of all. Even with all precautions, not every collection of moths can be induced to oviposit. To stimulate egg production, two or three withered apples are placed in the cage containing 300 to 500 adult moths. This cage is set into the oviposition case where it is undisturbed for four days. As the number of hours of daylight is much less in February and March than when the adult moths are normally active from June to September, it has been found possible by the use of lights to increase the amount of oviposition by extending the number of hours of light to 14 or 15 per day. In the case housing the oviposition cages, the air must be clean and free from moldy odors. The case is operated at a constant temperature of 80°F. between 8 A. M. and 4 P. M. During the remainder of the day and night the temperature falls to approximately 70°F., room temperature. The relative humidity is controlled constantly between 70 and 75 per cent during the period of constant temperature. At night, with the falling temperature, the relative humidity approaches saturation, 90 per cent or higher. This rhythm of temperatures and humidities seems superior to any set of constants found.

At the end of four days the oviposition cages are removed and opened. All moths still active are collected and put into other cages. The cellophane lining coated with eggs is removed and cut into strips suitable for storage in hatching boxes.

**Incubation of Eggs.**—Hatching boxes may be of several designs. Mailing tubes or cardboard or metal boxes will serve. In all cases glass shell vials 0.75 x 2.5 inches are fitted into the sides. Newly hatched larvae are attracted into these vials by the light. From these they are transferred by means of a camel's hair brush to the test fruit.

A special incubator is provided for the hatching of the eggs. As soon as the papers of eggs are removed from the oviposition cages and placed in the hatching boxes, they are set in this incubator until the young larvae appear. Here the temperature is maintained constant between 75° and 80°F., with a relative humidity constant of 80 per cent. A glass window in one side of the case admits light that in turn attracts the newly hatched larvae into the vials.

**Infestation of Apples.**—Apples to be infested are sprayed with the respective insecticides 24 hours in advance of the time larvae are to be transferred to them. With a camel's hair brush, 10 larvae are transferred to each apple. The infested fruit is then suspended in a constant temperature (80°F.) and humidity chamber (60 per cent relative humidity) for a period of 24 hours. During this time the larvae may establish themselves in the apples under very favorable conditions. The fruit are removed from the case after 24 hours and stored in a cool place for five days. On the sixth day after infestation, each apple is graded for the number of entrances and stings made by the codling moth larvae.

#### BIBLIOGRAPHY

FARRAR, M. D., FLINT, W. P.

Rearing Codling Moth Larvae Throughout the Year. Journ. Econ. Ent. 23: 41-44. 1930.

GLENN, PRESSLEY A.

Codling Moth Investigations of the State Entomologist's Office, 1915-1916-1917. Natural History Survey Bull. Vol. 14, Art. 7, 1922.

# The Bionomics of the Ladybeetles

W. V. Balduf

University of Illinois, Urbana, Illinois

## ABSTRACT

The ladybeetles are among our most popular insects. All of the mid-western species seem to pass the winter exclusively as adults. Some of the smaller forms live under large scale insects or in the nests of ants, but the most common ones are active on plant surfaces where they search for prey, and lay their eggs in masses. Most masses contain 20 to 30 eggs, and the daily production declines as the end of the ovipositional period of an individual is approached. Individuals of *Chilocorus similis* deposited an average total of 16 eggs while *Hippodamia convergens* produced an average of 731 per female in her entire life time. Incubation generally requires eight days or less, and the larvae are said to bear egg bursters on the thorax. Four instars compose the larval stage in almost all known cases. These are of relatively brief duration, the stage as a whole usually lasting from 16 to 30 days. The mature larvae attach themselves to exposed surfaces of objects by the posterior end of the abdomen, the means being either an anal secretion or a special caudal appendage. Larvae covered with waxy plates or fibers retain the last exuvium as a shelter for the pupal stage, but most ladybeetles shed this skin and crowd it back to the tip of the body. For most part, the pupal stage lasts a week or less, and the new adult remains quiet in the pupal skin until fully colored and hardened. The adults of certain common species lived from one to fourteen months in captivity.

One of the three subfamilies of the Coccinellidae is but little known and the second, which embraces our squash ladybird and Mexican bean beetle, eats exclusively plant tissues. The third group, or Coccinellinae, largely contains predacious forms, but the tribe Psylloborini is fungivorous. Plant lice, scale insects and red spiders are the principal prey, but other small soft-bodied Arthropoda form a part of their fare. However, even the predatory ladybeetles commonly take pollen and fungous spores with their animal food. According to some observations, only the liquid parts of the prey were ingested but some larvae and adults swallow the solid with the fluid parts. Their voracious feeding on aphids and scales makes ladybeetles of inestimable benefit to man, and they have accordingly been variously employed in biological control. The mass hibernating habit of *Hippodamia convergens* in California mountains favors its use in combating insect pests in the valleys. This, and some other species of the world, concentrate in masses of many thousand individuals at altitudes of about 10,000 feet, and occupy the same spots year after year. *Ceratomegilla fuscilabris*, a familiar species of the midwestern plains, commonly assembles in large numbers at the base of trees in the edges of woods.

# The Occurrence of the American Eagle Along the Ohio River in Illinois

Clarence Bonnell

*Township High School, Harrisburg, Illinois*

The investigation here recorded was prompted by reading the pamphlet, "Save the Bald Eagle", published by the Emergency Conservation Committee, New York City, and recently distributed by the Isaak Walton League.

About the year 1922, a large specimen of this bird was shot in the wing by Louie Gaskins and another hunter of Harrisburg as it flew over a slough northeast of Shawneetown. It was brought to our high school where it was kept until its wing healed and the characteristic white head of the adult appeared. It was then released. Since that time various newspapers of the locality have published numerous accounts of specimens being killed.

Rev. Fr. Sharbough of Shawneetown has a mounted specimen which was killed in the Wabash bottoms a few years ago. He reports that he has seen three or four eagles in that vicinity within the last year.

Reports indicate their greater prevalence about the Wabash River than along the Ohio in Illinois. Jake Lauderdale of Brownfield, Pope County (inland from the Ohio), reports seeing none for thirty years but has news of one being seen two years ago.

Harry Woolcott of Harrisburg who has a summer camp in Kentucky below Carrsville reports seeing one on a tree on the Illinois side across from his camp.

Captain William Hale of Shawneetown has seen bald eagles near Cave-in-Rock, Hardin County, within the last year, and formerly as many as six times a year, sitting on trees out in the bottoms but has never seen any nests.

Carl Eswine of Shawneetown who has spent most of his life on the Ohio and about the lakes of the Wabash bottoms says that from two to six eagles have spent the winter months within a radius of ten miles of the mouth of the Wabash, usually alone along the river, from autumn till spring. He knows of no nesting places.

William Zachmeier of Shawneetown who keeps the pilot lights from Shawneetown to the mouth of the Wabash says he has seen about six in the past two years, generally perched on trees near the river. He has seen as many as four at one time. They stay all winter.

James Daily of Ridgway, Gallatin County, knows of four that roosted back of his place along the Wabash bottoms between New Haven and Shawneetown during the last winter. He thinks he has seen from twenty to thirty in the past fifteen years, resting on trees or flying up and down the Wabash. Some are killed in the Wabash bottoms every year, he says, also, that some are said to nest in a place called "The Loops", about seven miles southeast of New Haven.

Bailey Williams, of Broughton, a teacher, lives on a farm near Big Hill, a lookout point in section 35, T. 6 S., R. 7 E. in southeastern Hamilton County. He remembers that a pair nested in a large post oak tree at the edge of the rocky slope on Big Hill about 1910 or 1912. The next year the

neighbors drove them off. His father, H. S. Williams, a former game warden living on a farm near New Haven, confirms the above and reports a nest seen in a big pecan tree near the Brushy Slough close to the Wabash four or five years ago. Bailey Williams saw one eagle near his home this year and one during the duck hunting season on the Wabash, three or four miles northeast of New Haven. A large one stayed near his home for three weeks during the winter of 1927. He is now caring for a young one which was shot in the wing and brought to him.

Another young one I found being cared for on the farm of a Mr. Walser near New Haven. Mr. Walser knew of rumors of nests up the Wabash near Mt. Carmel but claimed to have never seen any nests in Illinois himself. The two young captive specimens which I have seen recently are large which confirms the statement of Ridgway that the young frequently have greater measurements than the adults. Some fishermen and hunters of the Wabash bottoms distinguish the young ones as gray eagles and the adults as bald eagles in the belief that they are two different species.

Jack Street of New Haven says he has seen eagles at Yellow Banks, a slough emptying into the Wabash, but knows of no nests in recent years. Walser and Street and others interviewed at New Haven had no definite knowledge of present nesting places. It is evident that several eagles, mostly young ones, are killed in the Wabash bottoms every year. It is doubtful whether any nests are to be found, though I was not sure whether all of my informers would have told me if they knew of any.

The sentiment along the lower Wabash appears to be that the eagles should be exterminated. The usual tales of their destructiveness are current. Here is work for the Isaac Walton League or other conservationists. It would be interesting to know just where the young eagles that frequent the lower Wabash valley and the Ohio are reared. Should the two convalescent captive specimens be released, it would be worth while to have them banded.

# The Effect of X-Rays on the Incubation Period, Sexual Development, Egg-Laying Capacity and Brooding Tendencies in White and Brown Leghorn Chickens

J. M. Essenberg

*Loyola University, School of Medicine, Chicago, Illinois*

Conflicting conclusions have been reached by various investigators who have studied the effects of x-rays on the developing chick embryo. In an effort to ascertain more clearly the destructive as well as the stimulating qualities of Roentgen rays, we have rayed a large number of hen's eggs at different stages of incubation and with various dosages. The chicks from eggs so treated have been studied before and after hatching. Many of them have been raised to maturity in order that latent effects of x-rays may be observed. The results are here recorded.

## MATERIAL AND METHODS

Fertile eggs of reliable quality were used throughout the experiment. All were incubated before irradiation. The age of the embryo varied from 19 to 243 hours incubation. The young chicks were reared in a brooder and later, at 4 to 5 weeks old, transferred to a chicken coop, located on the roof of the Medical Building. The coop was so constructed as to protect the birds from excessive temperature changes, and supply plenty of space for exercise. The floor was covered with shavings which were changed once every week. Automatic traps were used for laying.

Young chicks were fed on "Purina Chicken Starter". Older birds received mixed grain in addition. All birds were given meat scraps and greens twice a week.

The x-ray machine used was a "Type C" model made by the Standard X-Ray Company. It was equipped with a Coolidge therapy tube and a Landauer Roentgenometer. The focal distance was 10 inches and the filter was equal to 4 mm. aluminum. The Roentgenometer was kept at 3.2 which, by calculation, delivered 0.6 r per second. The set-up of the machine remained constant for the duration of the experiment. The dosage varied from 30 to 600 r.

## RESULTS

**Effect of X-Rays on the Incubation Period.**—The incubation period of all x-rayed eggs varied between 19 and 22 days. If the incubation period was expressed in hours and the data organized on the basis of dosage, the average incubation period for 30 r was 484 hours, for 80 r, 495 hours and for 400 r it was 501 hours. The controls averaged an incubation period of 496 hours, which is 8 hours less than the accepted 21 days. From these data, two significant facts are apparent. First, the incubation period in x-rayed

white and brown leghorn eggs varies directly with the x-ray dosage and secondly, small dosages, less than 80 r, accelerate development and dosages more than 80 r retard the developmental process.

**Effect of X-Rays on Sexual Development.**—In the experiment, sexual maturity was indicated in the female by the laying of the first eggs and in the male by a successful attempt at crowing. In the female, attainment of sexual maturity varied from 2 months 6 days after hatching to 5 months 14 days. The average was 4 months 14 days. The average in the controls was 5 months 17 days, an acceleration of 1 month 3 days in favor of the hens from rayed eggs. In case of the males, sexual maturity varied from 1 month 27 days to 2 months 24 days; the average being 2 months 9 days. The average for the controls was 3 months 5 days, which shows an acceleration of 26 days in case of the x-rayed specimens.

**Effect of X-Rays on the Egg-laying Capacity.**—The egg-laying capacity of 121 hens has been recorded. Of these 57 were hens from x-rayed eggs and 64 from eggs that had not been rayed. Of the experimental birds, there were some whose egg-laying record extended over more than two years; the majority extending over 1 and 1½ years; none are included in the calculation of averages if their egg-laying record did not extend beyond 8 months. The normal or non-rayed hens were used for other experiments as soon as their egg-laying became regular. The egg-laying capacity for the rayed birds averaged 8.8 per month which is very low as compared with normal capacity of Leghorn chickens. Data supplied by the poultry farms from which the eggs were obtained give the average of 18 eggs for pullets and 24 for hens per month. Several peculiarities were noticed in the history of rayed chickens. As a rule, the first egg-laying period was very active; some pullets laid from 20 to 26 eggs per month for 6 to 7 months. Then a gradual decrease set in which was followed by total cessation of egg production. Periods of rest of several months occurred, in some as long as 6 months, which was followed by another exaggerated laying period and another rest period. The subsequent laying periods were usually marked by shorter time and lesser productivity. The egg-laying course in the non-rayed pullets was different. Productivity during the fifth or sixth months after sexual maturity was irregular and low, averaging 6.8 per month.

### BROODING TENDENCIES

It will be remembered that our flock of birds consisted of pullets and hens rayed in egg, non-rayed pullets which were rayed as soon as they began to lay regularly and of course, a few male birds. During the 5 years of experimentation, no definite brooding signs have been noted in the colony. Since we did not have non-rayed hens that would serve as controls, no claim of an x-ray cause for the absence of brooding can be made without further investigation.

# Sex Conditions in a Japanese *Valvata*\*

Clarence Lee Furrow

*Knox College, Galesburg, Illinois*

Sex conditions in the genus *Valvata*, a group of fresh-water prosobranchiate snails, have until recently received little attention. Much study, however, has been directed toward other snails, but the most recent investigations have been made on the marine members of this group. Von Kemnitz (1914) first reported on sex conditions in *Valvata piscinalis* which were of

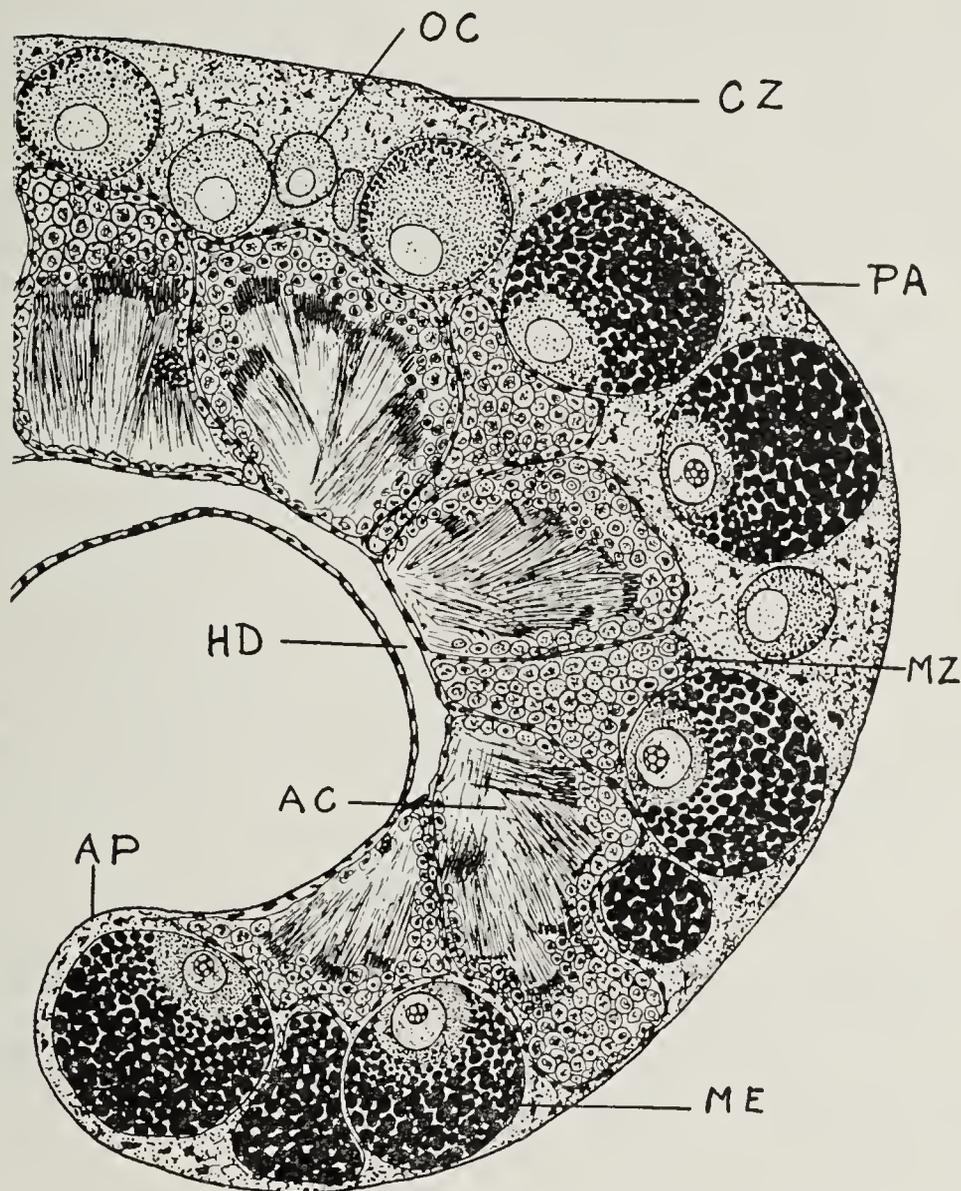


Fig. 1.—A diagram of a section of the hermaphrodite gland of *Valvata japonica*. The topographical relationship of the male and female zones is shown.

AC—acinus  
AP—apical region  
CZ—cortical zone (female)  
MZ—medullary zone (male)

HD—hermaphrodite duct  
PA—parenchyma  
ME—a mature egg  
OC—a young ovocyte

Bavarian origin. In these snails he observed no special deviations in structure or cell history and further stated that spermatogenesis occurs without complications or irregularities. Later, Artom and Cavallini (1931) found in *Valvata cristata* a tendency toward atypical spermatogenesis. While these

\* Contributions from the Biological Laboratories of Knox College No. 48.

investigators recorded the finding of both atypical and normal (typical) spermatozoa in *Valvata cristata*, they also reported finding only normal spermatogenesis in *Valvata piscinalis*. Both of these species were collected in Italy.

In one of the American species, *Valvata tricarinata*, a higher degree of spermic abnormality has been observed (Furrow, 1931, 1935). In this species four distinct types of spermatozoa have been identified, only one of which follows a normal course of development. The other three types vary in their deviation from a condition which resembles the eupyrene spermatozoa to that of the aypyrene forms.

Through the courtesy of Dr. Denzaburo Miyadi of the Otsu Hydrobiological Station of Kyoto Imperial University, specimens of the Japanese species, *Valvata japonica*, have been placed at my disposal for study and comparison with other members of the genus. This Japanese snail resembles *Valvata sinccra*, one of the American fresh-water prosobranchiates in its general external and anatomical features. The shell of *Valvata japonica* is approximately 5 mm in diameter, and there are five and one-half whorls. The shell is smooth, noncarinated, somewhat globose, and yellowish-brown in color. The sculpture is of regular striae and the sutures are solid and well impressed.

Internally, the animal is similar in structural detail to other members of the genus. The hermaphrodite gland occupies the last or apical whorl. The male zone and female zone are segregated. The female germ cells occupy the cortical region and are restricted to the peripheral marginal zone. The male germ cells are located in the acini of the medulla.

In the preliminary examination of this material cytological conditions indicate that the Japanese *Valvata* also exhibits a type of functional protandry (Fig. 1). In the following diagram maturation stages in the male cells are almost completed and the acini are filled with mature spermatozoa. This is the condition of the gland just before the beginning of the "male phase" in the sexual cycle, a stage which has been already demonstrated in *Valvata tricarinata*. The female germ cells are shown approaching the stage of development when they will soon follow the spermatozoa to the hermaphrodite duct. From the preliminary study it is apparent that atypical spermatogenesis occurs in *Valvata japonica*. The complete course of the process has not been observed at this stage of the study.

#### BIBLIOGRAPHY

- ARTOM, C., and CAVALLINI, F., 1931; Presunti de spermatogenesi atipica in Molluschi Prosobranchii ermafroditi del genera *Valvata*. Boll. Soc. Biol. sper. 6.  
 FURROW, C. L., 1931; Spermatozoan dimorphism in *Valvata tricarinata*. Trans. Illinois State Acad. Sci. 23.  
 ———— 1935; Development of the hermaphrodite genital organs of *Valvata tricarinata*. Zeit. f. Zellforschung u. mikro, Anat. 22 Band, 3 Heft.  
 KEMNITZ, G. A. VON, 1914; Beträge zur Kenntnis des Spermatozoendimorphismus. Arch. Zellforsch. 12

# Annular Rings in the Long Bones of Turtles and Their Correlation With Size

Norman T. Mattox

*Department of Zoology, University of Illinois, Urbana, Illinois*

A preliminary study of the cross-sections of the long bones of turtles was undertaken following the suggestion of Dr. A. R. Cahn. The objective in view in this study was to determine whether or not there were annular rings present in these bones, and if so to determine any possible relationship between these rings and the size (or age) of the turtles.

The author is greatly indebted to Dr. A. R. Cahn, University of Illinois, whose helpful suggestions and assistance have made this study possible.

Six turtles, *Chrysemys marginata*, two males and four females were taken from Illinois River at Meredosia, Illinois. These turtles were all of different sizes. From these turtles the two femurs, mandibles and humeri were removed and each bone was cut with a fine-toothed metal saw, so that three cross-sections, 1 mm. in thickness, near the ends of the bones were obtained from each bone. These sections were then dried, after which they were fastened to micro-slides with canada balsam.

After the balsam was thoroughly dry and set the bones were ground down to a desirable thickness for microscopic study. Two methods were employed in the grinding process. For one set a carborundum stone No. 112 was used, and for the other different grades of carborundum powder in the following order Nos. 200, 400 and 600; the finer powders being used as a finishing method. The use of the powders proved to be more satisfactory as they gave more even surfaces rapidly.

Two procedures were then used before a study of the sections was undertaken. Half of the sections were simply washed and left to dry, while the other half were lightly stained with basic fuchsin. Upon examination the unstained sections were found to have a greater contrast of structure. While those that had been stained could be used in this study, it was found that a marked contrast was lacking.

Upon a microscopic examination of the finished slides it was apparent that there were present definite concentric rings. It was also noticed that all of the rings were not of the same thickness nor of the same distance apart. As to the appearance of these rings, they presented a solid, dense annulation against the lighter body of the bone which contained the numerous lacunae. An examination of all the sections demonstrated that the mandibles did not present as clear a picture of the rings as did the humeri and femurs; they were therefore eliminated from the study.

An attempt was next made to count the rings with the objective in view of correlating their number with the size of the turtle. After a study of each section, checking one with the other, a count of the number of rings was established for each bone. It was found that the smaller turtles, hence probably the younger individuals, had fewer rings per bone than the larger turtles. It was noted, however, that there is not a definite, continuous increase in the number of rings with an increase in size of the individual. It is entirely plausible to postulate that the variation in the number of rings

is due to individual differences in growth. The variation in the distances between the rings can likewise be supposed to be due to different environmental conditions and individual nutrition. A difference in sex is also noticed, the males being smaller than the females as a rule.

From this study it is tenable to correlate the number of rings in the long bones with the age of the turtle. The postulation is that the rings are a result of the temporary cessation of growth during hibernation causing the heavy ossification of the bone tissue on the outside edge of the bone. The next years growth would then be laid down on the outside of this annular ring. The variations resulting in the number of rings can therefore be due to individual physiological differences. Also seasonal differences would be likewise shown in much the same way as in the annular rings of woody plants, trees.

#### SUMMARY

1. A preliminary study of the rings in the long bones of turtles has been made.
2. A correlation of the number of rings in the bones and the size of the turtle has been noted.
3. It has been postulated that the number of rings occurring in the long bones may be used to determine the age of the turtle.

## Modifications Induced in the Plumage of *Passer domesticus* (Linnaeus) by Experimental Hyperthyroidism\*

Dorothea Starbuck Miller

*Knox College, Galesburg, Illinois and University of Iowa, Iowa City, Iowa*

The effect of experimental hyperthyroidism on the plumage of birds has been under investigation over a period of more than twenty years. Moulting, changes in the rate of feather growth, and alterations in feather structure have been reported in a variety of birds. Modifications in the pigmentation of feathers following thyroid administration have been repeatedly described. According to some investigators, the color change is in the direction of loss of pigment, while others find that hyperthyroidism causes increased pigmentation of the plumage. The assumption of female plumage in young males of the domestic fowl fed with thyroid preparations has been described by several investigators. Since Keck found that sexual dimorphism in the plumage of the English sparrow is not controlled by sex hormones, it became of interest to test whether other hormones may produce effects on feather patterns.

The present study was undertaken to examine the possible influence of the thyroid on the pigmentation and sexual dimorphism of sparrow plumage. The effects of hyperthyroidism on regenerating feathers were tested in normal and castrated males and females. In each series, feathers were plucked from selected areas which show definite color patterns. Only one side was deplumed in every case. Since it has been shown that thyroxin administration has no effect on fully developed feathers, the untreated side served as a control. Several days after depluming, thyroxin was administered. In most of the experiments, a water solution of Squibb's crystalline thyroxin was injected into the breast muscle. In two series, Squibb's thyroxin tablets were fed to the birds.

In the first experiment, feathers were plucked from various areas: the crown, side of the head, wing coverts, tail, and wing primaries. Injections were begun three days later. The most striking modifications were produced in the chestnut brown lesser wing coverts of the male sparrow. The regenerated feathers were uniformly slate grey in color, showing no brown coloration. Accordingly, other areas of brown feathers were tested. In every case, the brown feathers were replaced by grey ones.

In order to examine the nature of the pigment modification occurring after thyroxin injection, paraffin sections of feathers from the lesser wing covert of male sparrows were made. The brown melanin granules which crowd the barbs of the normal feather are very sparse in the grey feathers which regenerated after thyroxin administration. The greying of the feather caused by hyperthyroidism is really a loss of brown pigment.

In the next series, a large patch of feathers was plucked from the ventral surface of normal male sparrows. This included a patch of black breast and throat feathers and an area of silver grey belly feathers. The feathers which regenerated after thyroxin injection were all uniformly buffy grey

\* Contributions from Knox College Laboratories No. 49.

in color. The color of the regenerated plumage resembles the female type much more closely than the normal male plumage.

An additional effect of the injections appeared in the birds of this group. In the sparrow, the beak of the male is intensely black during the breeding season. At the close of the breeding season, the beak becomes light horn colored. The beak color has been shown to be a reliable index of testicular activity. In the males injected with thyroxin in the fall and early winter, when the beak is normally light in color, the beak became dark. In those injected in the spring and early summer, the black color of the beak was lost prematurely. It appears that hyperthyroidism accelerates the normal sexual cycle, both at the beginning and at the end of the breeding season.

A series of castrated males and ovariectomized females were deplumed and injected as in the normal series. The capons suffer more severely than the normal males in loss of weight and moulting, but the pigment modifications are less marked. Of the eight injected male castrates, only two regenerated definitely grey feathers in the lesser wing coverts. The others showed some brown pigment, in varying degrees from tan edges on the grey feathers to nearly normal chestnut color.

A series of 15 normal male sparrows was used to determine the threshold of reaction to injected crystalline thyroxin. The chestnut brown feathers of the lesser wing coverts were plucked from the left side. Injections were begun three days after depluming. Doses ranging from .02 mg. to 1 mg. of crystalline thyroxin were given at intervals of three days until each bird had received three injections. Amounts below .1 mg. cause no visible modification in normal pigmentation. A barely noticeable change is produced by .1 mg., while .25 mg. effects a definite color modification. A dose of .75 mg. is required for the complete loss of brown pigment. The threshold of reaction to crystalline thyroxin in the English sparrow is approximately .1 mg. per 25 g. of body weight, or 4 mg. per kg. body weight.

In one group of sparrows, Squibb's .8 mg. thyroxin tablets were fed *per os*. Feathers were plucked from representative areas as in the previous groups. Doses ranged from five to 14 tablets. The effects of this treatment were slight and not constant. Even the birds receiving the highest dosage showed only a slight dilution of the normal color. It is evident that thyroxin is much less potent when fed in tablet form than when injected intramuscularly.

**Conclusions.**—(1) The regenerating plumage of *Passer domesticus* is sensitive to the influence of hyperthyroidism. The most conspicuous modifications in pigmentation occur in the chestnut brown contour feathers of various body regions, and in the black breast feathers. Most of the brown pigment granules which normally color these feathers fail to develop, making the feathers appear slate grey.

(2) The feathers of the light grey belly region of the male, regenerating after thyroxin injection, appear darker than normal.

(3) After thyroxin injection, the regenerating male plumage is modified, at least superficially, in the direction of the female color. The feathers which regenerate in the lesser wing coverts, the breast region, and the belly region resemble the female more than the normal male type. It is possible that the thyroid may be involved in the control of sexual dimorphism in feather pattern.

(4) Capons exhibit more severe general effects than the normal males, but the color of the feathers is modified to a smaller degree.

## Visual Cells of a Nocturnal Animal\*

Margaret S. Pennington

*Knox College, Galesburg, Illinois*

The eyes of a nocturnal animal are of interest morphologically since they show evidences of adjustment to differing environments, also because they show a relative degree of adjustments in different forms.

The retinas of cat, opossum and rat were double embedded in celloidin and paraffin and sectioned at 2, 4, and 6 microns. The usual cytological methods of staining were employed.

The relative number and distribution of the visual cells varies considerably in lower vertebrates. The variation is due to the animal's adjustment to his environment. In birds, the number of cones is much higher than the number of rods. The diurnal reptiles have only cone cells. In nocturnal animals as the bat and mouse, there are only few rudimentary cones present among the rods. Other nocturnal vertebrates such as the shark, ray, certain reptiles, the mole, and monkey have only rod cells.

In the study of the visual cells, first the rods and cones in the retina of the cat, an animal of nocturnal habits, were studied. The cones were flask or cone-shaped, narrowed at the neck, where the fiber apparatus is situated. The rods are comparatively thick and very granular. There are about three to five rod cells to every cone cell in the cat retina. The cat not only requires rod cells for vision in dim lights, but also cone cells for clear vision of details.

In contrast to the cat, the rod cells of the opossum were very much thinner and filamentous. The opossum has no cone cells because it is an animal of nocturnal habits and requires only rod cells for vision in dim lights.

In the prepared slides of the albino rat, only rod cells could be found toward the center of the retina. Further away, a few rudimentary cones were found interspersed with the rod cells. There are only about five or six rod cells to every cone cell. Toward the periphery of the retina, only rod cells were present. The rods were very thin and filamentous while the cones were conical shaped. However, the cones were less conical than those of the cat, tending to lose their flask shape and to be broad at the lower extremity, narrowing at the top.

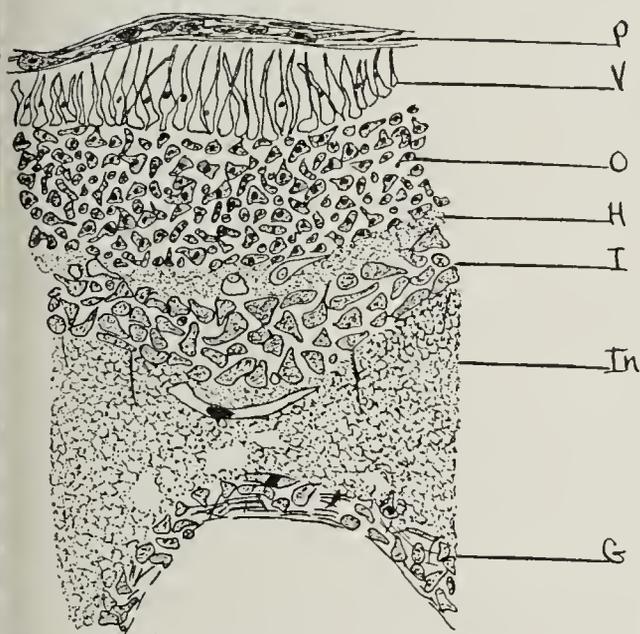


Fig. 1.—Vertical section through rat fovea

- P Pigment epithelium
- V Visual layers, rod and cone cells
- O Outer nuclear layer
- H Henle's fibre layer on outer reticular layer
- I Inner nuclear layer
- In Inner reticular layer
- G Layer of ganglionic cells

\* Contributions from the Biological Laboratories of Knox College No. 50.

In the hooded rat, the cones evidenced more of tendency to be thicker at the bottom gradually becoming thinner toward the top. The cone shape is not entirely lost, but it is not as evident as in the cat. The rods are very thin and filamentous with granules interspersed throughout the cell. There are about seven or eight rod cells to every rudimentary cone cell.

In the fovea of the rat, cone cells are found exclusively. They have the same characteristics as the cone cells found in other portions of the rat's eye. They have a broad base and become narrower at the top. They lack the distinct conical shape of the cat cone cells. There are rod cells appearing toward the periphery of the fovea becoming more and more numerous the further away from the center of the fovea. The nuclear layer of the retina thins out slightly in this region. The nuclei of the granular layer, or Henle's fiber layer, broadens towards the center of the fovea. The reticular layer is decreased almost to nothing. The ganglion layer increases at the periphery of the fovea and decreases to one layer at the center of the fovea.

Conclusion:

In reference to the rat, it was concluded that,

(1) The cones are rudimentary as evidenced by their shape—broad at the base and narrower at the top.

(2) The rod cells are highly developed being very thin and filamentous allowing the light and dark rays to be reflected to a greater degree.

(3) There are approximately five rod cells to every cone cell.

(4) There are rudimentary cone cells exclusively in the fovea. There are only rod cells at the periphery of the retina while both rod and cone cells are interspersed in between them.

# An Illinois Marsh Willow sawfly (*Amauronematus lineatus*) (Hymen., Tenthredinidae)

Herbert H. Ross

*Illinois Natural History Survey, Urbana, Illinois*

In Illinois there are many species of sawflies which feed on the numerous kinds of willows growing along the edges of rivers and streams. Extensive collecting for several years throughout the state indicates that only one of these, namely, *Amauronematus lineatus*, feeds on the willow found in small marsh and temporary pond situations.

The species occurs commonly in the northern two-thirds of Illinois. It is one of the earliest willow insects to begin active feeding. The adults emerge from about the first of April until the first of May. Egg-laying takes place soon after emergence. The eggs are ovoid, deposited in a slit cut in the lower epidermis of the willow leaves by the saw of the female, and appear as whitish pustules. In the laboratory at room temperature the eggs hatch in six or seven days, but in the field they probably require two to four weeks. This estimate is based upon observations of *Dolerus illini* eggs, which are deposited at the same time as those of *A. lineatus* and may require thirty days for incubation. The larvae feed upon the leaf edges and grow rapidly, becoming full grown in about three weeks. They then form a brown cocoon at the base of the willows and are dormant until the following spring. The entire feeding period is over before the middle of June. From an ecological standpoint the species may be regarded as a vernal predominant of the *Salix humilis consocias*.

This sawfly belongs to the subfamily Nematinae which taxonomically speaking is in a state of confusion. It contains several hundred species differing in a large number of morphological characters that can be well shown only by illustrations. This applies equally to both adults and larvae, and yet very few papers dealing with nearctic species of Nematinae are illustrated. For this reason, the species under discussion is here briefly re-described to bring out the diagnostic characters of the larvae and adults. The male has not been definitely associated with the female before, so an allotype of this sex is herein designated.

## AMAURONEMATUS LINEATUS (Harrington)

*Nematus lineatus* Harrington, Can. Ent., vol. 25, no. 3, March, 1893, p. 59, ♀.

*Amauronematus lincolnensis* Rohwer, *ibid*, vol. 41, no. 1, Jan., 1909, p. 19,

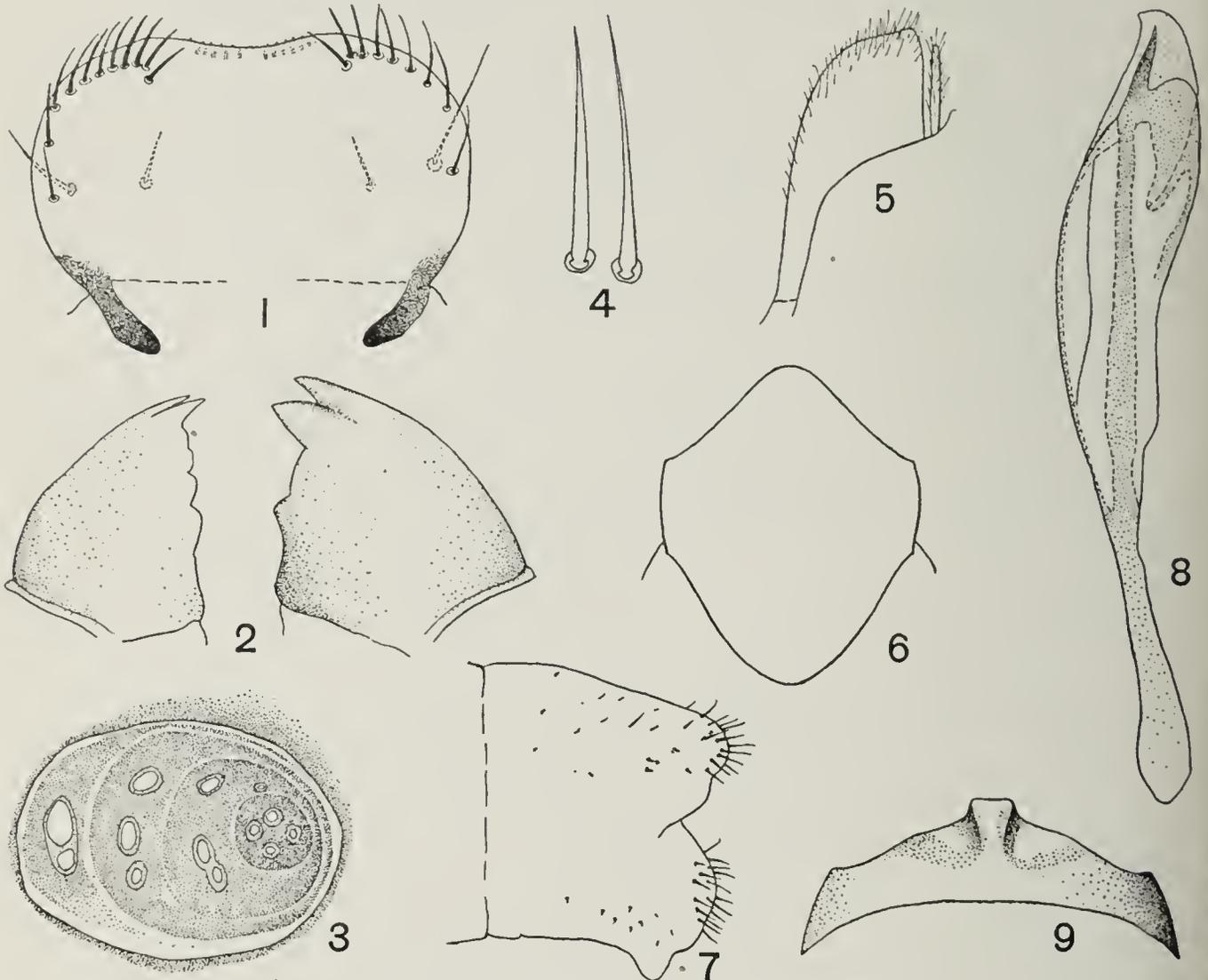
♀. *New synonymy*.

*Female*.—Length 10 mm. Color yellowish brown, with small black areas on dorsum of head and thorax. Dorsum of abdomen with black varying from a narrow, interrupted black line of the meson to an area covering almost the entire dorsum. The species is similar in general appearance to some other species such as *knabi* Rohwer, but may be distinguished from them by the long sheath, fig. 5.

*Male*.—Length 9 mm. Head and thorax almost entirely black, with brown areas around the eyes, antennae and lateral sutures of thorax. Abdomen with dorsum black and venter mottled with yellowish and blackish

brown. Legs pale yellowish brown, the coxae and upper and lower edges of the femora somewhat suffused with darker brown. Genitalia yellow.

Procidentia (fig. 9) clearly defined, tapering towards base, projecting only slightly beyond apex of segment, the apical portion of the segment excavated on each side of the procidentia. Subgenital plate relatively short, its apex rounded when expanded, fig. 6, but in dried specimens often curled at extreme tip so as to appear slightly emarginate. Genitalia typical of the genus; penis valve as in fig. 8.



EXPLANATION OF FIGURES

Morphological characters of *Amauronematus lineatus*:

- Fig. 1.—Epipharynx of larva.  
 2.—Mandibles of larva, dorsal view.  
 3.—Antennae of larva.  
 4.—A larger magnification of apical setae of epipharynx.  
 5.—Sheath of adult female, lateral view.  
 6.—Subgenital plate of adult male.  
 7.—Apical segment of larva, lateral view.  
 8.—Penis valve of adult male, lateral view.  
 9.—Procidentia of adult male, dorsal view.

*Allotype*.—♂; Snyder, Ill., April 14, 1930, coll. Frison and Ross. Deposited in the collection of the Illinois State Natural History Survey.

*Larva*.—Length when mature, 18 mm. Head and body pale green, the body with a fairly wide grayish band down each side above the spiracles. Diagnostic structural characters as follows: Labrum with four long setae and an irregular pattern of pits. Epipharynx, fig. 1, with a row of nine to twelve setae on each side at the apex. Antennae flat, fig. 3, with one incomplete and two complete rings surrounding the small, slightly raised central disc. The arrangement and size of the sensory openings are quite variable, seldom being exactly alike even in the two antennae of the same individual. Segments 4 to 8 of abdomen with 6 annulets. Apical segment rounded, fig. 7, without projections or paired armature.

## Some Interesting Pre-Linnaean Names

Harley Jones Van Cleave

*University of Illinois, Urbana, Illinois*

Even the institutions and the practices with which we are most familiar have usually come into existence by gradual processes of development from simple, scarcely recognizable beginnings. This developmental point of view, so common in our evolutionary considerations of biological phenomena, is often lost sight of when we come to consider certain particular realms of thought and practice in science. In the fields of taxonomy and of nomenclature, we are guided by laws and rules and are influenced by opinions expressed by competent authorities, but to the average zoologist there is little tendency to look behind the rules to seek an understanding of their claim to validity. There is even less disposition to search for their origins.

In general, zoologists are more or less familiar with the International Rules of Zoological Nomenclature, formulated by the International Commission as a series of compromises resulting in the crystalization and codification of the practices which had become established among the various peoples whose biologists had been contributing to the field of taxonomy. Since these International Rules state that the Tenth Edition of Linnaeus' *Systema Naturae* is the work which inaugurated the consistent, general application of binary nomenclature in zoology, most persons fail to look behind this monumental work of 1758 for evidences of the beginnings of the system of naming animals. At least an attitude of tacit acceptance seems to place the system of binomial nomenclature on the level of a miraculous discovery. One does not have to go far in the study of the history of nomenclature to find that this reputed child of Linnaeus' brain did not spring forth as a fully formed concept, perfect in its earliest inception. The mere fact that the *Systema Naturae* underwent ten editions, over a period of twenty-three years, before a "consistent, general application of the binary nomenclature in Zoology" was attained, gives ample evidence of a development from rather imperfect beginnings. With Linnaeus, the system was at first a concept, imperfectly applied, which took years for a genius to perfect. Many would say that even the concept was not original with the great Swedish naturalist.

Without in any manner reflecting on his personal attainments nor on the justly earned high esteem with which his name is revered, I wish to point out a few evidences of procedure and practice common among naturalists before the day of Linnaeus and to call attention to these as a probable basis for the natural development of a system which it happened to be Linnaeus' good fortune to accept and develop. Activity in any field of endeavor is so diversified that historians, looking on the past, can almost always pick out from the broad stream of contributions, minor currents which in retrospect seem to mark the origin of well defined movements. All too often these relations are accidental and not directly causal. Every great discovery when once attributed to an individual has contenders for the honors. Many of the grounds are merely lucky coincidences and too often vague suggestions assume new significance in the light of new discoveries.

Because indistinct mutterings may become oracular pronouncements to willing ears there are dangers of being branded as iconoclastic when one attempts to depict natural origins for well accepted doctrines.

Without attempting to credit or discredit any individual or group of individuals for the distinction of originating the accepted system of zoological nomenclature, there are facts and evidences tending to show a gradual growth of habit and of form in the application of technical names to organisms. Foremost of these is the fact that Latin was the accepted language of culture. Its utilization as the medium for describing and for naming organisms was but a natural following of a fixed custom. The introduction of a distinctive type face for scientific names was apparently a mechanical rather than an intellectual choice.

As early as 1670 we find instances of utilizing Latin names for organisms even when the text was in another language. The writer has discovered an interesting instance in the Philosophical Transactions of the Royal Society of London. In this pioneer journal of colonial times there are many early narratives of American natural history communicated by prominent colonists back to their colleagues at home. One of these narrations finds particular application here for in volume 5 of the Philosophical Transactions (1670, page 1151) is printed an "Extract of a Letter from John Winthrop, Esq. Governor of Connecticut in New England, to the Editor, concerning some Natural Curiosities of those Parts, especially a strange and curious Fish, sent for the Repository of the R. S." The object of this letter was a basket-star found off the New England coast. Governor Winthrop gave a most thorough though zoologically imperfect description of the animal in English but when he assayed to name it he fell into the Latin as shown in the following quotation: "The fish, as yet nameless, we may call *Piscis Echinostellaris Visciformis*; its body resembling an echinus or egg-fish, the main branches a star, and the dividing of the branches, the plant mistle-toe." The descriptive phrase applied to this animal is just as formal and distinctive a name as many of the earlier names of Linnaeus before he adopted and developed the system of binomial designation.

It is not surprising that out of beginnings such as the foregoing, in common usage, the descriptive words used to designate animals should come to have more definite meaning and form. At least a crudely parallel instance had previously become established before this time in the combination of surname and Christian name for designating human individuals.

Many of Linnaeus' early names were no more regular in formation than Governor Winthrop's formal descriptive name for the basket-star. As one instance we may cite the fact that in the sixth edition of the *Systema Naturae* (1748) the golden pheasant instead of a binomial name bore the descriptive phrase *Phasinus crista flava, pectore coccineo*. A less striking transformation came in the name of the nine banded armadillo. In the tenth edition this has the truly binomial form *Dasypus novemcinctus* though ten years earlier it bore the descriptive phrase *Dasypus cingulis novem* in the sixth edition.

One of the most difficult things in the realm of nomenclature is the reading of motives into the cold, formal scientific names given by the early authors. Many names which have strictly binomial form seem to be accidental, yet out of accidents such as these nomenclature had its probable origin. In one of the ancient books which I happen to own, Daniel Le Clerc has given a number of name forms which would look well in the tenth edition of Linnaeus but which cannot by any stretch of the imagination be regarded as truly generic and specific names. They seem so very distinctly modern that only the date 1715 on the title page warns one of their

invalidity. Under the centered caption LUMBRICUS LATUS is described a human parasite (page 37) which had been rather frequently mentioned in the older literature under this same name at least back to the year 1609. Though perfect in form this name has no standing because of the canon which rules that binomial nomenclature reached its consistent general application in 1758.

Instances of this type have particular significance as examples of the ruthless way in which Linnaeus misapplied classical names and names in general use since antiquity. Le Clerc followed an ancient usage when he used the name Lumbricus for a tapeworm while Linnaeus for some unknown reason in this as in many other cases used a well authenticated name in a wholly new meaning. Following Linnaeus' error we today continue to use the name Lumbricus as the generic designation of one of the common European earthworms.

In the same book mentioned above Le Clerc (1715) described a tapeworm from cats and dogs (page 212) under the name Taenia canina. He utilized these two words as a centered heading above his description, sharply setting them off in capitals from the descriptive phrase which followed: TAENIA CANINA, *aliquae Canum & Felium Vermes*.

Forty-three years later Linnaeus gave this same name, without change, and thereby rendered it a valid generic and specific designation. More recently this species has been transferred to the genus Dipylidium.

The instances of pre-Linnaean names here cited are not unique. They are examples of hundreds of others cited and discussed in the literature on nomenclature. Every branch of zoology has its classical instances that give endless opportunity for speculation as to the true origin and meaning of binomial nomenclature. C. W. Stiles in his prolific writings and Leonhard Stejneger in his interesting article entitled "A chapter in the history of zoological nomenclature" (1924) have cited numerous instances of names apparently in good form antedating the period of Linnaeus. Some authors go so far as to say that Tournefort and other predecessors of Linnaeus originated the use of the generic name and the generic concept as we now use and understand them. Without taking sides in this discussion as to priority, the writer has attempted to show some of the evidence as to how common, natural usage grew into a system for which Linnaeus is generally and justly accredited as the founder and developer.

## The Destruction of Bird Life by Hail

John D. Mizelle

University of Illinois, Urbana, Illinois

On Thursday, April 20, 1933, a hailstorm of considerable severity passed through the city of Baton Rouge, Louisiana. Hailstones fell at the Louisiana State University from 8:30 to 8:50 p. m. The hail completely covered the ground, making a field of white that showed up plainly during the intermittent flashes of lightning. From reports made to the Department of Zoology, the path of the storm was estimated to be 50 miles long and 25 miles wide. The intensity of the storm varied in different parts of the area, suggesting alternate light and heavy streaks; Baton Rouge was in the center of one of the heavily beaten areas. The size of the hailstones ranged from that of an average-sized marble to that of a golf ball. Dr. R. J. Russel of the Department of Geology recorded maximum sizes of one and one-half inches in diameter.

One of the significant points about the storm was the simple construction of the hailstones. Ordinarily hail is made up of alternate concentric rings of hard and soft ice, with hard ice at the center. Specimens from this storm contained less than the average number of rings which were of more than average thickness. This construction accounted for the marked softness of the ice and the readiness with which it melted.

Birds in the path of the storm without shelter were either beaten to death or hopelessly crippled. The following casualties were recorded in the vicinity of the university campus:

Scarlet tanagers, <i>Piranga erythromelas</i> (males).....	27
Cow birds, <i>Molothrus ater ater</i> .....	3
Mocking birds, <i>Mimus polyglottis polyglottis</i> .....	6
Towhees, <i>Pipilo erythrophthalmus erythrophthalmus</i> .....	1
English sparrows, <i>Passer domesticus domesticus</i> .....	7
Cardinals, <i>Cardinalis cardinalis cardinalis</i> .....	3
Woodthrushes, <i>Hylocichla mustelina</i> .....	1
Rose-breasted grosbeaks, <i>Zeleloidea ludoviciana</i> .....	1
Meadow larks, <i>Sturnella magna magna</i> .....	6
Black-billed cuckoos, <i>Coccyzus erythrophthalmus</i> .....	3
Red-wing blackbirds, <i>Agelaius phoeniceus phoeniceus</i> .....	3
Red-eyed vireos, <i>Vireosylva olivacea</i> .....	1
Indigo bunting, <i>Passerina cyanae</i> .....	1

Had detailed study been made, the above number of birds affected would have been much greater. As shown by the table a number of scarlet tanagers were taken. These birds are seldom found in this region except when they light to feed during their migratory flight. Other significant points were the presence of the black-billed cuckoo (the first record for this locality), and the rose-breasted grosbeak.

Two men while training a pointer, found twenty-five quail on a five-acre plot of ground near Istrouma, a small town on the outskirts of Baton Rouge. The dead and crippled birds in such a small area furnishes an index to the possible number of birds killed in the thousand square miles covered.

This is the heaviest hail storm known in Baton Rouge in the last fifty years, and although destructive in nature it has permitted collection of valuable scientific information and provides one example of how the balance of nature is accomplished.

## A New Species of *Zanclophorus* From *Cryptobranchus alleganiensis*\*

A. C. Walton

*Knox College, Galesburg, Illinois*

Through the courtesy of Dr. C. G. Huff of the University of Chicago, material of an intestinal parasite from *Cryptobranchus alleganiensis* has been placed at my disposal for study and description. Both male and female specimens are present in the collection and afford the basis for establishing a new species of the genus *Zanclophorus* and also furnish a second record of the occurrence of this genus in an amphibian host. As in the case of *Zanclophorus cryptobranchi*, these specimens are much smaller than are the species recorded from reptilian hosts, but they show the characteristic well-defined three lips which are bordered internally by a chitinous band and which have the lateral margins of the adjacent lips supported by curved cuticular plates. Each lip bears two prominent papillae. The vestibule is prominent and is heavily cuticularized. The cylindrical esophagus ends in a double bulb, the posterior portion of which is greatly enlarged and provided with cutting plates. The cardia are also cuticularized. The tail of the male (Fig. 7) shows five pairs of post-anal papillae; two lateral and three sub-ventral in position. There are also two pairs of ad-anal and three pairs of pre-anal papillae in addition to a single median pre-cloacal papillus. A pre-anal sucker and well-developed ventral muscle bands are also found. The spicules are sub-equal, slender, and slightly flanged. The accessory piece is well-defined, although but poorly cuticularized. The vulva in the female opens in the posterior fourth of the body. The opposed uteri contain 1- to 2-celled embryos; this form like the other species from *Cryptobranchus* being apparently oviparous.

The average measurements are as follows:

*Male*:—Body length, 6-7 mm.; greatest thickness, 0.25-0.28 mm.; length of vestibule, 0.115-0.125 mm.; length of esophagus, 1.15-1.22 mm.; diameter of anterior bulb, 0.175-0.182 mm.; measurements of posterior bulb, 0.165-0.17 mm. by 0.185-0.195 mm.; nerve-ring, 0.45-0.48 mm. from the lips; excretory pore, 0.85-0.95 mm. from the lips; cloacal-tail distance, 0.35-0.4 mm.; sucker-cloacal distance, 1.15-1.22 mm.; spicule measurement, 0.75-0.76 mm.; accessory piece length, 0.08-0.082 mm.

*Female*:—Body length, 7-8 mm.; thickness at vulva, 0.3-0.32 mm.; length of vestibule, 0.12-0.125 mm.; length of esophagus, 1.2-1.22 mm.; diameter of anterior bulb, 0.16-0.17 mm.; measurements of posterior bulb, 0.175-0.18 mm. by 0.19-0.2 mm.; nerve-ring, 0.52-0.55 mm. from the lips; excretory pore, 0.92-0.945 mm. from the lips; vulva-anus distance, 1.8-2 mm.; anus-tail distance, 0.36-0.42 mm.; segmenting ova measure 0.06 mm. by 0.12 mm. as they enter the ovejector.

The general characteristics are such as to place these forms in the genus *Zanclophorus*. While the size and relative position of the various structures separate them from the other species of the genus, the most striking characteristic is that of the variability of the cuticular plates which support the lips. The usual position of these plates is along the adjoining margins of the lips in the form of "U-shaped" structures (Figs. 1a, 1b). Some of the specimens show considerable variance from this plan of struc-

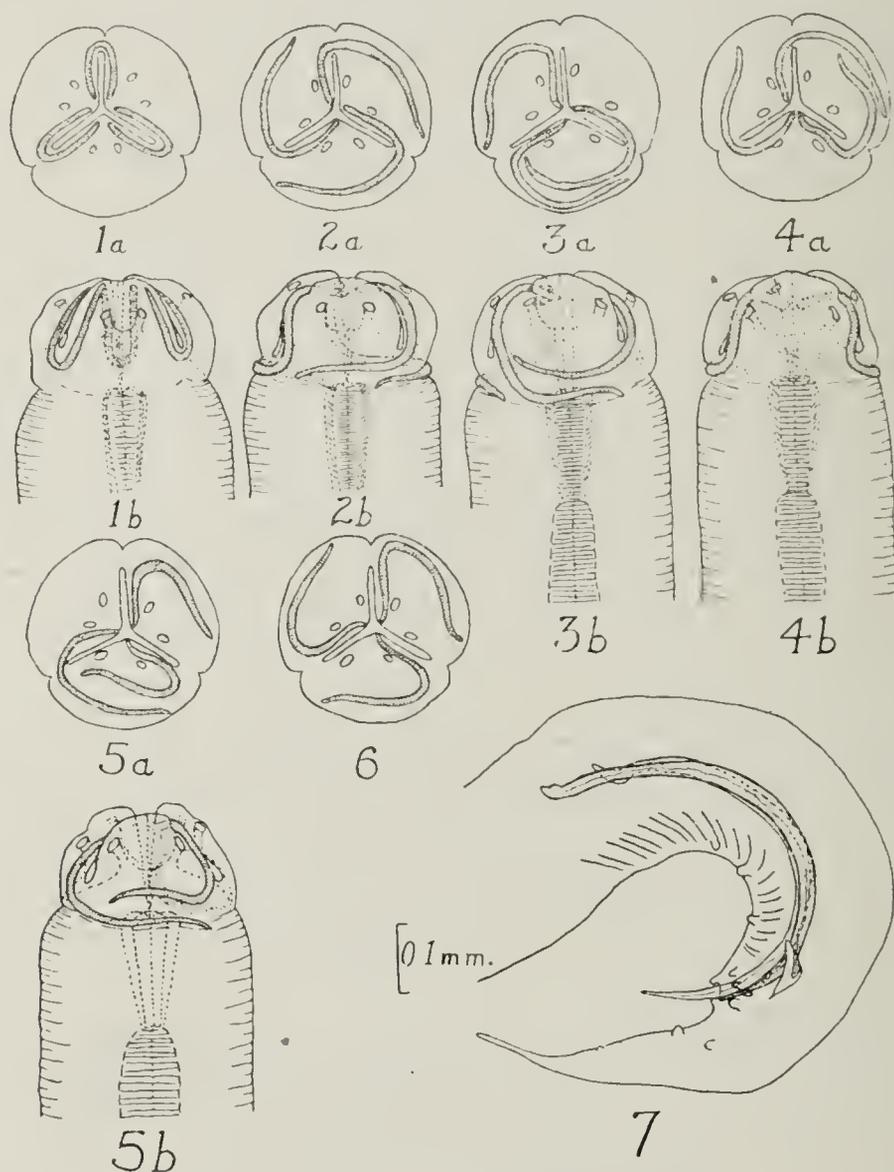
\* Contributions from the Biological Laboratories of Knox College No. 51.

ture (Figs. 2a, 2b, 3a, 3b, 4a, 4b, 5a, 5b, 6), the "U-shape" giving way to a number of other forms, usually because one of the legs of the "U" fails to curve up the side of the adjacent lip. Sometimes the variation is symmetrical either to the right or to the left. In other cases the lips show asymmetrical placing of the plates. In all of these variations there is a support along the base of at least two of the lips somewhat similar to the one found in *Spironoura cryptobranchi*. It seems that this form is showing definite transitional stages between the basal bar of the lips of some *Spironourids* and the "U-shaped" lateral bars of the lips of *Zanclophorus cryptobranchi*, thus affording another link connecting these two genera of the Family Kathlaniidae.

Because of this striking variability, the species is named *Zanclophorus variabilis* n. sp.

The type host is *Cryptobranchus alleganiensis*.

The type material is in the Helminthological Collection of the U. S. National Museum.



EXPLANATION OF FIGURES

Figs. 1a, 2a, 3a, 4a, 5a, 6. *Zanclophorus variabilis*. End views of heads of different specimens showing variations in the arrangement of the cuticular lip supports.

Figs. 1b, 2b, 3b, 4b, 5b. Lateral views of same heads shown in 1a, 2a, 3a, 4a, 5a.

Fig. 7. *Zanclophorus variabilis*. Lateral view of tail of male.

#### LITERATURE CITED

- WALTON, A. C. 1930. Studies on some Nematodes of North American Amphibia. II. Cryptobranchidae. Jour. Parasitol., 17(1): 20-24, 6 figs.  
 ———— 1933. The Nematodes as Parasites of Amphibia. I. Jour. Parasitol., 20(1): 1-32, 1 pl.

STATE OF ILLINOIS  
HENRY HORNER, Governor

TRANSACTIONS  
OF THE  
ILLINOIS STATE  
ACADEMY OF SCIENCE

VOLUME 28

MARCH, 1936

NUMBER 3

Announcement

Twenty-ninth Annual Meeting

Officers and Committees, General Program

Section Meetings, Junior Section

General Information



Friday and Saturday, May 1-2, 1936

QUINCY, ILLINOIS

PUBLISHED BY THE ACADEMY  
AFFILIATED WITH THE STATE MUSEUM DIVISION  
DEPARTMENT OF REGISTRATION AND EDUCATION  
CENTENNIAL BLDG., SPRINGFIELD, ILL.

PUBLISHED QUARTERLY

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

## OFFICERS AND COMMITTEES

1935-1936

*President*, CHARLES D. SNELLER, M. D., 320 Jefferson Bldg., Peoria  
*First Vice-President*, C. L. FURROW, Knox College, Galesburg  
*Second Vice-President*, O. D. THURBER, Quincy High School, Quincy  
*Secretary*, WILBUR M. LUCE, University of Illinois, Urbana  
*Treasurer*, GEORGE D. FULLER, University of Chicago, Chicago  
*Librarian*, A. S. COGGESHALL, State Museum, Springfield  
*Editor*, DOROTHY E. ROSE, State Geological Survey, Urbana

*The Council* is composed of the President, the two Vice-Presidents, the Secretary, the Treasurer, the Librarian, the last two retiring Presidents and the retiring Secretary.

### *Committee on Conservation:*

T. H. FRISON, University of Illinois, Urbana, *Chairman*  
HENRY C. COWLES, University of Chicago, Chicago  
M. M. LEIGHTON, State Geological Survey, Urbana  
W. H. HAAS, Northwestern University, Evanston  
JENS JENSEN, Ravinia  
PAUL HOUDEK, 710 N. Gross Street, Robinson  
BRUCE W. MERWIN, Southern Illinois State Teachers College, Carbondale  
R. S. SMITH, University of Illinois, Urbana  
H. J. VAN CLEAVE, University of Illinois, Urbana

### *Committee on Ecological Survey:*

A. G. VESTAL, University of Illinois, Urbana, *Chairman*  
ORLANDO PARK, 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, Southern Illinois State Teachers College, Carbondale  
GEORGE D. FULLER, University of Chicago, Chicago

### *Committee on Legislation and Finance:*

DON CARROLL, State Geological Survey, Urbana, *Chairman*  
W. A. NOYES, University of Illinois, Urbana  
MARY M. STEAGALL, Southern Illinois State Teachers College, Carbondale  
EDSON S. BASTIN, University of Chicago, Chicago  
JOHN R. NEAL, M. D., 609 S. Walnut, Springfield

### *Committee on Affiliation:*

CLARENCE BONNELL, Harrisburg Township High School, Harrisburg, *Chairman*  
H. H. RADCLIFF, 1346 W. Macon Street, Decatur  
ROSALIE M. PARR, University of Illinois, Urbana  
MARY M. STEAGALL, Southern Illinois State Teachers College, Carbondale  
H. O. LATHROP, Normal University, Normal

### *Committee on Membership:*

JOHN VOSS, Manual Training High School, Peoria, *Chairman*  
A. H. SUTTON, University of Illinois, Urbana  
L. I. BOCKSTAHLER, Northwestern University, Evanston  
FATHER GEORGE M. LINK, 524 E. Lawrence Avenue, Springfield  
O. D. THURBER, Quincy High School, Quincy

*Committee on High School Science and Clubs:*

- MABLE SPENCER, Granite City High School, Granite City, *Chairman*  
ROSALIE M. PARR AND LYELL J. THOMAS, University of Illinois, Urbana,  
*Advisory Committee*  
LOUIS A. ASTELL, University High School, Urbana, *Editor and Radio Service*  
ROSE M. CASSIDY, Maine Township High School, Des Plaines, and HARRY L.  
ADAMS, Bloomington High School, Bloomington, *Co-chairmen in Charge*  
*of Competition*  
ROBERT EVERS, Quincy High School, Quincy, and GEORGE ROGERS, Student  
Quincy High School, Quincy, *Local Arrangements*

*Delegate to the American Association for the Advancement of Science:*

- 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, APRIL 30, 1936

- 8:30 p. m. Meeting of the Council (*Lincoln-Douglas Hotel*).

FRIDAY, MAY 1, 1936

QUINCY SENIOR HIGH SCHOOL, QUINCY, ILLINOIS

- 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 (*Lobby of the First Floor Corridor*).
- 9:00 a. m. Meeting of the Council with local committee and delegates from affiliated societies (*Room 215*).
- 9:30 a. m. Preliminary business meeting of the Academy. Appointment of committees on nominations, resolutions, and auditing (*Room 215*).

GENERAL SESSION, HIGH SCHOOL AUDITORIUM

- 8:00 a. m. *Address of Welcome*, MIKE FINN, Secretary of the Quincy Chamber of Commerce, Quincy, Illinois.  
*Presidential Address*, PRESIDENT CHARLES D. SNELLER, M. D., Peoria, Illinois.  
*Address*: DR. T. E. MUSSELMAN, Gem City Business College, Quincy, Illinois.
- 9:00 a. m. *Geography Symposium on the Tropics*  
DR. W. H. HAAS, Northwestern University, Evanston.  
DR. ROBERT S. PLATT, University of Chicago, Chicago.  
DR. W. O. BLANCHARD, University of Illinois, Urbana.
- 12:00-1:00 p. m. Luncheon, First Christian Church, one-half block east of the High School. Price 45 cents.
- 2:30 p. m. *Section Meetings*. Election of Chairman for 1936-37; papers; demonstrations and discussions.
- 7:00 p. m. *Annual Banquet* (Informal), Congregational Church, one block west of the High School. Reservations should be made in advance. Use the card sent out with this program. Secure tickets at the registration desk at the time of registration, 60 cents per plate.
- 8:45 p. m. *Address of Greeting*, W. E. NELSON, Superintendent of Schools, Quincy.  
*Annual Public Lecture*, *High School Auditorium*, DR. ANDREW CONWAY IVY, Head, Department of Physiology and Pharmacology, Medical School, Northwestern University, Chicago.

## SATURDAY, MAY 2, 1936

8:00 a. m. Meeting of the new Council (Room 215, Quincy High School).

9:00 a. m. Inspection trips leave from the 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 trip will be under the auspices of the State Geological Survey. Dr. M. M. Leighton, Chief of the State Geological Survey, and Dr. George E. Ekblaw will be in charge with Father Callistus Bifoss of Quincy College in charge of local arrangements. Outcrops and relations of Peorian and late Sangamon loesses, which are especially thick and unusually coarse grained along the Mississippi River bluffs, Early Sangamon soil, Illinois glacial drift, Yarmouth soil and Kansan glacial drift of the Pleistocene system; of the Warsaw, Keokuk, and Burlington formations of the Osage group; and, if time permits, of some of the upper formations of the Kinderhook group will be examined and studied. Special attention will be given to the chert in the Osage group, complementing with field observations the topic of chertification as discussed in the symposium of the Geology Section on Friday Afternoon. Participants should wear clothes and shoes suitable for hiking and should provide their own lunches.

*Industrial Trip*—Mike Finn, Secretary of the Quincy Chamber of Commerce will aid the local committee in making arrangements for this trip. The Gardner Denver Governor Works, The Excelsior Stove Co., Menke Stone and Lime Quarry, Moorman Manufacturing Co., and The Strawboard are plants which will be visited as time permits.

*Biological Trip*—Dr. T. E. Musselman, widely known naturalist, and Robert Evers of the Biology Department of Quincy High School are in charge of local arrangements for this trip.

*Anthropological Trip*—Louis Daerr, Jr. of Quincy and O. D. Thurber of the Biology Department of Quincy High School are in charge of local arrangements. Typical burial mounds of the area will be open for inspection and a burial ground of vault graves of a new type for Illinois will be visited.

Complete details of the Field Trips will be announced in the final program.

## PROGRAM OF SECTION MEETINGS

FRIDAY, MAY 1—1:30 P. M.

### AGRICULTURE

Room 232

J. R. HOLBERT, U. S. Dept. of Agriculture, Bloomington, *Chairman*

Election of Chairman for the year 1936-37.

Program to be announced.

### ANTHROPOLOGY

Room 118-24

J. B. RUYLE, D. D. S., Champaign, *Chairman*

Election of Chairman for 1936-37.

1. Some Anthropological Aspects of Western Illinois—O. D. THURBER, Senior High School, Quincy.
2. Mound Builders of Western Illinois—CLARENCE F. WILLIAMS, Pittsfield.
3. The Evolution of the Mouth—L. H. WOLFE, D. D. S., Quincy.
4. Basic Cultures of Peoria County—A. M. SIMPSON, Peoria (lantern).
5. Evidence of Woodland Culture at Mossville in Peoria County—F. L. BARLOGA, Peoria (lantern).
6. The Teeth and Bones of the Mound Builders as Related to Their Diet—JOHN B. RUYLE, University of Illinois, Urbana.
7. Rock Carvings in Southern Illinois—BRUCE MERWIN, Southern Illinois State Normal University, Carbondale.

3. Archaeology of Western Kentucky—FAIN W. KING, Research Archeologist, University of Chicago, Wickliffe, Kentucky (lantern).
4. Tree Rings as a Chronological Method of Determining the Age of Mounds—KENNETH L. KNIGHT, Illinois State Normal University, Normal.
5. Indian Camp Sites Along the Mackinaw River in McLean County—W. C. HUDDLESTON, Illinois State Normal University, Normal.
6. A Cache of Unusual Flint Blades—FRANK W. ALDRICH, Bloomington.
7. The Evolution of the Bannerstone—BRYON KNOBLOCK, LaGrange (lantern).
8. Anthropology of the Lake Michigan Region—WARREN C. VAN MALE, Waukegan.
9. Variations and Changes in Measurements in the Flattening of the Skull—JOHN F. BARRETT, University of Illinois, Urbana.

## BOTANY

Room 332

HARRY W. GIVENS, Department of Biology, Joliet Township High School and Junior College, Joliet, *Chairman*

lection of Chairman for the year 1936-37.

1. Response of Some Sensitive Stigmas—HARRY J. FULLER, University of Illinois, Urbana (20 minutes).
2. An Interesting Preservation of Color in the Red Algae and Certain Fungi—E. L. STOVER, Eastern State Teachers College, Charleston (10 minutes).
3. A Demonstration (microprojection) of the Lily-type Embryosac as Redescribed by D. C. Cooper—E. L. STOVER, Eastern Illinois State Teachers College, Charleston (15 minutes).
4. Reduction in Number of Trees in Maturing Pine Forest—LEWIS N. TURNER, University of Arkansas, Fayetteville, Arkansas (To be read by title).
5. Barrens Vegetation in Illinois—A. G. VESTAL, University of Illinois, Urbana (20 minutes).
6. Bryophytes—GLADYS C. GALLIGAR, James Millikin University, Decatur (10 minutes).
7. Was there an Outbreak of Bacterial Wilt of Corn in Central Illinois in 1891 and 1892?—NEIL E. STEVENS, University of Illinois, Urbana (20 minutes).
8. Comparative Study of Illinois Bogs on Cary and Tazewell Drifts—JOHN VOSS, Peoria High School, Peoria (10 minutes).
9. Floral Zones of Southern Mexico—A. C. NoÉ, University of Chicago, Chicago. (10 minutes).
10. The Unit of Instruction in General Botany—JEROME ISENBARGER, Wright Junior City College, Chicago (30 minutes).
11. Sample Plot Statistics in the University Woods—JOHN D. MEES, W. M. MARBERRY, AND A. G. VESTAL, University of Illinois, Urbana (12 minutes, lantern).

## CHEMISTRY

Room 419

J. H. REEDY, University of Illinois, Urbana, *Chairman*

lection of Chairman for 1936-37.

On account of the number of papers offered, this program will be given in two sections. There will be a brief intermission between papers for discussion. During this time visitors may change rooms if they so desire.

### SECTION A

1. The Chemical Mineral Resources of Southern Illinois—J. W. NECKERS, Southern Illinois State Normal University, Carbondale.
2. New Analytical Reagents (demonstration)—G. F. SMITH, University of Illinois, Urbana.
3. The Application of Chemical Research to the Problems of the Illinois Mineral Industry—F. H. REED, Illinois State Geological Survey, Urbana.

4. The Effects on Corn and Wheat Gels Produced by Pretreating the Starches with Freezing and with Chemical Reagents—SYBIL WOODWORTH AND MAJEL M. McMASTERS, Department of Home Economics, University of Illinois, Urbana.
5. Some Anomalous Properties of Organic Fluorine Compounds—G. C. FINGER AND F. H. REED, Illinois State Geological Survey, Urbana.
6. Photography as a High School Course—J. H. SAMMIS, Peoria High School, Peoria.
7. An Improved Apparatus for the Demonstration of the Fixation of Atmospheric Nitrogen (demonstration)—W. S. HALDEMAN, Monmouth College, Monmouth.
8. Some Interesting Methods of Balancing Equations—C. W. BENNETT, Western Illinois State Teachers College, Macomb.
9. (Title to be Announced)—W. F. BAILEY, MacMurray College, Jacksonville.
10. (Title to be Announced)—H. S. LITTLEPAGE, Victoria Consolidated Schools, Victoria.
11. Why High School Chemistry?—R. L. FRISBIE, Joliet High School, Joliet.
12. The Effect of Lactose Upon the Deposition of Calcium, Phosphorus and Magnesium in the Body—S. I. TWOMEY, J. SMITH, M. HATHAWAY AND J. OUTHOUSE, Department of Home Economics, University of Illinois, Urbana.
13. Corrosion Characteristics of  $\text{SiO}_2\text{-Al}_2\text{O}_3\text{-CaO-MgO}$  Glasses—CHARLES F. FRYLING AND FAY V. TOOLEY, Illinois State Geological Survey, Urbana.

## SECTION B

1. Some Recent Models of the Periodic Table—B. S. HOPKINS, University of Illinois, Urbana.
2. Presentation, Correlation and Demonstration in Laboratory Work—CARL E. SCHILZ, Lincoln College, Lincoln.
3. Chemistry in Highway Construction—F. A. DYKINS, State Highway Laboratory, Springfield.
4. Cold Light (demonstration)—L. F. AUDRIETH, University of Illinois, Urbana.
5. The Coal Testing Laboratory as Related to the Modern Coal Industry—O. W. REES, Illinois State Geological Survey, Urbana.
6. The Position of Organic Chemistry in a General Chemistry Course—JULIUS J. GOUZA, Edwardsville High School, Edwardsville.
7. Titanium Dioxide-Hydrogen Peroxide Compounds—D. G. NICHOLSON, University of Illinois, Urbana.
8. Present and Future Energy Sources—H. E. PHIPPE, Eastern Illinois State Teachers College, Charleston.
9. Place of Projects in High School Chemistry—MAX E. WOODWORTH, Pittsfield High School, Pittsfield.
10. Putting Thrills Into Laboratory Experiments—EVERETT S. ANDERSON, Quincy High School, Quincy.
11. Some Home-made Laboratory Apparatus Used in Elementary Chemistry—H. P. LEIGHLY, Rantoul High School, Rantoul.
12. Acid Catalysis in Liquid Ammonia—CHAS. SLOBUTSKY AND L. F. AUDRIETH, University of Illinois, Urbana.
13. The Application of Modern Valence Ideas to the Teaching of Chemistry—JOHN DEVRIES, Knox College, Galesburg.

## ECONOMICS

No program has been planned for this section for the 1936 meeting.

## GEOGRAPHY

Room 417

FLEMIN W. COX, Southern Illinois State Teachers College,  
Carbondale, Illinois, *Chairman*

lection of Chairman for 1936-37.

- Alaska, Unique Adjustments Yet Unsung—CLIFTON C. AID, Morton Junior College, Cicero.
- Geography of The Foochow Basin—LIN KWAN-TE, Northwestern University, Evanston.
- Some Trends in Illinois Agriculture and Their Geographical Significance—W. O. BLANCHARD, University of Illinois, Urbana.
- A Study of Results in Geography Teaching—LINA WEBB, Benton High School, Benton.
- An Atlas of the Geography of Illinois—WALTER H. VOSKUIL, State Geological Survey, Urbana.
- Human Geography in Relation to the Zonation of Vegetation in the San Francisco Mountain Region—H. O. LATHROP, Illinois State Normal University, Normal.
- Gardening in Fairbanks, Alaska—EDNA M. GUEFFROY, Illinois State Normal University, Normal.
- Answer to the Artical Entitled, "Geography the Forgotten High School Subject"—CLARE SYMONDS, Quincy High School, Quincy.
- Geographic Aspects of Meat Production—EMILIE HUCK, New Baden High School, New Baden.
- Population Pressure in Puerto Rico—WM. H. HAAS, Northwestern University, Evanston (lantern).
- Maps Showing Fruit Distribution in Illinois—RALPH S. HARRIS, Westport Senior High School, Kansas City, Missouri.
- Bloomington Under the Geographic Microscope—MARGARET MEANS, Bloomington High School, Bloomington.
- The Relation of Dams and Reservoirs to Water Supply of Southwestern California—RICHARD H. JAHNS, Northwestern University, Evanston (lantern).
- The Influence of Lake Michigan Upon the Climate of Illinois—W. E. POWERS, Northwestern University, Evanston (lantern).
- Exceptional Weather Phenomena of Recent Years—HAROLD B. WARD, Northwestern University, Evanston.

## GEOLOGY

Room 314

HAROLD R. WANLESS, Department of Geology, University of Illinois,  
Urbana, *Chairman*

lection of Chairman for 1936-37.

- A Pleistocene Bog Deposit and the Fossil Fauna Recovered from it—E. S. RIGGS, Field Museum, Chicago (15 minutes).
- Volcanic Phenomena in the Craters of the Moon, Idaho—G. FREDERICK SHEPHERD, Museum of Science and Industry, Chicago (10 minutes).
- The Stratigraphy and Structure of the Mississippian System of the Quincy Region—GEORGE E. EKBLAW, Illinois State Geological Survey, Urbana (10 minutes).
- The Glacial Geology of the Quincy Region—M. M. LEIGHTON, State Geological Survey, Urbana (10 minutes).
- Subsurface Geology of the Quincy Region—L. E. WORKMAN, State Geological Survey, Urbana (10 minutes).
- Economic Utilization of the Burlington Formation in the Quincy Area—J. E. LAMAR, State Geological Survey, Urbana (10 minutes).
- Progress of Geologic Mapping in Illinois, 1844-1936—J. MARVIN WELLER, State Geological Survey, Urbana (10 minutes).
- Present Status of Classification of Illinois Coal with Respect to Operation of the Guffey Bill—GILBERT H. CADY, State Geological Survey, Urbana (10 minutes).

9. Local Appearance of Harrisburg Coal on the Duquoin Anticline at Duquoin—E. T. BENSON, State Geological Survey, Urbana (10 minutes).
10. Coal Balls from the Clarson Mine at Nashville, Illinois:
  - (1) Occurrence—G. H. CADY, State Geological Survey, Urbana (10 minutes).
  - (2) Preservation of Plant Tissues—J. M. SCHOPF, State Geological Survey, Urbana (10 minutes).
12. Separation and Concentration of Vitrain, Clarain, and Fusain in Illinois Coal—C. C. BOLEY AND L. C. McCABE, State Geological Survey, Urbana (10 minutes).
13. Origin of Chert—CHARLES H. BEHRE, JR., Northwestern University, Evanston (5 minutes).
14. Discussion of Origin of Chert—L. E. WORKMAN, G. E. EKBLAW, State Geological Survey, and others (5 minutes).
15. The Study of a Remarkable Meteor—A. J. JAMES, Houston, Texas (10 minutes).
16. Heavy Minerals and Marine Sediments Off the Middle Atlantic Coast—G. V. COHEE, University of Illinois, Urbana (10 minutes).
17. A Collecting Trip Into the Jurassic of Southern Mexico in 1935—A. C. NOÉ, University of Chicago, Illinois State Geological Survey, Chicago (10 minutes).
18. New Neppeline Syenites from French River, Ontario—T. T. QUIRKE, University of Illinois, Urbana (10 minutes).
19. A New Means of Demonstrating Optical Figures—T. T. QUIRKE, University of Illinois, Urbana (10 minutes).

## MEDICINE AND PUBLIC HEALTH

F. W. TANNER, Department of Bacteriology, University of Illinois,  
Urbana, *Chairman*

No program has been planned for this section for the 1936 meeting.

## PHYSICS

Room 416

OTIS B. YOUNG, Department of Physics, Southern Illinois State Normal  
University, Carbondale, *Chairman*

Election of Chairman for the year 1936-37.

1. Laboratory Switch Board of Low Cost—CLARENCE R. SMITH, Aurora College, Aurora.
2. Does the Crystal Structure of Solid Single Crystal Bismuth Exist After the Bismuth Crystal is Melted?—J. HENRY SCHROEDER, Southern Illinois State Normal University, Carbondale.
3. A Cold Cathode Rectifier (demonstration)—CHAS. T. KNIPP, University of Illinois, Urbana.
4. Origin of Positive Rays in a Cathode-ray Discharge Tube Having a Hollow Cathode (demonstration)—CHAS. T. KNIPP AND JAMES E. HOLCOMB, University of Illinois, Urbana.
5. Merits of a National Radio Fraternity in a Non-technical College—OTIS B. YOUNG, Southern Illinois State Normal University, Carbondale.
6. The Gravitational Constant (experimental)—F. M. McCLENDON, Monmouth College, Monmouth.
7. Heat Insulation—F. M. McCLENDON, Monmouth College, Monmouth.
8. The Paradox in Beginning College Physics—OTIS B. YOUNG, Southern Illinois State Normal University, Carbondale.
9. Electrical Discharge Phenomena in Insulation Under High Continuous Potentials—H. A. BROWN AND E. B. PAINE, University of Illinois, Urbana.
10. Flexural Vibrations of Piezoelectric of Quartz Rods—J. T. TYKOCINER AND M. W. WOODRUFF, University of Illinois, Urbana.
11. Electronic Devices for the Observation of Circuit and Line Transients—H. J. REICH, University of Illinois, Urbana.

# PHYSIOLOGY AND EDUCATION

Room 215

ROBERT H. GAULT, Department of Psychology, Northwestern University,  
Evanston, *Chairman*

lection of Chairman for 1936-37.

Problems in Connection with Administration and Supervision of Special Schools and Classes—FRANK L. BEALE, Assistant Superintendent of Schools, Board of Education, Chicago.

Preparation of the Adolescent Mind for Life—DAVID CONDRON, Quincy High School, Quincy.

The Contribution of Physical Training to the Education of Adolescents—LEON G. KRANTZ, Northwestern University, Evanston.

Motivated Remedial Reading in the Secondary School—DAVID KOPEL, Northwestern University, Evanston.

## ZOOLOGY

Room 313

DONALD B. McMULLEN, Department of Biology, Monmouth College,  
Monmouth, *Chairman*

lection of Chairman for 1936-37.

Remains of Animal Life from the Kingston Kitchen Midden Site near Peoria, Illinois—FRANK COLLINS BAKER, University of Illinois, Urbana (10 minutes).

The Problem of Self-fertilization Among Hermaphrodite Snails—CLARENCE L. FURROW, Knox College, Galesburg (12 minutes).

Mastodons of the Mississippi Valley—O. D. THURBER, Quincy High School, Quincy (15 minutes).

Evolution in the Habits of Lycaenid Butterflies—W. V. BALDUF, University of Illinois, Urbana (12 minutes, lantern).

Studies on the Lymnaeid Snail, *Fossaria parva* (Lea)—C. CLAYTON HOFF, Peoria (15 minutes).

A Study on the Migration of Birds—T. E. MUSSELMAN, Gem City Business College, Quincy (15 minutes).

A Note on the Staining of the Excretory System of Trematodes—DONALD B. McMULLEN, Department of Biology, Monmouth College, Monmouth (15 minutes, lantern).

Recent Advances in Vibro-tactile Sensitivity—LOUIS D. GOODFELLOW, Northwestern University, Evanston (15 minutes, lantern).

The Damsely *Enallogma* sp. as an Intermediate Host of *Camallamus trispinosus* (Leidy)—WILEY W. CRAWFORD, Blackburn College, Carlinville (10 minutes).

Notes on a Species of *Stephanoprora* (Echinostomidae) from American Crows that were Fed Freshwater Fish—PAUL BEAVER, Oak Park Junior College, Oak Park (15 minutes).

onstrations.

Some Parasites of Florida Amphibia—A. C. WALTON, Knox College, Galesburg (15 minutes, microscopes).

The Staining of the Excretory System of Trematodes—DONALD B. McMULLEN, Department of Biology, Monmouth College, Monmouth.

Preparations of *Camallamus trispinosus* (Leidy)—WILEY W. CRAWFORD, Blackburn College, Carlinville.

ILLINOIS STATE ACADEMY OF SCIENCE

JUNIOR SECTION

HIGH SCHOOL SCIENCE AND CLUBS

MABEL A. SPENCER, Granite City Community High School,  
Granite City, *Chairman*

ROSE M. CASSIDY, Park Ridge, Des Plaines High School and HARRY L. ADAMS, Bloomington High School, Bloomington, *Co-chairmen of Exhibits.*  
ROBERT EVERS, AND GEORGE ROGERS, Quincy High School, Quincy, in charge of local arrangements.

FRIDAY, MAY 1, 1936

- 8:00 a. m. Registration (*North end of first floor corridor*).
- 8:00-11:00 a. m. Arrangement of Competitive Entries. Exhibits of Scientific Equipment by Scientific Companies.
- 11:30-12:30. Luncheon, First Christian Church, one-half block east of High School, 45 cents.
- 2:00 p. m. *High School Auditorium*. Presentation of Junior Academy Officers by LOUIS ASTELL, University High School, Urbana.  
*President*, ROBERT JOHNSON, Maine Chemistry Club, Park Ridge-Des Plaines.  
*Vice-President*, BOB MEEKER, Bloomington Geology Club, Bloomington.  
*Secretary-Treasurer*, MERLE REED, Dupo Community High School, Dupo.  
Presentation of Clubs by DR. ROSALIE M. PARR, University of Illinois, Urbana.  
Community Singing, arranged by Maine Chemistry Club, Directed by TOM GRIMMER.
- 2:45 p. m. Variety in Building a Science Club Program, Talks by High School Delegates.  
Biography: Life and Works of Mendel—LORRAINE ANDERSON, Mendel Club, Visitation High School, Chicago.  
Visual Aids: Visual Aids in Science Club Programs—BURTON SELLERS, Edisonian Science Club, Kankakee.  
The names and topics of other students will appear in the final program.
- 6:00 p. m. Annual Banquet, Luther Memorial Church, 50 cents.  
Music by the Quincy High School Orchestra.  
Presentation of Awards.  
Community Singing Directed by TOM GRIMMER.
- 7:00 p. m. Annual Public Lecture, *High School Auditorium*, FAY COOPER COLE, Professor of Anthropology, University of Chicago, Chicago.  
(Subject to be announced).  
DR. C. D. SNELLER, President of the Senior Academy and DR. T. E. MUSSELMAN of the Gem City Business College, will both appear on the Junior Academy Program. The times of their appearances will be announced on the final program.

# HEADQUARTERS OF THE ACADEMY

## QUINCY HIGH SCHOOL

QUINCY, ILLINOIS

Registration Desk in Lobby of First Floor Corridor

Telegrams and other messages may be sent to individuals in care of O. D. Thurber, Quincy High School, and called for at the registration desk in the High School or High School Office.

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. Reservations for the annual informal banquet should be made in advance. For your convenience in making these a printed form is enclosed with this program.

Housing facilities for out-of-town guests attending the Junior Section will be provided in private homes reasonably near the High School for \$1.00 per person, including breakfast. Sponsors of Science Clubs wishing these accommodations should communicate before April 29 with O. D. Thurber, Quincy High School, Quincy, Illinois.

---

### HOTEL RATES

#### *Lincoln-Douglas:*

Single room with bath \$2.50-\$3.00.  
Double room with bath \$4.00-\$5.00.

#### *Quincy:*

Single room with bath \$2.00; without bath \$1.50.  
Double room with bath \$3.00; without bath \$2.00.

#### *Newcomb:*

Single room with bath \$1.50; without bath \$0.75.  
Double room with bath \$2.00; without bath \$1.50.

#### *Park:*

Single room with bath \$1.75; without bath \$1.00.  
Double room with bath \$2.50; without bath \$1.50.

Persons planning to stay in hotels should send reservations in advance. For your convenience a printed card for this purpose is enclosed with this program.



TRANSACTIONS  
OF THE  
ILLINOIS STATE  
ACADEMY OF SCIENCE

---

VOLUME 28

JUNE, 1936

NUMBER 4

---

Minutes of Council Meetings  
Minutes of Twenty-ninth Annual Meeting  
Reports of Officers and Committees  
Constitution and By-Laws  
Index to Volume 28



EDITED BY DOROTHY E. ROSE

PRINTED BY THE ILLINOIS STATE ACADEMY OF SCIENCE

Affiliated with the

STATE MUSEUM DIVISION, CENTENNIAL BUILDING

SPRINGFIELD, ILLINOIS

---

PUBLISHED QUARTERLY

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

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 1935-36

*President*, CHARLES D. SNELLER,  
Peoria, Illinois

*First Vice-President*, C. L. FURROW,  
Galesburg, Illinois

*Second Vice-President*, O. D. THURBER,  
Quincy High School, Quincy, Illinois

*Secretary*, WILBUR M. LUCE,  
University of Illinois, Urbana, Illinois

*Treasurer*, GEORGE D. FULLER,  
University of Chicago, Chicago, Illinois

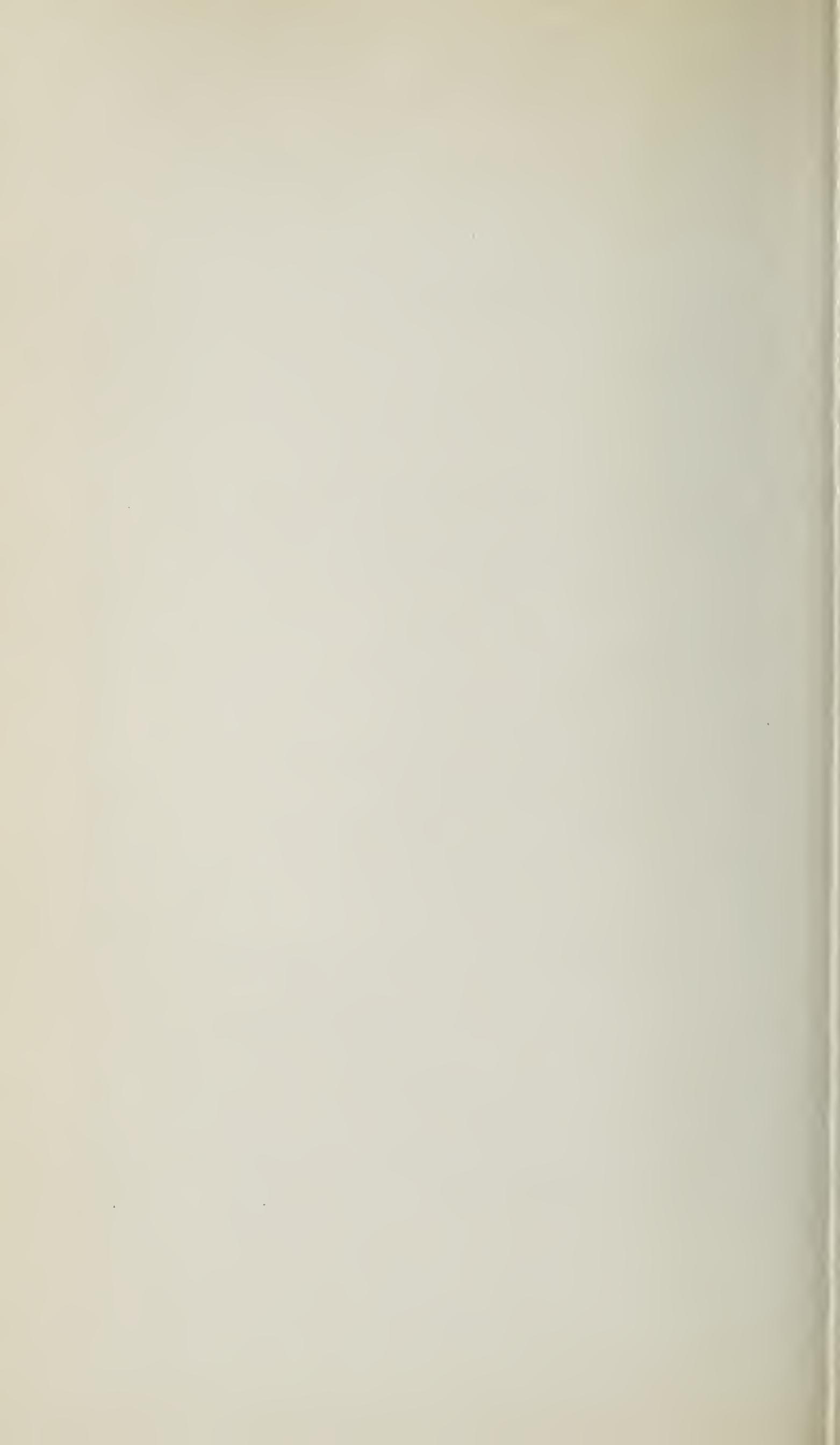
*Librarian*, ARTHUR S. COGGESHALL,  
State Museum Division, Springfield, Illinois

*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.

CONTENTS

	PAGE
Minutes of Meetings of the 1935-1936 Council.....	285
First meeting .....	285
Second meeting .....	285
Third meeting .....	286
Fourth meeting .....	287
Fifth meeting .....	287
Sixth meeting .....	288
Reports of Officers and Committees for 1935-36.....	288
Report of the Secretary.....	288
Minutes of the Twenty-Ninth Annual Meeting.....	288
Morning Business Meeting.....	288
Afternoon Business Meeting.....	288
Section Meetings and General Sessions.....	289
Junior Section Meeting.....	290
Winners of Awards.....	290
Report of the Treasurer.....	294
Report of the Auditing Committee.....	295
Report of the Editor.....	295
Report of the Publications Committee.....	296
Report of the Librarian.....	296
Report of the Committee on Affiliation.....	296
Report of the Committee on Ecological Survey.....	296
Report of the Committee on Membership.....	297
Report of the Committee on Conservation.....	297
Report of the Committee on High School Science and Clubs.....	298
Report of the Delegate to the A. A. A. S. Meeting.....	300
Report of the Delegate to the Illinois Conservation Council.....	301
Report of the Committee on Resolutions.....	302
Constitution and By-Laws.....	303
Constitution and By-Laws of the Junior Section.....	306
Affiliated High School Science Clubs.....	308
Scientific Societies Affiliated with the Academy.....	309
Libraries Receiving the Transactions.....	310
Index to Volume 28.....	313



# MINUTES OF MEETINGS OF THE 1935-1936 COUNCIL

---

## FIRST MEETING

The first meeting of the new council was held at the Tilden-Hall Hotel, Bloomington. It was called to order by President Sneller at 7 a. m., the others present being George D. Fuller, Laurence L. Quill, and Charles H. Behre, Jr. It was suggested that memorials for E. W. Washburn, Frank L. Stevens, H. F. Ferguson, and Robert E. Richardson be published in Volume 28, Number 1. The Secretary was instructed to secure these memorials. It was decided by a majority vote of the Council to accept the invitation of the city of Quincy and Quincy High School to hold the 1936 meeting at Quincy High School. Mr. O. D. Thurber was accordingly elected Second Vice-President of the Academy and the Chairman of the Committee on Local Arrangements. Rockford College, Southern Illinois State Normal University, Carbondale, Augustana College, Rock Island, and Northwestern University have all extended invitations to meet on their campuses within the next few years. Dr. Lyell J. Thomas was selected as the Delegate to the Academy Conference at the St. Louis Meeting of the A. A. A. S. Mr. V. O. Graham was re-selected as the delegate to the Conservation Council of Chicago. The following were appointed to the Finance and Legislation Committee: Don Carroll, Chairman, W. A. Noyes, Mary M. Steagall, Edson S. Bastin, and John R. Neal. The Committee on Ecological Survey included A. G. Vestal, Chairman, Orlando Park, V. O. Graham, V. E. Shelford, W. C. Allee, L. E. Sawyer, C. E. Montgomery, John Voss, Mary M. Steagall, and George D. Fuller. The Committee on Conservation was to be composed of T. H. Frison, Chairman, Henry C. Cowles, M. M. Leighton, W. H. Haas, Jens Jensen, Paul Houdek, Bruce W. Merwin, R. S. Smith, and H. J. Van Cleave. The Secretary was instructed to notify all persons concerned. The Secretary was asked to inquire the personnel of the Committee on High School Science and Clubs from Mr. L. A. Astell. The meeting adjourned at 7:45 a. m.

## SECOND MEETING

The second meeting of the Council was held in the Chemistry Building at the University of Illinois, Urbana, on August 19, 1935, at 1:30 p. m. The meeting was called to order by President Sneller. The members present were C. D. Sneller, C. L. Furrow, L. L. Quill, George D. Fuller and W. M. Luce. The resignation of Dr. L. L. Quill as secretary, who is leaving the state, was accepted and Dr. W. M. Luce was appointed to take his place. Professor D. B. McMullen of Monmouth College was appointed Chairman of the Zoology Section, and the Secretary was instructed to notify him of his appointment. In accordance with the recommendation of the members of the section in economics, the Council voted that meetings of this section be temporarily dropped. The question of a list of speakers for the Affiliated Speakers' Bureau was discussed. Dr. Quill stated that Professor Behre was handling this matter. Professor Adolph C. Noé was appointed a delegate to represent the Academy at the Seventh American Scientific Congress to be held in Mexico City from the 8th to the 17th of September, 1935. Professor Jesse

M. Greenman was appointed a delegate to represent the Academy at the International Botanical Congress to be held in Amsterdam in September, 1935. It was voted to accept the A. A. A. S. grants for research. The funds granted to the Academy for the current year are \$175. It was voted that \$100 of this fund be granted to Dr. A. G. Vestal for aid in the preparation of the Bibliography of the Ecology of Illinois. A committee consisting of the Secretary and Professor H. J. Van Cleave, Chairman, was appointed to select grantees for the remainder of the A. A. A. S. research funds.

Professor C. L. Furrow in behalf of Knox College and the Knox County Academy of Science extended an invitation to the State Academy to hold its annual meeting in 1937 (the hundredth anniversary of the founding of Knox College) in Galesburg.

D. L. Carroll was appointed to serve on the library committee in place of M. M. Leighton. L. L. Quill's place on the same committee was filled by the appointment of the Secretary to this duty. It was voted to add the library of the Leningrad Industrial Institute to the list of exchanges. The meeting adjourned at 3:30 p. m.

### THIRD MEETING

The Council met at the University Club in Urbana, November 30, 1935. The meeting was called to order at 1:15 p. m. by President Sneller. Others present were Dr. Fuller, Dr. Behre, Mr. Thurber, Dr. Thomas, Mr. Astell, Miss Rose, and the Secretary.

The first topic discussed was the matter of instructions to the Academy delegate, Dr. L. J. Thomas, to the Academy Conference of the A. A. A. S. The chief problem in this connection was the use of the A. A. A. S. Research fund and how this fund might be employed for the best interest of the Academy. The grant for the current year was \$175. At the August, 1935 meeting of the Council it was voted that \$100 of this grant should go to Professor A. G. Vestal for aid in preparation of the second volume of the Bibliography of the Ecology of Illinois. At that same meeting a committee was appointed consisting of the Secretary and Prof. H. J. VanCleave, Chairman, to select grantees for the remainder of the fund. The committee decided that the remainder should be granted to Mr. Frank C. Baker for aid in his investigation of the Pleistocene mollusca of Illinois. Ballotting by mail the Council approved this recommendation and the names of the grantees were sent to the Secretary of the A. A. A. S. who sent checks directly to grantees.

Dr. Thomas was instructed to determine if such things as the publication of the *Transactions* and the publication of papers were to be construed as aids to research.

The question of the distribution of the *Transactions* was discussed. After discussion it was voted that these should be distributed to educational institutions and to members free but that non-members should be required to pay a nominal fee to help defray the cost of those numbers in the volume which had been printed at the expense of the Academy.

Plans for the annual meeting and public lecture were discussed. Dr. T. E. Musselman was appointed local member of the membership committee. Several suggestions were made as possibilities for the annual public lecture.

Miss Rose gave a report of the Publications Committee. She reported that the publication plan was on schedule. Several papers of questionable worth were discussed and disposed of.

Mr. Astell outlined the status of the program of the Committee on High School Science and Clubs. He stated that one of their aims was to become

self supporting. It was voted that the Academy grant funds to the Committee not to exceed \$50.

The meeting adjourned at 4:30 p. m.

#### FOURTH MEETING

The meeting of the Council was called to order by President Sneller in the small dining room at the University Club in Urbana at 1:30 p. m., February 15, 1936. Others present were Dr. Fuller, Mr. Thurber, Miss Rose, Mr. Chouinard, Mr. Astell, and the Secretary.

Following the recommendation of the chairman of the section in medicine and public health it was voted that no program for this section be held at the 1936 meeting of the Academy. Several suggestions were made as speakers for the annual public lecture. The Council decided to ask Dr. Andrew Conway Ivy of Northwestern University to give the lecture and President Sneller was requested to extend the invitation and make the necessary arrangements. The Council also agreed to ask Dr. T. E. Musselman of Quincy to address the general session of the Academy at the annual meeting.

Plans for the annual meeting were taken up. Mr. Thurber discussed the local arrangements and the plans for handling the meeting at Quincy. A tentative plan for the business meeting was outlined and approved. A discussion of inspection trips in connection with the annual meetings followed. Mr. Chouinard spoke briefly of the advance publicity campaign and the data which were needed to make this successful.

Miss Rose suggested that an editorial fee of \$1.00 be charged for each of the papers published in the *Transactions*. This fee is to partially cover the cost of preparing these papers for publication.

The report of Dr. L. J. Thomas as delegate to the A. A. A. S. Academy Conference was read and accepted. A committee consisting of Dr. Lyell J. Thomas, chairman, Dr. Harold R. Wanless, and Dr. Wilbur M. Luce was appointed to make recommendations as to the grantees for the A. A. A. S. research funds. The Secretary was instructed to pay the fee and make out the form for the registration of the Academy at Springfield.

The meeting adjourned at 4 p. m.

#### FIFTH MEETING

The fifth meeting of the Council was called to order by President Sneller in the Lincoln-Douglas Hotel, Quincy, at 8:30 p. m., April 30, 1936. Others present were Dr. Fuller, Mr. Furrow, Mr. Thurber, and the Secretary.

The Secretary and Mr. Thurber gave a report on the arrangements for the annual meeting.

The Council approved the payment by the Treasurer of bills incurred by the Committee on Local Arrangement, by the Committee on Publicity and by the sectional chairmen in the preparation of programs.

The Secretary in behalf of the Committee on Research Grants stated that this committee would make its final recommendations at the first meeting of the new Council Saturday morning. He called for suggestions from the Council as to the names of persons who would be suitable recipients of the grants. Several names were suggested by members of the Council.

It was moved and voted that an editorial fee of one dollar be charged to the author for each paper published by the Academy in the *Transactions*. The method and the time of collection of this fee was left to be determined by the Editor. The funds from the fee are to be used to help defray part of the expense for editorial service in connection with the preparation of

these manuscripts for publication. The fee does not apply to papers given before the general sessions of the Academy.

The invitations extended to the Academy for the meeting place of the 1937 annual meeting were discussed.

The meeting adjourned at 11 p. m.

### SIXTH MEETING

The Council met with the Committee on Local Arrangements and the Delegates of the Affiliated Societies in Room 213, Quincy High School, at 8:00 a. m., May 1, 1936. Mr. O. B. Young presented an invitation for the Academy to meet at Southern Illinois State Normal University, Carbondale, in May, 1937. The Secretary reported that a list of available speakers would be distributed to the affiliated societies some time during the summer.

The meeting adjourned at 8:30 a. m.

(Signed) WILBUR M. LUCE, *Secretary*

## REPORTS OF OFFICERS AND COMMITTEES FOR 1935-1936

### REPORT OF THE SECRETARY

#### MINUTES OF THE TWENTY-NINTH ANNUAL MEETING, QUINCY

##### MORNING BUSINESS MEETING

The preliminary business meeting of the twenty-ninth annual meeting of the Illinois State Academy of Science was called to order by President Sneller in room 215, Quincy Senior High School, at 8:40 a. m., May 1.

President Sneller asked the Secretary to read the announcement of the appointment of the following special committees to prepare reports for the 5 p. m. business meeting in room 215, Quincy High School:

(a) Auditing Committee: Charles E. Olmsted, John M. Beal, and Scott V. Eaton, *Chairman*.

(b) Nominating Committee: Charles H. Behre, Jr., Clarence Bonnell, and B. Smith Hopkins, *Chairman*.

(c) Committee on Resolutions: A. G. Vestal, Don Carroll, and Fred R. Jelliff, *Chairman*.

The meeting adjourned until 5 p. m.

##### AFTERNOON BUSINESS MEETING

The afternoon business meeting of the Academy was called to order by President Sneller at 5:00 p. m. in room 213, Quincy High School.

The minutes of the preliminary business were read and approved.

The report of Resolutions Committee was presented by Mr. Jelliff, chairman, and was accepted by the vote of the meeting.

The report of the Nominating Committee was presented by Clarence Bonnell in the absence of Chairman Hopkins. The committee made the following nominations:

President: C. L. Furrow, Knox College, Galesburg.

First Vice-President: Harold R. Wanless, University of Illinois, Urbana.

Secretary: Wilbur M. Luce, University of Illinois, Urbana.

Treasurer: George D. Fuller, University of Chicago, Chicago.

Elective member of the Publications Committee: L. J. Thomas, University of Illinois, Urbana.

The following chairmen of committees were nominated, each chairman having the power to select the membership of his committee from the Academy membership:

T. H. Frison, State Natural History Survey, Urbana, Committee on Conservation.

John Voss, 200 Dixon Ave., Peoria, Membership Committee.

Clarence Bonnell, Harrisburg, Committee on Affiliation.

Mable Spencer, Granite City, and Rose M. Cassidy, DesPlaines, Co-chairmen of the Committee on High School Science and Clubs.

The Committee recommended that the committee on Ecological Survey be discontinued.

Delegate to the A. A. A. S. Academy Conference, Wilbur M. Luce, University of Illinois, Urbana.

Delegate to the Conservation Council of Chicago, V. O. Graham.

The Secretary was instructed to cast a single ballot for these nominees and recommendations.

A Committee on the Compilation of Ecological Bibliography was established with A. G. Vestal, University of Illinois, Urbana, as chairman with the power to appoint the personnel of the remainder of the committee.

President Sneller called for invitations from the floor for the next annual meetings but no further invitations were extended.

The Treasurer's report was read and approved.

The Auditor's report was read and approved.

The following reports were read and approved: Editor, Librarian, Committee on Affiliation, Committee on Membership, Committee on Ecological Survey, Committee on Conservation, Publications Committee, High School Science Clubs, Delegate to the A. A. A. S. Academy Conference, and Delegate to the Conservation Council of Chicago.

The following resolution was moved by Mr. Jelliff and was passed by a standing vote:

*Resolved*, That we extend our sincere thanks to our President, Secretary, Treasurer, and all other officers and committees who have so ably, unselfishly and patriotically served this society during the past year.

The meeting adjourned at 5:55 p. m.

WILBUR M. LUCE, *Secretary*

## SECTION MEETINGS AND GENERAL SESSIONS

The Friday afternoon program consisted of the presentation of 119 papers before nine section meetings. For the public lectures given Friday evening Dr. Fay-Cooper Cole of the University of Chicago addressed the Junior Academy members on the subject, *Digging in Our Backyard*. Dr. Andrew Conway Ivy of Northwestern University Medical School presented the annual public lecture of the Academy on the topic, *The Endocrine Glands*.

On Saturday the sessions of the Academy were field trips. These trips were four in number, each drawing a good attendance. The Geological trip led by Dr. M. M. Leighton, Chief of the State Geological Survey, Dr. George E. Ekblaw, also of the State Geological Survey, and Father Callistus Bifoss

of Quincy College, visited sites of geological interest in the vicinity of Quincy. An Industrial trip under the direction of Mr. M. Finn of Quincy made an intensive tour of some of the manufacturing plants located in Quincy. An Anthropological trip led by Mr. Louis Daerr, Jr. and Mr. O. D. Thurber, both of Quincy, visited and studied the various types of Indian burial mounds in the Quincy area. A Biological trip under the direction of Dr. T. E. Musselman and Mr. Robert Evers, both of Quincy, visited the Coe cross beds and the commercial mushroom beds and other points of biological interest in the region of Quincy.

## JUNIOR SECTION MEETING

### WINNERS OF AWARDS

#### LOVING CUPS

All-round Club: Botkemzo Club, Parker Senior H. S., Chicago.

Biology: Joliet Science Club, Joliet Township H. S., Joliet.

Chemistry: Maine Chemistry Club, Maine Township H. S., Park Ridge-DesPlaines.

Geology: Geology Club, Bloomington High School, Bloomington.

Physics: Morton Physics Club, J. Sterling Morton High School, Cicero.

Junior High School: David Prince Junior H. S., Jacksonville.

#### BIOLOGY

First place: Joliet Township H. S., Joliet.

Second place: Bloomington H. S., Bloomington.

Third place: Visitation H. S., Chicago.

Fourth place: Parker Senior H. S., Chicago.

#### *Individual Poster*

- (1) Donald Baker—University H. S., Normal, Birds in Water Colors.
- (2) Iva Wellman—Joliet H. S., Legs of a Bee.
- (3) Marie Haugh—Visitation H. S., Science Poster.

#### *Group Poster*

- (1) Parker Senior H. S. — Zoology Poster.
- (2) Joliet Township H. S.—Unit of Biology.
- (3) Visitation H. S. — Painted Flowers.

#### *Individual Projects*

- (1) Don Richard — University of Chicago H. S., Fern prothallia.
- (2) Margaret Ruth Baker—E. I. S. T. C. H. S., Pollen Grains.

- (3) Vernon Brown — Bloomington H. S., Plant Nutrition.

#### *Group Projects*

- (1) Clinton Community H. S., Five Aquaria.
- (2) Joliet H. S.—Trees.
- (3) University H. S., Normal—Tests for Purity of Milk and Water.

#### *Individual Commercial Products*

- (1) Marjorie Mason — Bloomington H. S., Drug Plants.
- (2) Richard Krall — Joliet H. S., Soy Beans and Products.

#### *Group Commercial Products.*

- (1) Bloomington H. S. — Filling America's Sweet Tooth.
- (2) Joliet H. S. — Commercial Products.

*Individual Collections*

- (1) Virginia Lindsley—Joliet H. S., Insect Collections.
- (2) Emily Bainbridge—E. I. S. T. C. H. S., Trees of Eastern Illinois.
- (3) Walter Bittner—Bloomington H. S., Seeds.

*Group Collection*

- (1) University of Chicago H. S., Seed Collection.
- (2) Joliet H. S.—Insect Life History.
- (3) Parker Senior H. S.—Collection of Insects.

*Models*

- (1) Virginia Lindsley—Joliet H. S., The Heart.
- (2) Rita Gilmore—Visitation H. S., Butterfly Model.

*Science Note-Book*

- (1) Evelyn Sear—Joliet H. S., Science Note-Book.
- (2) Mildred Perkins—Parker Senior H. S., Zoology Note-Book.
- (3) Eileen Crow and Jean Brigham—Bloomington H. S., Plants.

## CHEMISTRY

First place: Maine Township H. S., DesPlaines-Park Ridge.  
 Second place: J. Sterling Morton H. S., Cicero.  
 Third place: Normal Community H. S., Normal.  
 Fourth place: Visitation H. S., Chicago.

*Individual Poster*

- (1) Julienne Biasi—Normal Community H. S., Vanishing Cream.
- (2) William Rapp—Granite Community H. S., Soy Beans.
- (3) Jack Ruoss—Maine Township H. S., Medicinal Plant Derivatives.

*Group Projects*

- (1) Dupo Community H. S., Crystals.
- (2) Quincy Community H. S., Lime-Kiln.
- (3) Granite City Community H. S., Mineral Location Map.

*Group Poster*

- (1) Bloomington H. S., Chemical Charts.
- (2) Maine Township H. S., The Halogens.
- (3) Visitation H. S., Sulfuric Acid.

*Individual Commercial Product*

- (1) Jack Keith—Normal Community H. S., Hydrogenation of Olive Oil.
- (2) Leonard Daniels—J. Sterling Morton H. S., Flash Point Tester.
- (3) Robert Noonan—Maine Township H. S., Hydrogenation of Cotton-seed Oil.

*Individual Project*

- (1) Lyle Waddell—Bloomington H. S., Photo Prints and Toning.
- (2) Richard Sudhalt—Granite City H. S., Electro-Chemistry.
- (3) Vincent Kowalewski—J. Sterling Morton H. S., Furnace for melting alloys.

*Group Commercial Products*

- (1) Maine Township H. S., Paint Making.
- (2) J. Sterling Morton H. S., Apparatus to Break Up Tallow.
- (3) Normal Community H. S., Silvering Mirrors.

*Individual Collection*

- (1) B. W. McElroy — J. Sterling Morton H. S., Collection of Elements.
- (2) Edward A. Jones—Maine Township H. S., Collection of Rubber.
- (3) Kathryn Ryan — Visitation H. S., Stock-yard Products.

*Group Collection*

- (1) J. Sterling Morton H. S., Periodic Chart.
- (2) Visitation H. S., Cellulose Collection.
- (3) Maine Township H. S., Paper Collection.

*Models*

- (1) Mabelle Baugh — Visitation H. S., Water Filtration.
- (2) Berne Tarnowski — J. Sterling Morton H. S., Atomic Models.
- (3) Ryburn Robinson — Granite City Community H. S., Water Softeners.

*Science Note-Books*

- (1) Eleanor Thompson — Normal Community H. S., Chemistry Science Note-book.
- (2) Mary Frances Payne — Normal Community H. S., Chemistry Science Note-book.
- (3) Dorothy J. Summers — Maine Township H. S., Chemistry Note-book.

## GEOLOGY

- First place: Bloomington H. S., Bloomington.  
 Second place: Granite City Community H. S., Granite City.  
 Third place: E. I. S. T. C. H. S., Charleston.

*Individual Poster*

- (1) Richard Hokhauser — Granite City H. S., Crystal Structure of Minerals.

*Individual Project*

- (1) Robert Bowen—Bloomington H. S., Map of U. S. with Rocks.

*Group Project*

- (1) Bloomington H. S., Formation of Limestone.

*Individual Collection*

- (1) Arlin Reynnels, Jr.—E. I. S. T. C. High School, Indian Relics.
- (2) Robert Bowen — Bloomington H. S., Fossils.

*Models*

- (1) Charles Stine—Bloomington H. S., Geysers.

*Note-Book*

- (1) Floyd Brown—Bloomington H. S., Geology Scrap-book.

## PHYSICS

- First place: J. Sterling Morton H. S., Cicero.  
 Second place: Kankakee H. S., Kankakee.  
 Third place: Parker Senior H. S., Chicago.  
 Fourth place: Arlington Heights H. S., Arlington Heights.

*Individual Projects*

- (1) Fred Vacek — J. Sterling Morton H. S., Theory of Sound Waves.

- (2) Louis Palinke—Kankakee H. S., Public Address System.
- (3) Herman A. King — Arlington Heights H. S., Public Address System.

*Group Project*

- (1) J. Sterling Morton H. S., Properties of Light.
- (2) Parker Senior H. S., Mercury Vacuum Pump.

*Science Note-Book*

- (1) Arthur Onaka—J. Sterling Morton H. S., Second Semester Note-book.

*Individual Commercial Products*

- (1) John Hruby—J. Sterling Morton H. S., Public Address System.

*Model*

- (1) Donald Koss—J. Sterling Morton H. S., Flea Electric Motor.

## JUNIOR HIGH SCHOOL

First place: David Prince Junior H. S., Jacksonville.

Second place: Richard E. Byrd H. S., Kankakee.

Third place: J. Sterling Morton Junior H. S., Cicero.

*Individual Poster*

- (1) Jimmie Jordon — David Prince Junior H. S., Hibernation.

*Group Commercial Products*

- (1) David Prince Junior H. S., Constellation Finder.

*Group Posters*

- (1) Richard E. Byrd Junior H. S., The Human Body.
- (2) David Prince Junior H. S., Air Routes.

*Individual Collection*

- (1) Virginia Buckley — Richard E. Byrd H. S., Leaves.
- (2) Fred R. Bailey, Jr. — David Prince Junior H. S., Soils.

*Individual Projects*

- (1) Charlotte Stella — Richard E. Byrd Junior H. S., Trees and Shrubs.
- (2) Tom Dickman — David Prince Junior H. S., Tree Directory.

*Group Collection*

- (1) David Prince Junior H. S., Rocks.

*Group Project*

- (1) J. Sterling Morton Junior H. S., Model of Plants.
- (2) David Prince Junior H. S., Neighborhood Trees.
- (3) David Prince Junior H. S., Finger Printing.

*Individual Models*

- (1) Gilbert Barker — Richard E. Byrd Junior H. S., 2 Tube Radio.
- (2) William Scheldman — David Prince Junior H. S., Hygrometer.

*Individual Commercial Products*

- (1) James Shelton — David Prince Junior H. S., Slides.

*Individual Science Note-Book*

- (1) Jane E. Cheffer — Richard E. Byrd Junior H. S., The Earth.
- (2) Virginia Buckley — Richard E. Byrd Junior H. S., Scientists.
- (3) William Benson—David Prince Junior H. S., General Science.

## NEWS-LETTERS

<i>Hand Work and Printed</i>		<i>Mimeographed</i>	
(1)	Visitation H. S., "Chem Flashes".	(1)	J. Sterling Morton H. S., "Mor-to Chem".
(2)	Maine Township H. S., "Lab-News".	(2)	Joliet Twp. H. S., "The 'J' News".
(3)	Kankakee H. S., "Kesci Flashes".	(3)	Visitation H. S., "Mendel News".

## RADIO NOTE-BOOKS

(1)	Betty Mae Johnson — Maine Township H. S.	(1)	Marjorie Mansfield — Maine Township H. S.
-----	--	-----	---

## REPORT OF THE TREASURER

For the year ending April 25, 1936

*Receipts*

Balance on hand April 30, 1935.....	\$210.03	
Initiation fees and dues.....	706.00	
Sale of Transactions.....	54.55	
Junior Academy .....	98.80	\$1,069.38

*Expenditures*

## Expenses of annual meeting, 1935:

Programs .....	\$71.80	
Officers' expenses .....	13.75	
Registration .....	5.65	
Publicity .....	4.51	
Sectional chairman .....	47.27	
Junior Academy .....	28.91	
	<hr/>	\$171.89
Editor's honorarium .....		150.00
Editor's expenses .....		52.78
Secretary's honorarium .....		100.00
Secretary's expenses .....		87.62
Treasurer's expenses .....		43.95
Council meetings .....		20.30
Printing Transactions .....		159.14
Postage on Transactions.....		30.22
Junior Academy .....		32.60
		<hr/>
Balance in University State Bank.....		220.88
		<hr/>
		\$1,069.38

*Statement of resources on hand held by treasurer, April 25, 1936*

Balance in University State Bank.....	\$220.88
Mortgage Bonds, face value.....	600.00
Office supplies .....	5.00
	<hr/>
Total resources .....	\$825.88

In presenting the annual financial report the Treasurer would direct attention to the fact that the income of the Academy from members' dues has remained practically the same for the past four years. Income from other sources has on the contrary decreased. Although the funds available for the year have been \$200 less than those of last year the balance is practically the same as last year. This has resulted from decreased expenditures, several items, notably the expenses of the Junior Academy, being decidedly below the usual amounts. The need for a larger income is urgent.

The present membership of the Academy consists of 79 life members, 472 fully paid up annual members, 162 members one year in arrears, 80 members two years in arrears, and 54 members who are three years in arrears and are being dropped from the rolls at the present meeting. We have received 78 new members during the year, 24 have resigned and 9 annual and 4 life members have died.

The net membership on April 25, 1936, not including those being dropped at the present meeting but including the new members, consists of 874 personal members, a net loss of 12 during the year. There are also 20 affiliated societies and 50 clubs in the Junior Academy.

The entire report is respectfully submitted.

GEO. 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 authorized by vouchers signed by the President and the Secretary. The balance in the University State Bank of \$220.88 agrees with the statement.

(Signed) SCOTT V. EATON  
J. M. BEAL  
C. E. OLMSTED

Chicago, Illinois  
April 30, 1936

#### REPORT OF THE EDITOR

No. 4 of Volume 27 of the Academy's *Transactions* was distributed in August 1935, and No. 1 of Volume 28 in October 1935, and Nos. 2 and 3 in April, 1936. In addition to the regular numbers a General Index to the first 25 volumes of the *Transactions* was prepared and published in June-July, 1935. Copies of the General Index are available from the Secretary.

In order to better meet the quarterly publication schedule, it is desirable that section chairmen enforce the ruling that all papers be handed in at the time of the annual meeting.

The increase in the number of papers on this year's program will decrease the number that can be printed in full in volume 29. The present estimate is that the 2-page limit (1,000 words) will have to be closely observed.

Additional printing funds are needed, both for those numbers printed by the State and those printed by the Academy.

Respectfully submitted,

DOROTHY E. ROSE, *Editor*

May 1, 1936

## REPORT OF THE PUBLICATIONS COMMITTEE

It has been possible to maintain the publication of abstracts and manuscripts as outlined by the report of the Publications Committee for the year 1934-35. While this plan is functioning fairly satisfactorily in the present emergency there is urgent need for an increase in our funds to the end that more full length papers may be published instead of the 1,000 word abstracts which is now the limit for most of the papers presented before the Academy. Your committee requests therefore that every effort be made to obtain an appropriation from the General Assembly of the State of Illinois of at least \$3,000 for the coming biennium instead of the \$2,000 now granted for the present biennium.

Submitted in behalf of the Publications Committee.

WILBUR M. LUCE, *Secretary*

## REPORT OF THE LIBRARIAN

During the past year approximately one hundred scientific publications were received in exchange for Transactions of the Academy. Numerous requests for copies of the Transactions were filled. These requests came from individuals and institutions in several foreign countries as well as in the United States.

The number of Transactions on hand that were published since volume 27, number 3, is as follows:

Volume 27, Number 4 .....	150	June	1935
28, 1 .....	125	Sept.	1935
28, 2 .....	153	Dec.	1935
28, 3 .....	0	March	1936
General Index, Volumes 1-25.....	900	June	1935

The supply of Volume 26, number 3, published in March, 1934, is now exhausted.

Respectfully submitted,

ARTHUR STERRY COGGESHALL, *Librarian*

## REPORT OF THE COMMITTEE ON AFFILIATION

The Committee on Affiliation has received no applications from organizations desiring to affiliate and no notice of withdrawals.

Respectfully submitted,

CLARENCE BONNELL, *Chairman*

## REPORT OF THE COMMITTEE ON ECOLOGICAL SURVEY

Progress on Part II of the bibliography of the ecology of Illinois may be reported as satisfactory. Though most of the citations now on hand require verification or completion, their present bulk is equivalent to about 60 printed pages, and many more titles are in sight.

The chairman has suggested to the members of the committee that they ask to be discharged as an official body, with the strong probability that activities heretofore carried out by members of the committee will be continued by them as individuals. It may be carried in mind that future conditions may occasion a greater need than at present for a committee on ecological survey, and in such event the committee might well be reconstituted.

The chairman invites discussion of the proposal that the committee be discontinued.

Respectfully submitted,

A. G. VESTAL, *Chairman*

## REPORT OF THE COMMITTEE ON MEMBERSHIP

The activities of the membership committee chiefly consisted of sending many letters to prospective members throughout the state. Personal contacts were made whenever possible and the latter method proved to be by far the most successful.

In addition to the original committee consisting of

A. H. Sutton, Urbana  
L. I. Bockstahler, Evanston  
Rev. George M. Link, Springfield  
O. D. Thurber, Quincy

the following members were asked to serve:

Ray E. Coats, Lewistown  
F. J. Friedli, Belleville  
E. L. Stover, Charleston  
J. C. Frazier, Bloomington  
Clarence R. Smith, Aurora  
Sister Mary Ellen, River Forest  
A. O. Boatman, Carthage  
Wm. Bailey, Carbondale  
E. Mitchell Gunnell, Galesburg  
G. N. Hufford, Joliet  
Karl G. Larson, Rock Island  
C. E. Montgomery, DeKalb  
Elizabeth Crigler, Jacksonville  
H. D. Waggoner, Macomb  
D. B. McMullen, Monmouth

Taking into consideration the present economic conditions and other factors, I feel that the number of new members secured is indicative of a successful campaign.

Respectfully submitted,

JOHN VOSS, *Chairman*

## REPORT OF THE COMMITTEE ON CONSERVATION

Last year the Committee on Resolutions sponsored and the Academy approved a resolution requesting the Committee on Conservation to appoint a member or to appoint a subcommittee to aid in the protection, preservation and scientific study of anthropological remains in Illinois. In accordance with the intent of this resolution, the chairman of your Conservation Committee requested Professor Fay-Cooper Cole of the University of Chicago to accept the chairmanship of this new subcommittee and to suggest other members of the Academy especially qualified for service thereon. I am glad to report to the Academy that Professor Cole kindly accepted the chairmanship and that Mr. Frank W. Aldrich, McLean State Bank and Trust Company, McLean; Paul S. Martin, Curator of Anthropology, Field Museum of Natural History, Chicago; and M. M. Leighton, Chief of the Illinois State Geological Survey, Urbana have all accepted membership on this subcommittee. It is my understanding that a meeting of this group is scheduled for the present Academy session.

As in past years, your Conservation Committee has been active in supporting legislation favoring the better preservation and utilization of our natural resources. Many letters have been written to United States senators and representatives urging the passage or defeat of certain bills and the response to these appeals has been most gratifying.

Your committee supported action in the Senate restoring to the House Appropriation Bill an item of \$45,000 for silvicultural investigations of which \$20,000 was for the Central States Forest Experiment Station which now has an office, laboratory and experimental area in the Shawnee National Forest Unit in southeastern Illinois. More data are needed for an intelligent forest planting program in the central states than any other large region in the United States due to the long neglect of forestry values in this part of the country. Larger expenditures such as National Forest Units, which the Academy has always supported, may be easily a money-wasting proposition if the forestry program is not developed on sound information provided by the experimental method. I am glad to state that this item was reinstated in the Senate but action in the House on this Senate amendment has not been taken to date.

Other measures supported in the United States Senate and House pertained to the regulation of the sardine fishing industry off the coasts of California, Oregon and Washington. Certain practices are now being followed by some fishing industries just off the three mile limit of the western coast states which seriously threaten the existence of this valuable species of fish. The bills do not call for the elimination of such an essential industry. They do call for regulations insuring the preservation of the species of fish which makes this industry possible. In the interest of both the fishing industry and consumer alike this resource should be kept on a sustained yield basis.

The defeat of House Resolution 9275 in the United States House and Senate was urged in many letters to the members of the House and Senate Committees on Public Lands. The bill as introduced would have been the entering wedge for certain private interests in Glacier Bay National Monument and hence the defeat of the national will in getting this area established as a national monument. Quite naturally, the defeat of this bill was urged by all national conservation agencies in the country.

The Glacier Bay National Monument in southeastern Alaska was set aside with the express purpose of preventing any activities which would tend to disturb this great demonstration area of interglacial forest, glacial action and adjustment of animal and plant life to such conditions. Such areas must be kept inviolate if they are to serve the best interests of the purposes to which they are dedicated and in the long run the best interests of our country.

As stated last year, I believe the most important function of your Conservation Committee 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,

T. H. FRISON, *Chairman*

April 29, 1936

#### REPORT OF THE COMMITTEE ON HIGH SCHOOL SCIENCE AND CLUBS

The work for this year has been divided into four sections. Mr. Louis Astell of the University High School, Urbana, has had complete charge of the Radio and News Magazine Sections. He has done a very remarkable piece of work in each of these fields. Miss Rose Cassidy of Maine Township High School, at DesPlaines has been assisted by Mr. Harry L. Adams at Bloomington High School. These two persons have completed a very success-

ful exhibit. The work of the General Expansion and Program Department has been under the direction of the General Chairman.

We have had much the same outline of work as has been done in past years. The few exceptions which have been made were experimental and fairly successful, if one may judge from appearances. We wish especially to improve the scientific quality of science club activities, for that reason we have tried having discussion of exhibits by experienced judges.

We have at the present time, approximately fifty clubs in good standing. About twenty-five clubs attended the meetings and enthusiasm was very apparent.

(Signed) MABEL SPENCER,  
General Chairman

## ANNUAL REPORT

### I. RADIO SERVICE

The Illinois Junior Academy of Science is bringing to a close the third and most brilliant annual series of broadcasts. Of the thirty-five numbers, thirty-two were originated over WILL (890 kilocycles)—and for the most part, rebroadcast over WCBS of Springfield—and were presented under the general theme of "Great Events in Science." The remainder of the numbers, informational in character, originated over WTAD (900 kilocycles) at Quincy.

The programs presented over WILL and WCBS were of the two general types; those by leading scientists of the University of Illinois, culminating in the second annual address of President Arthur Cutts Willard, and those by student groups representing affiliated science clubs. A copy of President Willard's talk, "Air Conditioning for Human Comfort," will be made available for each affiliated club and should become a part of the permanent records of each organization. The student-group type of program, which is in its second year, began under the leadership of the Edisonian Science Club of Kankakee with two programs widely different in nature. This year's schedule includes six such student-group programs in the form of dramatizations, experiences in widely known scientific expeditions, round-table discussions and resumés of state and national activities by the actual student participants.

Our appreciation is extended to the radio stations WCBS and WTAD for partial service, and to WILL for complete service extending throughout the academic year. Finally, to the coterie of scientists, contributing unstintingly of their time and energy to make the series of broadcasts possible, we tender our respect and our thanks.

### II. SCIENCE CLUB SERVICE

Three issues of Science Club Service represent the year's work in published service specifically designed for the benefit of sponsors and those in charge of state-wide organizations of Junior Academies. The policy has been broadened to be of more direct benefit to the state organizations which are contributing funds, purchasing space, and exchanging materials. Copy is being published in columns as from Contributing Editors as fast as such writers can be located. It is believed that the material published is of sufficient value to clubs within the state to justify its inclusion and that the inter-relating activity is highly beneficial for the Junior Academy movement.

The following Contributing Editors represent a leadership in which we may well feel a sense of security and pride:

Doctor Howard E. Enders, representing Indiana, is General Chairman of the Indiana Junior Academy of Science, and Dean of the School of Science in Purdue University.

Doctor Hazel E. Branch, representing Kansas, is General Chairman of the Kansas Junior Academy of Science, and Head of the Zoology Department of the University of Wichita.

Doctor Anna A. Schnieb, representing Kentucky, is General Chairman of the Kentucky Junior Academy of Science, and Professor of Education and Psychology at Eastern Kentucky State Teachers College.

Mr. Karl F. Oerlein, representing Pennsylvania,—formerly sponsor of the widely-known Steinmetz Scientific Society of the Upper Darby Senior High School at Upper Darby, Pennsylvania,—is now a member of the staff of the State Teachers College at Indiana, Pennsylvania.

Quantity shipments of the Science Club Service have been made, during the current academic year, to the following states: Indiana, Kansas, Kentucky, Minnesota, Missouri, Oklahoma, and Pennsylvania. With Illinois, this represents eight states; a proof of the merits of the leaflet in meeting the needs of those for which it is intended.

### III. RECOMMENDATIONS

- (1) Radio: Continuation of the regular series over WILL with an increasing number of club broadcasts. More broadcasts over other local stations through personal appearances of zone chairmen and affiliated clubs. Separate chairman of radio service.
- (2) Science Club Service: Continuation of the leaflet with at least three issues. Editorial policies to remain substantially as at present. . . . Critical comments for the improvement of the leaflet to be pooled and made available for reference.

### REPORT OF THE DELEGATE TO THE A. A. A. S. MEETING

St. Louis, Missouri, December 30, 1935

The Academy Conference delegates met in the new Hotel Jefferson the afternoon of December 30, Dr. O'Kane presiding for roll call. Twenty-two academies had official delegates present. The delegate from Ohio was elected new chairman.

Four papers were presented for consideration and discussion.

(1) Dr. Enders of Purdue University gave a Brief History of the Junior Academy Movement and pointed out its rapid growth and the important service of the Illinois State Academy of Science in fostering and initiating it in the Illinois Junior Academy of Science, which was plainly the leader in the field.

(2) Watson Davis, editor of Science News Letter, offered this weekly magazine as a service paper to high school clubs and sponsors as follows: four pages in Science News Letter devoted quarterly or eight issues at 25 cents for the year.

(3) The Committee on Junior Academies, Dr. Caldwell, Dr. Enders, Mr. Astell, reported no definite action on the establishing of a general center as a clearing house for sponsor materials but were voted by the delegates present to continue their investigations another year.

(4) Dr. Caldwell, reporting on Grants to State Academies for Research Instead of the Old Bonus System, announced that of twenty-nine academies approached on the question of continuing the research grants, twenty-four were heard from as follows: 20 approved the plan; 3 preferred to return to the old basis; 1 was non-committal.

The A. A. A. S. Council has approved the plan for one more year. A discussion followed as to the use of the money by academies, and Dr. Caldwell stated that any approval of the academies for the use of the funds will

be approved by the A. A. A. S. Council, the general and permanent secretaries.

All Academy recommendations for research grants will be published in *Science*. Dr. E. C. Faust made the motion, which was seconded and passed by the delegates, that a note of recognition be made with each publication of research done with the aid of these grants.

Hope was expressed that others might contribute to this A. A. A. S. research fund.

The secretary of the Virginia Academy of Science stated that they had turned down the use of the fund for the publication of research.

Dr. Cattell stated that there is about \$4,000 per year available from the A. A. A. S. research fund and that if wisely distributed, he could see no reason why it should not be continued indefinitely.

Dr. Belsinger, the Academy conference secretary, briefly reported on materials and data he had collected from academies other than Texas on (a) What academies in other states are doing; (b) The financing of Academy publications; (c) Distribution of source materials for junior academies. This will appear in *Science*.

The Conference adjourned to the banquet given by the A. A. A. S. Council for Academy delegates. Short talks were given by Dr. Burton Livingston, and by Dr. Carl T. Compton. Dr. Compton stated that the most significant advance made by the state academies was the development of junior academies.

LYELL J. THOMAS, *Delegate*

#### REPORT OF THE DELEGATE TO THE ILLINOIS CONSERVATION COUNCIL

The Illinois Conservation Council has held one meeting each month from October until May during the past year.

The perennial problem of upholding our National Park standards again caused much concern. The insistence from the Reclamation service for a tunnel through the Rocky Mountain National Park threatened the whole conservation movement. The proposal to convey water from the west side of the mountains to the eastern side through a National Park is difficult to understand. It indicates either a complete ignorance of the standards or else a purposeful effort to break them at one place as a precedent for other, later infringements.

Conservation Week, May 10th to 17th, fits into the educational program. No better method, looking to the future, can be found than that which provides for conservation education.

The dedication of the Jackson Park Wild Life Sanctuary was held Thursday noon, April 16th. The sanctuary was presented to the people of Chicago by the president of the park board, Mr. Donoghue and accepted by the Chairman of the Illinois Conservation Council, V. O. Graham. This twenty-acre water area will serve as a resting place for water birds during migration and as a feeding station for many birds at other times.

A need for other forms of National preserves than those at present provided for is now evident. Virgin areas of America's native vegetation need to be held and administered by the National Park Service as inviolate in which there shall be no disturbance of plant or animal life.

The conservation picture in Illinois shows a great improvement along at least two fronts: First—the development of the national forest area in the southern part of our state and second—in water pollution control.

Respectfully submitted,

(Signed) V. O. GRAHAM, *Delegate*

## REPORT OF THE COMMITTEE ON RESOLUTIONS

Your committee would report the following resolutions:

The Academy wishes to express its gratitude and appreciation to the residents of Quincy who have contributed to the success and pleasantness of the meeting: Mr. O. D. Thurber, Chairman of the Committee on Arrangements, Mr. T. E. Musselman, and all of the other members. It wishes to acknowledge the generous helpfulness of the Quincy Chamber of Commerce and its Secretary, Mr. Finn, and of the press of Quincy.

RESOLVED: That we commend the enterprising people of Quincy for providing so beautiful and commodious a High School building, with all its many facilities for the education of its boys and girls.

RESOLVED: That we express our appreciation and admiration for the fine work being done by the Junior Academy and for its exceptional line of exhibits, and that we commend Miss Mabel A. Spencer, its Chairman, Louis A. Astell, the committee, and all others who are promoting this work among the young people of Illinois.

RESOLVED: That we heartily commend the Illinois State Geological Survey for its research program calculated to discover further uses of the mineral resources of the State, and thus to increase employment; and that the State Academy urge that the Federal and State Governments encourage such research in every possible way.

RESOLVED: That the State Academy favors a wise policy of conservation, that, while ministering to present needs, will pass our resources on to future generations, and that we commend research having this end in view.

Because of the great inadequacy of space and ill-suited laboratory conditions and facilities of the State Geological Survey and the State Natural History Survey for research on the natural resources of the State, we urge that every possible consideration be given by the State General Assembly and the Governor of the State to the construction of a State Natural Resources Building for this work.

It is with regret and a sense of loss that we note the deaths of the following members of the Academy during the past year:

Dr. Onward Bates, 934 John's Road, Augusta, Ga.

Mr. W. C. Hawthorne, Life, 3529 W. Monroe St., Chicago, Ill.

Mr. Ross B. Wynne, 7335 Kenwood Ave., Chicago, Ill.

Mr. Thos. L. Hankinson, Life, State Normal College, Ypsilanti, Mich.

Dr. O. L. Schmidt, 38 S. Dearborn St., Chicago, Ill.

Mr. Herman M. Adler, 2525 Rose Walk, Berkley, Calif.

Mr. H. G. Easterly, R-2, Carbondale, Ill.

Mr. Walter F. Boyes, Galesburg, Ill.

Dr. Clyde A. Finley, Galesburg, Ill.

Mr. George Horspool, Galesburg, Ill.

Mr. Walter G. Bain, Life, St. John's Hospital, Springfield, Ill.

Mr. G. M. Browne, 902 S. Normal St., Carbondale, Ill.

Miss Fannie Fisher, Life, State Museum, Springfield, Ill.

We appreciate the large service that these have rendered to the Academy and to their communities by their devotion to science, and feel that in their lives there is a source of inspiration.

Resolved that this resolution be made a part of our records, and that copies be sent to the families of the deceased.

(Signed) FRED R. JELLIFF, *Chairman*  
A. G. VESTAL  
DON CARROLL

# 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-laws 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 Science.

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 Article 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.)
- Blue Island*: Blue Island Biology Club, High School. (1936.)
- 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.)  
 Chicago Normal Science Club, Chicago Normal College. (1936.)  
 Crane Tech. Zoa-Phyta Club, Crane Tech. High School. (1934.)  
 Fenger Science Club, Fenger High School. (1936.)  
 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 Township 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.)
- Edwardsville*: Radio and Photography Club, High School. (1936.)
- 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.)  
*Mounds City*: Science Searchers, Community High School. (1936.)  
*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.)  
*Quincy*: Chemistry Club, High School. (1936.)  
*Riverside*: Catalyst Club, Riverside-Brookfield High School. (1935.)  
*Rochelle*: Rochelle Science Club, Township High School. (1936.)  
*Rockford*: Rockford Biology Club, Senior High School. (1930.)  
*Rockton*: Mote Scientifique, Hononegh Community High School. (1931.)  
*Roodhouse*: Science Fratres, High School. (1936.)  
*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, Stolph 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. Pepon. (1927.)  
 Illinois 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.  
 Instituto de Biologia Vegetal, Jardim Botânico, 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, Frankfort (Main), Germany.  
 Smithsonian Institute, Washington, D. C.  
 St. Norbert's College, West Le 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.

NOTICE:—Exchanges from state academies should be addressed to THE LIBRARIAN, STATE MUSEUM, SPRINGFIELD, ILL.



## INDEX TO VOLUME 28

- Adams, L. A., Dental variations of the dog, *Canis domesticus*, (2):243-4.
- Academy business**
- Affiliated high school science clubs, (4):308
  - Affiliated societies, (4):309
  - Affiliation, report of committee on, (4):296
  - American Association for the Advancement of Science, report of delegate to, (4):300
  - Announcement of 29th annual meeting, (3)
  - Annual meeting, minutes of (29th), (4):288.
  - Auditing committee, report of, (4):295
  - Conservation, report of committee on, (4):297
  - Constitution and by-laws, (4):303
  - Council meetings (1935-36), (4):285-8
  - Ecological survey, report of committee on, (4):296
  - Editor, report of, (4):295
  - High School Science and Clubs, report of committee on, (4):298
  - Illinois Conservation Council, report of delegate to, (4):301
  - Junior Section, constitution and by-laws, (4):306
  - Junior Section, winners of awards, (4):290-4
  - Legislation and finance, report of committee on, (4):291
  - Librarian, report of, (4):296
  - Libraries receiving the Transactions, (4):310
  - Membership, report of committee on, (4):297
  - Publications committee, report of, (4):296
  - Resolutions, report of committee on, (4):302
  - Treasurer, report of, (4):294
- Agriculture**
- Canada thistles in Illinois (Barnes), (2):50-1
  - Effect of seed coat injury on germination, vigor, and yield of corn (Koehler), (2):52-4
  - Insects in relation to production of red clover seed (Bigger), (2):60-3
  - Physiology of seed germination (Hottes), (2):49
  - Purity of Illinois seed stocks as revealed by seed analysis studies (Moore), (2):55-7
  - Sweet clover seed production (Newlin), (2):58-9
- Anderson, Scott**, A convenient chart for correcting barometer readings (2):211-2
- Andrews, Van**, Dental pathology of prehistoric man at the confluence of the Ohio and Mississippi rivers, (2):75-6
- Anthropology**
- Archaeology in southern Illinois (Merwin), (2):79-80
  - Bannerstones and related ceremonial objects from southern Illinois (Peithman), (2):73-4
  - Dental pathology of prehistoric man at the confluence of the Ohio and Mississippi rivers (Van Andrews), (2):75-6
  - Dryopithecus tooth pattern as a racial characteristic of the Mound Builders (Ruyle), (2):77-8
  - Method of restoration of the Indian mounds (McCoy), (2):69-70
  - New type of burial mound near Quincy, Illinois (Thurber), (2):67-8
  - Our debt to the Indian (Jordan), (2):71-2
  - Annular rings in the long bones of turtles and their correlation with size (Mattox), (2):255-6
  - American Eagle, occurrence along the Ohio River in Illinois (Bonnell), (2):249-50
  - Apparatus, design of some elementary physics laboratory (Overbeck), (2):235-6
  - Archaeology in southern Illinois (Merwin), (2):79-80
  - Atomic beam as a spectroscopic source (Carpenter), (2):215-6
  - Audrieth, L. F., and Long, A., Reactions in fused pyridine hydrochloride, (2):121-2
  - Audrieth, L. F., with Schmidt, M. T., Onium salts as acids—reactions of

- ammonium chloride at higher temperatures. (2):133-4
- Aurora, Mastodon and other finds at (Smith), (2):195-6
- Aurora Mastodon remains, geological setting of the (Powers), (2):193-4
- Balduf, W. V., The bionomics of the ladybeetles, (2):248
- Ball, Clayton G., Possible relations of mineral matter in coal to the time of coalification, (2):181-2
- Ball mill for general use, an inexpensive (Quill), (2):127-8
- Bannerstones and related ceremonial objects from southern Illinois (Peithman), (2):73-4
- Barnes, Joseph E., Canada thistles in Illinois, (2):50-1
- Barometer readings, a convenient chart for correcting (Anderson), (2):211-2
- Barrick, Stella H., with Boewe, G. H., and Hague, Stella M., Mosses from Apple River Canyon, Mississippi Palisades, and White Pines Forest State Parks, (2):83-4
- Beard, J. Howard, Rickets: its cause, effect, and prevention, (2):201-2
- Behre, Charles H., Jr., Some problems in the origin of the mineral veins, (1):5-18
- Bell, Alfred H., Status of the carbon-ratio theory in Illinois, (2):183
- Benson, E. T., Local calorific variations of coal No. 6 and the geological implications, (2):186-7
- Bigger, J. H., Insects in relation to production of red clover seed, (2):60-3
- Bismuth single crystals, on growing (Boyajian), (2):213-4
- Bird life, destruction by hail (Mizelle), (2):266
- Blanchard, W. O., Palestine in transformation, (2):149-50
- Bloomington-Normal, field study of (Odell), (2):153-8
- Boewe, G. H., Barrick, Stella H., and Hague, Stella M., Mosses from Apple River Canyon, Mississippi Palisades, and White Pines Forest State Parks, (2):83-4
- Bonnell, Clarence, The occurrence of the American Eagle along the Ohio River in Illinois, (2):249-50
- Boomer, S. E., Ripple tank experiments, (2):224
- Botany**
- Botany, thoughts on popularizing (Gumbart), (2):90
- Collection of fleshy ascomycetes from east central Illinois (Marks and Stover), (2):95-6
- Conservation of the wild flowers of Illinois (Mauntel), (2):97-8
- Effects of fuel oil on plants (Fuller and Leadbeater), (2):99
- Effects of sulphur deficiency on the growth and metabolism of the soy bean (Eaton), (2):88
- Germination behavior of the Rose Mallows (Shull), (2):111-2
- Germination of the seed and development of the seedling of *Calopogon pulchellus* (SW) R. BR. (Carlson), (2):85-6
- Mosses from Apple River Canyon, Mississippi Palisades, and White Pines Forest State Parks (Boewe, Barrick, and Hague), (2):83-4
- Origin of adventitious roots from leaf cuttings of *Saintpaulia ionantha* Wendl. (Schmitkons), (2):105
- Preliminary report of a study of the plants of Winnebago County, Ill. (Fernald), (2):89
- Paleobotanical significance of plant structure in coal (Schopf), (2):106-110
- Range indicator method in pH determinations of plant tissues (Stanfield), (2):113-4
- Simple apparatus for the steam method of softening woods for microscopic sections (Davis and Stover), (2):87
- Size and ornamentation of some modern and fossil Lycopod spores (Henbest), (2):91-2
- Some Paleozoic gymnosperm seeds and their evolution (Noé), (2):100
- Status of the southern shortleaf pine in the northwestern Ozark region (Turner), (2):115-6
- Types of pitting in conifers (Peirce), (2):101-4
- Wild life sanctuaries (Jensen), (2):93-4
- Boyajian, J. A., On growing bismuth single crystals, (2):213-4
- Brannon, J. M., and Prucha, M. J., Studies in milk pasteurization (2):203-4

- Brucella abortus*, results of examining pasteurized and unpasteurized milk for (Torrey and Graham), (2):207-8
- Burial mound near Quincy, Illinois, new type of (Thurber), (2):67-8
- Calopogon pulchellus* (SW) R. BR., germination of the seed and development of the seedling of (Carlson), (2):85-6
- Canada thistles in Illinois (Barnes), (2):50-1
- Carbon-ratio theory in Illinois, status of the (Bell), (2):183
- Carlson, Margery C., Germination of the seed and development of the seedling of *Calopogon pulchellus* (SW) R. BR., (2):85-6
- Carpenter, Benjamin, The atomic beam as a spectroscopic source, (2):215-6
- Chemistry**
- Detection of fortification or adulteration of meat broth with monosodium glutamate (Englis and Friedman) (2):119-20
- Illinois fluorspar as a chemical raw material (Reed and Finger), (2):129-30
- Inexpensive ball mill for general use (Quill), (2):127-8
- Onium salts as acids—reactions of ammonium chloride at higher temperatures (Schmidt and Audrieth), (2):133-4
- Physiological responses to vitamin E feeding (Pacini), (2):125-6
- Reactions in fused pyridine hydrochloride (Long and Audrieth), (2):121-2
- Tests for metal ions making use of organic dyes (Long and Tenney), (2):123-4
- Micro methods in qualitative analysis (Reedy), (2):131-2
- Church, Phil E., Surface temperatures of the Gulf Stream and the waters on its margins, (2):151-2
- Coal formation, temperature during (Thiessen), (2):184-5
- Coalification, geologic dating of time of (Fisher), (2):179-80
- Coalification, possible relations of mineral matter in coal to the time of (Ball), (2):181-2
- Coal No. 6, local calorific variations and the geological implications, (Benson), (2):186-7
- Coal No. 6, spores characteristic of Illinois (Schopf), (2):173-6
- Coal, paleobotanical significance of plant structure in (Schopf), (2):106-110
- Coal, significance of banded ingredients in (McCabe, L. C.), (2):188-90
- Coals, results obtained by chromic-sulphuric acid etching of (McCabe, W. S.), (2):177-8
- Codling moth larvae for testing insecticides, rearing (Farrar and McGovran), (2):245-7
- Conifers, types of pitting in (Pierce), (2):101-4
- Conservation of the wild flowers of Illinois (Mauntel), (2):97-8
- Corn, effect of seed coat injury on germination, vigor, and yield of (Koehler), (2):52-4
- Corn yield and climate in Illinois (Rose), (2):165-6
- Crew, Henry, An appraisal of the definitive system of units, (2):217-23
- Crow, Leonard R., A polyphase electric gun, (2):227-8
- Crow, Leonard R., Rotating magnetic fields, (2):225-6
- Cutshall, Alden D., Gazetteer of the origin of Illinois nomenclature, (2):167-8
- Davis, Glenn E., and Stover, E. L., Simple apparatus for the steam method of softening woods for microscopic sections, (2):87
- Definitive system of units, an appraisal of the (Crew), (2):217-23
- Dental pathology of prehistoric man at the confluence of the Ohio and Mississippi rivers (Andrews), (2):76
- Detection of fortification or adulteration of meat broth with monosodium glutamate (Englis and Friedman), (2):119-20
- Dog, dental variations of the (Adams), (2):243-4
- Dryopithecus tooth pattern as a racial characteristic of the Mound Builders (Ruyle), (2):77-8
- Eaton, Scott V., Effects of sulphur deficiency on the growth and metabolism of the soy bean, (2):88
- Economics**
- Future population in the agricultural industry in the State of Illinois (Lindstrom), (2):141-2
- History and forecast of population of the State of Illinois (Kellogg), (1):19-30

- Industrial opportunities in Illinois for the absorption of a growing wage-earning population (Newton), (2):145-6
- Occupational changes in the gainfully employed population of Illinois from 1870 to 1930 with economic consequences (Kellogg), (2):137-42
- Population problems in Illinois mining communities (Voskuil), (2):143-4
- Electric gun, a polyphase (Crow), (2):227-8
- Englis, E. T., and Friedman, B. S., Detection of fortification or adulteration of meat broth with monosodium glutamate, (2):119-20
- Essenberg, J. M., Effect of X-rays on the incubation period, sexual development, egg-laying capacity, and brooding tendencies in white and brown leghorn chickens, (2):251-2
- Fabry-Perot interferometer, a modified form of (Machler), (2):233
- Farrar, M. D., and McGovran, E. R., Rearing codling moth larvae for testing insecticides, (2):245-7
- Ferguson, Harry Foster (memoir), (1):33-4
- Fernald, Evelyn I., Preliminary report of a study of the plants of Winnebago County, Illinois, (2):89
- Finger, G. C., with Reed, Frank H., Illinois fluorspar as a chemical raw material, (2):129-30
- Fisher, D. Jerome, Geologic dating of time of coalification, (2):179-80
- Fleshy ascomycetes from east central Illinois, collection of (Marks and Stover), (2):95-6
- Fluorspar as a chemical raw material (Reed and Finger), (2):129-30
- Freeman, Ira M., Some topics in physiological mechanics, (2):229-30
- Friedman, Bernard S., with Englis, E. T., Detection of fortification or adulteration of meat broth with monosodium glutamate, (2):119-20
- Fuel oil, some effects on plants (Fuller and Leadbeater), (2):99
- Fuller, George D., and Leadbeater, Margaret R., Some effects of fuel oil on plants, (2):99
- Furrow, Clarence Lee, Sex conditions in a Japanese valvata, (2):253-4
- Gault, Robert H., Implications of vibro-tactile phenomena, (2):205-6
- Gazetteer of the origin of Illinois nomenclature (Cutshall), (2):167-8

## Geography

- Bloomington-Normal, a field study of (Odell), (2):153-8
- Corn yield and climate in Illinois (Rose), (2):165-6
- Gazetteer of the origin of Illinois nomenclature (Cutshall), (2):167
- Guatemalan banana farm (Platt), (2):159-60
- Industrial survey of LaSalle-Peru-Oglesby (Robinson), (2):163-4
- London and Paris: a comparison of their locations (Poggi), (2):161-2
- Palestine in transformation (Blanchard), (2):149-150
- Surface temperatures of the Gulf Stream and the waters on its margins (Church), (2):151-2

## Geology

- Bottom sediments of southern Lake Michigan (Hough), (2):197
- Geological setting of the Aurora mastodon remains (Powers), (2):195-6
- Geologic dating of time of coalification (Fisher), (2):179-80
- "Grassy Creek" shale (Weller), (2):191-2
- Local calorific variations in coal No. 6 (Benson), (2):186-7
- Mastodon and other finds at Aurora (Smith), (2):195-6
- New medium for teaching geology in the Middle West (Shepherd), (2):198
- Possible relations of mineral matter in coal to the time of coalification (Ball), (2):181-2
- Some problems in the origin of the mineral veins (Behre), (1):5-18
- Some recent attempts to correlate the later Paleozoic of America and Europe (Noé), (2):171-2
- Results obtained by chromic-sulphuric acid etching of Illinois coals (McCabe, W. S.), (2):177-8
- Significance of banded ingredients in coal (McCabe, L. C.), (2):188-9
- Spores characteristic of Illinois coal No. 6 (Schopf), (2):173-6
- Status of the carbon-ratio theory in Illinois (Bell), (2):183
- Temperature during coal formation (Thiessen), (2):184-5
- Graham, Robert, with Torrey, J. P., Results of examining pasteurized and unpasteurized milk for *Brucella abortus*, (2):207-8

- "Grassy Creek" shale (Weller), (2):191-2
- Gray, William T., Temperature of the gas in an interrupted carbon arc, (2):231-2
- Guatemalan banana farm (Platt), (2):159-60
- Gulf Stream and the waters on its margins, surface temperatures of the (Church), (2):151-2
- Gumbart, Louis F., Some thoughts on popularizing botany, (2):90
- Hague, Stella M., with Boewe, G. H., and Barrick, Stella H., Mosses from Apple River Canyon, Mississippi Palisades, and White Pines Forest State Parks, (2):83-4
- Henbest, Orrin J., Size and ornamentation of some modern and fossil Lycopod spores, (2):91-2
- History and forecast of population of the State of Illinois (Kellogg), (1):19-30
- Hottes, C. F., Physiology of seed germination, (2):49
- Hough, J. L., Bottom sediments of southern Lake Michigan, (2):197
- Hyperthyroidism, modifications induced in the plumage of *Passer domesticus* (Linnaeus) by experimental (Miller), (2):257-8
- Indian mounds, a method of restoration of (McCoy), (2):69-70
- Indian, our debt to the (Jordan), (2):71-2
- Industrial opportunities in Illinois for the absorption of a growing wage-earning population (Newton), (2):145-6
- Industrial survey of LaSalle-Peru-Oglesby (Robinson), (2):163-4
- Insects in relation to production of red clover seed (Bigger), (2):160-3
- Japanese *valvata*, sex conditions in a (Furrow), (2):253-4
- Jensen, Jens, Wild life sanctuaries, (2):93-4
- Jordan, R. V., Our debt to the Indian, (2):71-2
- Kellogg, H. L., History and forecast of population of the State of Illinois, (1):19-30
- Kellogg, H. L., Occupational changes in the gainfully employed population of Illinois from 1870 to 1930 with economic consequences, (2):137-40
- Koehler, Benjamin, Effect of seed coat injury on germination, vigor, and yield of corn, (2):52-4
- Ladybeetles, the bionomics of the (Balduf), (2):248
- Lake Michigan, bottom sediments of southern (Hough), (2):197
- Leadbeater, Margaret R., with Fuller, G. D., Some effects of fuel oil on plants, (2):99
- Lindstrom, D. E., Future population in the agricultural industry in the State of Illinois, (2):141-2
- London and Paris: a comparison of their locations (Poggi), (2):161-2
- Long, A., and Audrieth, L. F., Reactions in fused pyridine hydrochloride, (2):121-2
- Long, H. J., and Tenney, H. M., Some tests for metal ions making use of organic dyes, (2):123-4
- Lycopod spores, size and ornamentation of some modern and fossil (Henbest), (2):91-2
- McCabe, Louis C., Significance of banded ingredients in coal, (2):188-90
- McCabe, W. S., Results obtained by chronic-sulphuric acid etching of Illinois coals, (2):177-8
- McGovran, E. R., with Farrar, M. D., Rearing codling moth larvae for testing insecticides, (2):245-7
- McCoy, H. V., Method of restoration of Indian mounds, (2):69-70
- Machler, R. C., A modified form of Fabry-Perot interferometer, (2):233
- Marks, Ica, and Stover, E. L., Collection of fleshy ascomycetes from east central Illinois, (2):95-6
- Marsh, Charles R., An easily constructed oxygen liquefier, (2):234
- Marsh Willow sawfly (*Amauronematus lineatus*), an Illinois (Ross), (2):261-2
- Mastodon and other finds at Aurora (Smith), (2):195-6
- Mastodon remains, geological setting of the Aurora (Powers), (2):193-4
- Mattox, Norman T., Annular rings in the long bones of turtles and their correlation with size, (2):255-6
- Mauntel, Harry W., Conservation of the wild flowers of Illinois, (2):97-8
- Medicine and Public Health**
- Implications of vibro-tactile phenomena (Gault), (2):205-6

- Results of examining pasteurized and unpasteurized milk for *Brucella abortus* (Torrey and Graham), (2):207-8  
 Rickets: its cause, effect, and prevention (Beard), (2):201-2  
 Studies in milk pasteurization (Brannon and Prucha), (2):203-4

### Memoirs

- Ferguson, Harry Foster, (1):33-4  
 Richardson, Robert Earl, (1):35  
 Stevens, Frank Lincoln, (1):36-8  
 Washburn, Edward Dwight, (1):39-40  
 Merwin, Bruce W., Archaeology in southern Illinois, (2):79-80  
 Micro methods in qualitative analysis (Reedy), (2):131-2  
 Milk pasteurization, studies in (Brannon and Prucha), (2):203-4  
 Mineral veins, some problems in the origin of (Behre), (1):5-18  
 Miller, Dorothea Starbuck, Modifications induced in the plumage of *Passer domesticus* (Linnaeus) by experimental hyperthyroidism, (2):257-8  
 Mizelle, John D., The destruction of bird life by hail, (2):266  
 Moore, L. A., The purity of Illinois seed stocks as revealed by seed analysis studies, (2):55-7  
 Mosses from Apple River Canyon, Mississippi Palisades, and White Pines Forest State Parks (Boewe, Barrick, and Hague), (2):83-4  
 Newlin, Walter A., Sweet clover seed production, (2):58-9  
 New medium for teaching geology in the Middle West (Shepherd), (2):198  
 New species of *Zancklophorus* from *Cryptobranchus alleganiensis* (Walton), (2):267-8  
 Newton, William A., Industrial opportunities in Illinois for the absorption of a growing wage-earning population, (2):145-6  
 Noé, A. C., Some Paleozoic gymnosperm seeds and their evolution, (2):100  
     Some recent attempts to correlate the later Paleozoic of America and Europe, (2):171-2  
 Occupational changes in the gainfully employed population of Illinois from 1870 to 1930 with economic consequences (Kellogg), (2):137-40  
 Odell, Clarence Burt, Field study of Bloomington-Normal, (2):153-8  
 Onium salts as acids—reactions of ammonium chloride at higher temperatures (Schmidt and Audrieth), (2):133-4  
 Origin of adventitious roots from leaf cuttings of *Saintpaulia ionantha* Wendl. (Schmitkons), (2):105  
 Overbeck, Clarence J., Design of some elementary physics laboratory apparatus, (2):235-6  
 Oxygen liquefier, an easily constructed (Marsh), (2):234  
 Pacini, August J., Some physiological responses to vitamin E feeding, (2):125-6  
 Paleozoic gymnosperm seeds and their evolution (Noé), (2):100  
 Palestine in transformation (Blanchard), (2):149-50  
 Peirce, Alan S., Types of pitting in conifers, (2):101-4  
 Peithman, Irvin, Bannerstones and related ceremonial objects from southern Illinois, (2):73-4  
 Pennington, Margaret S., Visual cells of a nocturnal animal, (2):259-60

### Physics

- Atomic beam as a spectroscopic source (Carpenter), (2):215-6  
 Barometer readings, a convenient chart for correcting (Anderson), (2):211-2  
 Bismuth single crystals, on growing (Boyajian), (2):213-4  
 Definitive system of units, an appraisal of the (Crew), (2):217-23  
 Elementary physics laboratory apparatus, design of some (Overbeck), (2):235-6  
 Fabry-Perot Interferometer, a modified form of (Machler), (2):233  
 Multiple-scale voltmeters in the laboratory, protection of (Railsback), (2):237-8  
 Oxygen liquefier, an easily constructed (Marsh), (2):234  
 Polyphase electric gun (Crow), (2):227-8  
 Ripple tank experiments (Boomer), (2):224  
 Rotating magnetic fields (Crow), (2):225-6  
 Temperature of the gas in an interrupted carbon arc (Gray), (2):231-2  
 Thermodynamic surfaces, models of (Verwiebe), (2):239-40  
 Physiological mechanics, some topics in (Freeman), (2):229-30

- Plants of Winnebago County, Illinois, preliminary report of a study of the (Fernald), (2):89
- Plants, some effects of fuel oil on (Fuller and Leadbeater), (2):99
- Platt, Robert S., A Guatemalan banana farm, (2):159-60
- Poggi, Muriel E., London and Paris: a comparison of their locations, (2):161-2
- Population problems in Illinois mining communities (Voskuil), (2):143-4
- Powers, William E., Geological setting of the Aurora Mastodon remains, (2):193-4
- Prucha, M. J., with Brannon, J. M., Studies in milk pasteurization, (2):203-4
- Quill, Laurence L., An inexpensive ball mill for general use, (2):127-8
- Railsback, O. L., Protection of multiple-scale voltmeters in the laboratory, (2):237-8
- Range indicator method in pH determination of plant tissues (Stanfield), (2):113-4
- Reactions in fused pyridine hydrochloride (Long and Audrieth), (2):121-2
- Recent attempts to correlate the later Paleozoic of America and Europe (Noé), (2):171-2
- Reed, Frank H., and Finger, G. C., Illinois fluorspar as a chemical raw material, (2):129-30
- Reedy, J. H., Micro methods in qualitative analysis, (2):131-2
- Richardson, Robert Earl (memoir), (1):35
- Rickets: its cause, effect, and prevention (Beard), (2):201-2
- Ripple tank experiments (Boomer), (2):224
- Robinson, Mary A., Industrial survey of LaSalle-Peru-Oglesby, (2):163-4
- Rose, John Kerr, Corn yield and climate in Illinois, (2):165-6
- Rose Mallows, germination behavior of (Shull), (2):111-2
- Ross, Herbert H., An Illinois Marsh Willow sawfly (*Amauronematus lineatus*), (2):261-2
- Rotating magnetic fields (Crow), (2):225-6
- Ruyle, R. B., *Dryopithecus* tooth pattern as a racial characteristic of the Mound Builders, (2):77-8
- Schmidt, Marvin T., and Audrieth, L. F., Onium salts as acids—reactions of ammonium chloride at higher temperatures, (2):133-4
- Schmitkons, Katherine Louise, Origin of adventitious roots from leaf cuttings of *Saintpaulia ionantha* Wendl., (2):105
- Schopf, James M., Paleobotanical significance of plant structure in coal, (2):106-110
- Spores characteristic of Illinois coal No. 6, (2):173-6
- Seed germination, physiology of (Hottes), (2):49
- Seed production, sweet clover (Newlin), (2):58-9
- Seed stocks, purity as revealed by seed analysis studies (Moore), (2):55-7
- Shepherd, G. Frederick, New medium for teaching geology in the Middle West, (2):198
- Shull, Charles A., Germination behavior of the Rose Mallows, (2):111-2
- Smith, Clarence R., Mastodon and other finds at Aurora, (2):195-6
- Some interesting pre-Linnaean names (Van Cleave), (2):263-5
- Some thoughts on popularizing botany (Gumbart), (2):90
- Soy bean, effects of sulphur deficiency on the growth and metabolism of the (Eaton), (2):88
- Stanfield, J. Fisher, Range indicator method in pH determinations of plant tissues, (2):113-4
- Status of the southern shortleaf pine in the northwestern Ozark region (Turner), (2):115-6
- Steam method of softening woods for microscopic sections, simple apparatus for (Davis and Stover), (2):87
- Stevens, Frank Lincoln (memoir), (1):36-8
- Stover, E. L., with Davis, Glenn E., Simple apparatus for the steam method of softening woods for microscopic sections, (2):87
- Stover, E. L., with Marks, Ica, Collection of fleshy ascomycetes from east central Illinois, (2):95-6
- Temperature of the gas in an interrupted carbon arc (Gray), (2):231-2
- Tenney, Horace M., with Long, H. J., Some tests for metal ions making use of organic dyes, (2):123-4

- Tests for metal ions making use of organic dyes (Long and Tenney), (2):123-4
- Thermodynamic surfaces, models of (Verwiebe), (2):239-40
- Thiessen, Gilbert, Temperature during coal formation, (2):184-5
- Turber, O. D., New type of burial mound near Quincy, Illinois (2):67-8
- Torrey, J. P., and Graham, Robert, Results of examining pasteurized and unpasteurized milk for *Brucella abortus*, (2):207-8
- Turner, Lewis M., Status of the southern shortleaf pine in the northwestern Ozark region, (2):115-6
- Turtles, annular rings in long bones and their correlation with size (Mattox), (2):255-6
- Van Cleave, Harley Jones, Some interesting pre-Linnaean names, (2):263-5
- Verwiebe, Frank L., Models of thermodynamic surfaces, (2):239-40
- Vibro-tactile phenomena, implications of (Gault), (2):205-6
- Visual cells of a nocturnal animal (Pennington), (2):259-60
- Vitamin E feeding, some physiological responses to (Pacini), (2):125-6
- Voltmeters in the laboratory, protection of multiple-scale (Railsback), (2):237-8
- Voskuil, W. H., Population problems in Illinois mining communities, (2):143-4
- Walton, A. C., A new species of *Zanichlophorus* from *Cryptobranchus alleganiensis*, (2):267-8
- Washburn, Edward Dwight (memoir), (1):39-40
- Weller, J. Marvin, "Grassy Creek" shale, (2):191-2
- Winnebago County, Illinois, preliminary report of a study of the plants of (Fernald), (2):89
- Wild life sanctuaries (Jensen), (2):93-4
- X-rays, effect on the incubation period, sexual development, egg-laying capacity, and brooding tendencies in white and brown leghorn chickens (Essenberg), (2):251-2

### Zoology

American Eagle, occurrence along the Ohio River in Illinois (Bonnell), (2):249-50

Annular rings in the long bones of turtles and their correlation with size (Mattox), (2):255-6

Bionomics of the ladybeetles (Balduf), (2):248

Codling moth larvae for testing insecticides, rearing (Farrar and McGovran), (2):245-7

Dental variations of the dog (Adams), (2):241-2

Destruction of bird life by hail (Mizelle), (2):266

Japanese valvata, sex conditions in a (Furrow), (2):253-4

Marsh Willow sawfly, an Illinois (*Amaurone matius lineatus*) (Ross), (2):261-2

Modifications induced in the plumage of *Passer domesticus* (Linnaeus) by experimental hyperthyroidism (Miller), (2):257-8

New species of *Zanichlophorus* from *Cryptobranchus alleganiensis* (Walton), (2):267-8

Some interesting pre-Linnaean names (VanCleave), (2):263-5

Visual cells of a nocturnal animal (Pennington), (2):259-60

X-rays, effect on the incubation period, sexual development, egg-laying capacity, and brooding tendencies in white and brown leghorn chickens, (Essenberg), (2):251-2

TRANSACTIONS  
OF THE  
ILLINOIS STATE  
ACADEMY OF SCIENCE

VOLUME XXVIII  
1935-1936



EDITED BY DOROTHY E. ROSE

PRINTED BY THE AUTHORITY OF THE STATE OF ILLINOIS  
DEPARTMENT OF REGISTRATION AND EDUCATION  
STATE MUSEUM DIVISION, CENTENNIAL BUILDING  
SPRINGFIELD, ILLINOIS



## VOLUME XXVIII

---

### NUMBER 1—SEPTEMBER, 1935

Papers Presented in General Session at the Twenty-eighth Annual Meeting, Bloomington, May 3 and 4, 1935, pages 1-40.

### NUMBER 2—DECEMBER, 1935

Papers Presented in the Twenty-eighth Annual Meeting, Bloomington, May 3 and 4, 1935, pages 41-268.

### NUMBER 3—MARCH, 1936

Announcement of the Twenty-ninth Annual Meeting, Quincy, May 1 and 2, 1936, pages 268-280.

### NUMBER 4—JUNE, 1936

Minutes of Meetings of the 1935-36 Council; Minutes of the Twenty-ninth Annual Meeting; Reports of Officers and Committees; Constitution and By-Laws; Index to Volume 28; pages 281-320



STATE OF ILLINOIS  
HENRY HORNER, Governor

---

TRANSACTIONS  
OF THE  
ILLINOIS STATE  
ACADEMY OF SCIENCE

---

VOLUME 29

SEPTEMBER, 1936

NUMBER 1

---

Papers Presented in General Session at the  
Twenty-ninth Annual Meeting  
Memoirs



EDITED BY DOROTHY E. ROSE

DEPARTMENT OF REGISTRATION AND EDUCATION  
STATE MUSEUM DIVISION, CENTENNIAL BUILDING  
SPRINGFIELD, ILLINOIS

PRINTED BY AUTHORITY OF THE STATE OF ILLINOIS

---

PUBLISHED QUARTERLY

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

STATE OF ILLINOIS  
HON. HENRY HORNER, *Governor*  
DEPARTMENT OF REGISTRATION AND EDUCATION  
HON. JOHN J. HALLIHAN, *Director*  
STATE MUSEUM DIVISION  
ARTHUR S. COGGESHALL, *Chief*

---

ILLINOIS STATE ACADEMY OF SCIENCE  
AFFILIATED DIVISION OF THE  
STATE MUSEUM

OFFICERS FOR 1936-37

*President*, CLARENCE LEE FURROW,  
Knox College, Galesburg, Illinois

*First Vice-President*, HAROLD ROLLIN WANLESS,  
University of Illinois, Urbana, Illinois

*Second Vice-President*, EVELYN IDA FERNALD,  
Rockford College, Rockford, Illinois

*Secretary*, WILBUR M. LUCE,  
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 November, 1936



(14948)

CONTENTS

---

	PAGE
CHARLES D. SNELLER, The Mucous Membrane of the Nose ( <i>Address of the Retiring President</i> ).....	5
A. C. IVY, The Endocrine Glands.....	9
MEMOIRS	
WALTER GAVIN BAIN.....	17
THOMAS LEROY HANKINSON.....	19



# The Mucous Membrane of the Nose\*

Charles D. Sneller, M. D.  
*Peoria, Illinois*

THE NOSE is a remarkable organ. It has many functions very essential to the well-being of the individual. By nose we refer not merely to that proboscis projecting from the middle of the face but more particularly to its interior. This interior is made up of a right and left chamber, each about  $4\frac{1}{2}$  inches long from the front to the back, about  $2\frac{1}{2}$  inches high, and about  $\frac{1}{2}$  to  $\frac{3}{4}$  inch wide. It is the structure, the physiology, and the extent of this wall, or mucous membrane, with which this paper is concerned.

A very long time ago, between 500 and 1000 million years Paleontologists tell us, the most primitive form of animal life was a bit of animated "jelly" or protoplasm. This unicellular organism moved about in the primeval muck of the warm ocean. It must have had irritability, the power to react to its surrounding watery world, and to defend itself against destructive forces, i.e. chemical, physical, and living enemies. It must also have possessed the power of digestion and assimilation, so very essential to life itself. It must also have been able to remove oxygen from its watery environment. Lastly it surely possessed the power of reproduction so that life itself could move forward.

It was not long until external modifications of the protoplasm occurred. Finger-like processes grew out of the single cell. These cilia could move about and therefore came into greater contact with the world about. Locomotion was established. New territories were found. New experiences required adaptation and modification. And so were born cilia like those of our own mucous membrane which must have warmth, moisture, exact chemical surroundings and protection in order to function properly in this modern animal called man.

Next we come to a second consideration which takes us back to Devonian time about 350 million years ago. At this time the recently perfected backboned fish had appeared in the seas. They had made many experiments in form, size, and adaptation. The day arrived when they began to explore the shallow land streams. The hot and dry summer months came and these adventurers found themselves trapped in the dried-up pools or mud holes. Many died, but some had the power to accommodate themselves to their new environment. No longer could they take water through their gills and thereby get the oxygen needed for their very existence. Now those who were able quickly to develop

---

\* Abstract address of the Retiring President. Presented before the General Session at the Twenty-ninth Annual Meeting of the Illinois Academy of Science, May 1, 1936.

a pouch in the front part of the foregut were able to make use of the first lung. This first lung must have been very crude. Today we find lung-fish in certain streams of Australia and South America. Their gills are used during the wet season, and their very primitive lungs come into their own as quickly as the stream dries up in hot summer months.

A third consideration deals with a concept of man as a whole. Man may be defined as a tubular mass of cells arranged into tissues and organs with a tube passing from one end, the mouth and nose, to the other, the anus. Just like simpler organisms, this tubular mass of cells is covered by a protecting coat called the skin or epidemics. The long tube is lined inside by a specially constructed coat called the mucous membrane. These coats, the external and internal, are the great protectors of the organism which lies between them. If the coats are intact, no enemy can enter the host. Life might go on forever in an organism were it not for the invading enemies which eventually destroy all.

The most remarkable part of this inner coat or protecting membrane is the nasal part. In this membrane "fortifications" have been built through long phylogenetic improvements for the defence of the grand array of cells and organs called the human being.

We have touched briefly upon the early history of the cilia, the formation of the primitive respiratory system and the relationship of these structures to the tubular mass called Man. Now let us consider briefly the more essential functions of the grand entrance to Man's interior, the NOSE.

The nose is divided into right and left chambers which run from the front part of the nose, seen on the face, back to the entrance into the throat—the naso-pharynx. Projecting into these chambers from the outer walls are three masses of extremely vascular tissue surrounding elongated pieces of bone. These masses are called turbinates and are under sympathetic nerve control.

The chambers of the nose are lined throughout by a mucous membrane. This is modified here and there by the presence of the turbinates and the openings to cavities called sinuses. The membrane is composed of an inner layer of ciliated epithelium and a submucous supporting layer. From each cell of this membrane project six to twelve little finger-like processes called cilia. There are also a great many little glands in this membrane which secrete a mucus. This constantly bathes it through its entire extent. The mucus consists of about 95 per cent water, 4 per cent mucin, and 1 per cent solids. The cilia are constantly bathed and wave back and forth in rhythmic movements or "beats," six to eight times per second.

Rhythmic movements of cilia are in definite directions like wheat in a field being blown by the wind. Bits of carbon, when placed upon the mucous membrane in various places, are carried in these definite directions by the action of the constantly beating cilia. The nervous

system does not control their movements as demonstrated by taking bits of mucosa out of the nose, placing them in a physiological saline and seeing them still wave under a microscope. Here it can be observed that oils inhibit their movement while aqueous solutions of medications, such as  $\frac{1}{4}$  per cent ephedrin, stimulate their action.

Of tremendous importance to the health of the Nation is the drying of this membrane during the cold months of the winter when most people are confined in steam-heated apartments. The amount of moisture in this air is so far below the amount in the nasal mucous membrane that some of the moisture leaves the membrane and passes into the air. As the membrane dries, the cilia have greater and greater difficulty in moving dirt, bacteria, and other injurious products and rendering them harmless. The cilia must have moisture for movement and life, just as the cilia in the most primitive organisms. The nasal mucous membrane is capable of secreting about one quart of water a day. If most of this passes into the drier air, the cilia must be rendered useless or must die.

Bacteria, which are always being harboured in or on the mucous part of the membrane, penetrate the membrane between the dead or dying cilia and get into the underlying tissues. We then have the condition we call inflammation of the nose. The membranes swell. We have difficulty in getting air through the nose. We absorb toxins or poisons which the bacteria are making. No longer is the remarkable bacteriolytic action of the mucus capable of helping to defend the entrance to the body. The temperature rises. We go to bed. We have a bad case of coryza due to the drying of the mucous membrane. It may not be long before the infection has spread downward into the lining of the larynx, trachea, and bronchi. If we are more fortunate we may escape pneumonia.

Extending outward and backward from the nasal chambers are about eighteen cavities in the bones of the face and skull. These are the sinuses. They act as resonating chambers for the voice. They are lined with a membrane thinner than that of the nasal chambers. These sinuses, usually nine on each side of the nose, may likewise become infected and then the well known sinus infection develops. Various ailments affecting many other parts of the body may in time develop from unhealed sinus infections. All of these conditions might have been avoided if care in the protection of the cilia, phylogenetically very old, had been instituted before they were dried out or killed.

It may be of interest at this point to compare the size of the nasal chambers to that of a large hall. If we were to magnify the chambers three thousand times, we would witness a hall 300 feet high with cilia about one inch in height covering the walls and with bacteria about  $\frac{1}{6}$  to  $\frac{1}{3}$  of an inch long moving in the layer of mucus. Many rooms would be found to lead out through single doors from the sides, near the roof, and backward. These rooms would likewise be lined with a ciliated

wallpaper. The halls would be kept moist by the thousands of mucous glands in the walls and would be kept warm by the two sets of radiators called turbinates. These would be suspended part way up the lateral walls. They would have pipes of blood vessels about as large and as close together as the pipes in the radiators of our houses. These pipes would, however, be elastic. They could swell so that more warm blood would rush into the radiators or they could shrink so that less heat would be brought into the chambers. All of this would be under the control of the marvelous sympathetic nervous system, really an electrical system, without conscious control.

### SUMMARY

Man may be defined as a tubular mass of cells having two protective coats, one covering the outside and the other lining the central tube. The various organs lie between the two coats. The respiratory system is an outgrowth of the forepart of this tube, as in the lung-fish. The nose is one of the two entrances to the tube. It has developed into a remarkable organ for the protection not only of the respiratory system but also of the entire organism.

The nose has many functions, some of which are:

(1) Olfactory. The uppermost parts of the chambers have numerous end-organs for smell. They are but little developed in man as compared with many other animals.

(2) Respiratory. Air normally enters and leaves the respiratory system through the nose.

(3) Temperature regulator. The very vascular turbinates act as radiators to warm the air before it reaches the more delicate and sensitive bronchi and lungs.

(4) Moisture regulator. The entire respiratory system requires moisture in order that its ciliated mucous membrane may function. The mucous glands of the nose secrete about one quart of water a day.

(5) Expulsion of foreign matter. By the act of sneezing and by the ciliary action this matter is expelled.

(6) Bacteriostatic action. The mucus has the power to inhibit the growth of and often to kill many bacteria.

(7) Resonating chambers. The nasal chambers and the sinuses act as resonating chambers to improve the quality of the voice.

# The Endocrine Glands

A. C. Ivy, Ph.D., M. D.

*Nathan Smith Davis Professor of Physiology, Northwestern University  
Medical School, Chicago, Illinois*

It is an evident fact that the human body, in truth every living organism, must maintain itself in a relatively steady state (homeostasis). Life can exist only within certain limits of variation in the internal and external environment. Every action or change in the internal environment of the body is normally accompanied or followed by a compensatory action or change. For example, if an increased production of heat occurs in the body a mechanism is initiated for disposing of the heat; or when after a meal containing starches or sugar the blood sugar rises, a corrective process is instituted to decrease the blood sugar. The state of the body at any moment is a sum of the "positive" and "negative" processes going on.

In order to maintain a steady state, the bodily processes must be subject to excitation or inhibition; some way of speeding up or slowing down processes must exist.

The chief agencies through which bodily processes are augmented and retarded, or controlled, are: (1) the nervous system and (2) the hormone secreting cells or organs. The nerves, conducting nerve impulses, are nervous regulators of metabolism and the activities of the body. The hormones are chemical regulators of metabolism and the activities of the body. We are interested in this lecture in the hormonal regulation of the body, although in some instances the nerves regulate the production of hormones.

The hormones are secreted into the blood and/or lymph by glands without ducts, in contrast to such glands as the salivary glands. Hence, the terms "Ductless Glands" and "Glands of Internal Secretion" are applied to the hormone producing glands. The term, "Endocrine Glands" is also used, which means "to separate within." The hormones or internal secretions have been called autacoids, meaning self-remedial substances, because they act much like drugs or remedial agents. It is believed that two sorts of autacoids exist functionally, hormones (to excite) which speed-up bodily processes, and, chalones (to make slack), which slow-down bodily processes.

The endocrine glands concerning which we know most are as follows: The pituitary gland or hypophysis, which is located at the base of the brain almost in the center of the skull. It is divided into three parts, the anterior lobe, the posterior lobe and the intermediate part.

The parathyroids and the thyroid lobes are located in the neck just below the larynx and on each side of the trachea. The thymus, which may or may not produce a hormone is located in the upper part of the chest beneath the sternum or breast bone. The mucous lining of the stomach and upper intestine produce several hormones and a chalone. The "islets of Langerhans," cells located in the pancreas, secrete a hormone, the remainder of the pancreatic cells form the external or digestive secretion of the pancreas. The adrenal glands are located just above the kidneys. The ovaries and testicles, or the gonads, and the placenta secrete hormones. Some think that the liver secretes a hormone or hormones. In fact, there is some evidence which suggests that the endings of some nerves (autonomic nerves) give off hormones which actually cause smooth muscle to contract or relax and glands to secrete.

*The Pituitary Gland.*—The posterior lobe of the pituitary gland, which receives nerves from the hypothalamus or the base of the brain, controls water metabolism. When it or the appropriate region in the hypothalamus is destroyed or injured, as sometimes occurs in skull fracture, an animal or a human secretes a lot of pale urine (diabetes insipidus) and thirst is excessive. This abnormality may be corrected by injecting an appropriately made extract (pituin, antidiuretic principle) of the lobe subcutaneously. An extract of the gland (pituin, oxytocic principle) may be made which causes the uterus to contract and is used rather extensively in obstetric practice.

The anterior lobe secretes a number of hormones, it is believed; some say two, others five, and still others say ten or twelve. When the anterior lobe is removed in a young animal, the animal does not grow and the gonads do not develop and the thyroid and adrenals atrophy (pituitary infantilism). In the adult slow cachexia (Simond's disease) and death may result. The following extracts may be made from the anterior lobe: (1) An extract, phyone or somatotropin, that causes growth in hypophysectomized animals; (2) gonadotropin, follicle stimulating and lutein stimulating, that causes development of the testicles and ovaries, and certain changes in the ovary such as development of the follicle, corpus luteum, and ovulation; (3) prolactin, that causes development of the mammary gland and the secretion of milk; (4) thyrotropin, that causes growth of the thyroid; (5) adrenotropin that causes growth of the adrenals. There is also a relation between the anterior lobe and pancreatic or sugar diabetes. If the pancreas is removed from an animal it develops diabetes, the blood sugar rises abnormally and sugar is excreted in the urine. Now, if the anterior lobe is removed, the sugar usually disappears from the urine. Because of the diversified influences of the anterior lobe it has been referred to as "governor of the endocrines," the "motor of the ovaries," etc. If the anterior lobe does not produce adequate growth hormone, a pituitary dwarfism results. Such dwarfs may have normal gonads, and

reproduce normal offspring; yet, in many instances when growth hormone is not produced in adequate amounts, the gonad stimulating hormone is also inadequately produced. In such a case, of course, reproduction cannot occur. Sometimes boys or girls grow normally, but do not develop sexually, and become excessively fat (Froelich's syndrome, Dicken's fat-boy type). In such instances, a tumor of the anterior lobe may be found on X-ray examination. Although the failure of sexual development is generally ascribed to deficiency of the anterior lobe, the cause of the obesity is ascribed to a disturbance of the hypothalamus because it is claimed that with a normal anterior lobe an injury of the hypothalamus in the rat causes very marked obesity. In this connection it must be kept in mind that defective thyroid secretion may also cause obesity, but the type of obesity or the places at which excessive fat is deposited differs in the two conditions. In a few human patients anterior lobe extracts have been given with apparent improvement in the presence of stunted growth, stunted sexual development, and excessive obesity. Unfortunately, in many cases no improvement results; but it may be hoped that in the future more potent extracts for the human will be made and patients will be treated earlier when the possibility of success is greater.

When too much growth hormone is produced prior to or during pubertal growth, a pituitary giant (7-8 ft.) is said to result. When too much growth hormone is produced after 21 years of age, or after the period during which growth of the long bones occurs, then acromegaly occurs, in which condition the tip (acro) parts enlarge or continue to grow. The head, mandible, nose, lips, hands and feet enlarge. In acromegaly a tumor of the hypophysis is frequently found, which may be removed by operation. By giving growth hormone to hereditary dwarf-mice, mice of normal size have been produced; also, very large (giant) rats have been produced. When the growth hormone is given to young English bull dogs, an animal resembling an acromegalic human in certain particulars results.

*The Thyroid.*—The thyroid gland secretes thyroglobulin, a protein (globulin) plus a substance called thyroxin, according to present knowledge. It regulates the rate at which oxidation or combustion occurs in the body and in a specific manner. If too little is secreted, oxidation is abnormally low; if too much, oxidation is abnormally elevated. When the thyroid gland is removed from a young animal (e.g. rabbit, sheep) the mental and physical growth is stunted. This condition is called Cretinism and occurs in human babies or children. If desiccated thyroid is fed in proper amounts to Cretin animals or children, normal growth ensues. To obtain normal mental development thyroid should be fed early in the disease. A crystalline substance, thyroxin, has been isolated from the thyroid, which has the same effect as desiccated thyroid. Thyroxin contains idodine, the presence of which is necessary for potency. Iodine not only activates thyroxin, but it also apparently makes

it easier for the gland to secrete thyroxin and when present in an amount above that required for normal bodily needs, it causes the gland to store secretion ("colloid") in spaces within the gland. When the thyroid secretes hyponormally in the adult, the condition is called adult hypothyroidism. Hypothyroidism, of course, also occurs in childhood, but may not be sufficiently severe to cause obvious Cretinism, causing only lethargy, dullness, easy fatiguability, and a tendency toward obesity (hypothyroid obesity). The adult hypothyroid has similar symptoms, and then severe myxoedema of the skin occurs, in which condition the skin is thick and dry, the hair falls out, and the face appears to be "bloated." Like Cretinism, hypothyroidism with or without myxoedema responds to thyroid administration. Sometimes the thyroid is said to hypersecrete; the rate of oxidation is augmented, the heart beats rapidly, breathing is increased; the patient sweats easily, is irritable and the fingers are tremulous. That is, the patient is said to be suffering from hyperthyroidism, thyrotoxicosis, or a toxic goiter, if the thyroid is enlarged. In some exophthalmus (exophthalmic hyperthyroidism or goiter) occurs. The administration of iodine helps such patients; it sometimes controls the condition, but unfortunately it may rarely make the condition worse. In many cases the thyroid must be removed by a surgeon; it is occasionally treated with X-rays.

Goiter (enlarged thyroid) is believed to be due to a relative or absolute iodine deficiency. If iodine is given in proper doses to young sheep or to children who live in goiter regions, the occurrence of goiter is markedly reduced. Peculiarly goiter may be present without disturbing bodily processes or it may be associated with either hyper or hypothyroidism. The "situation" is very complicated.

*The Parathyroids* control calcium or lime metabolism chiefly, although phosphorus metabolism is frequently disturbed also. When the parathyroids are removed the calcium in the blood decreases, the muscles and nerves become more and more irritable, until finally the muscles begin to twitch violently and convulsions ensue. These symptoms may be controlled by the proper administration of calcium, or by the injection of parathyroid extract (parathormone or parathyrin). However, if too much extract is injected the blood calcium may become so high that death from calcium poisoning results.

*The Thymus* chiefly because it involutes or atrophies in most mammals at puberty and for other minor reasons is generally considered in a discussion of the endocrine glands. That it produces an internal secretion has never been proved. However, a very interesting observation has been made recently. If successive generations of rats are injected with an appropriately made extract of the thymus, the new-born rats of the 5th to 7th generation are much more prococious in regard to hair, body, and eye growth. For example, eight days after birth the rats whose ancestors received thymus have a heavy fur, their eyes are open,

and their weight may be as much as 37 gm., whereas the control rats have little or no fur, their eyes are closed, and they weigh only 11 gm. Just what this remarkable phenomenon means has not been determined.

*The Islets of Langerhans* in the pancreas produce insulin, which plays a very important role in sugar metabolism. I shall not repeat the remarkable story of this hormone, since I believe most of you are familiar with it. The use of the hormone, insulin, in the treatment of diabetes mellitus has saved and prolonged the lives of thousands of diabetic patients. There are at least one million people living in the United States today who, according to statistical studies, have or will develop diabetes and will benefit from the use of insulin.

*The ovaries* produce at least two hormones, one called theelin and the other progestin. Theelin or estrin has been crystalized. It is responsible for the development of the secondary female characters. In addition it causes certain specific premenstrual changes in the lining of the uterus and in the ducts of the mammary gland. Progestin is formed by the corpus luteum, which grows at the site of the follicle ruptured in the course of ovulation. It completes the preparation of the lining of the uterus for the implantation of the fertilized egg. If the egg is not fertilized and hence does not imbed in the uterus, the corpus luteum degenerates and menstruation results. The exact cause of menstruation, however, is still unsettled. Progestin or the corpus luteum is necessary for the maintenance of early pregnancy, because if removed in early pregnancy, abortion or death of the embryo occurs. In some animals progestin also acts on the mammary gland. Estrin increases and progestin decreases the irritability of the uterine muscle. The anterior lobe of the pituitary is concerned in the periodicity of the menstrual cycle. Relaxin is a hormone produced by the ovary. Together with theelin it causes softening and relaxation of the pelvic ligaments, thus increasing the size of the birth canal. In the pocket gopher estrin even causes a resorption of the symphysis pubis, thus enlarging the birth canal. Estrin also prevents or tends to prevent lactation.

The placenta produces estrin in large quantities and probably progestin also. In addition it produces emmenin (placental hormone) and a substance that is like, but not identical with, the gonad stimulating hormone of the anterior lobe of the pituitary.

All of these active principles have been and are being employed for certain female disorders, but it is too early to evaluate the results in a scientific manner.

*The testes* produce a hormone called androitin (crystalized), which causes the development of the secondary male characters. Some claim that a second hormone, or chalone, is produced, inhibin, which prevents excessive enlargement of the prostate gland.

*The adrenals* consist of two parts, the medulla and the cortex. The medulla produces epinephrine, or adrenin, which is thought to be given off during emotional excitement to assist the body in meeting the bodily emergencies associated with fight or flight. Hence, the so-called emergency function of the medulla of the adrenals. The medulla of the adrenals is not a vital structure. However, if the cortex is destroyed in animals, death results in a few days. In man it is sometimes destroyed slowly and Addison's disease, or chronic adrenal insufficiency, results which terminates in death. The active principle or hormone of the cortex may be extracted and is called cortin. Cortin keeps adrenalectomized animals alive and preserves the lives of patients with Addison's disease. In adrenal insufficiency the metabolism of sodium and potassium is deranged. The sodium in the blood decreases and the potassium increases to the extent that potassium poisoning results. Such animals are benefited markedly by giving sodium chloride. In fact, adrenalectomized animals may be maintained for months without cortin on a high sodium (sodium chloride and citrate) and low potassium diet.

*The gastrointestinal hormones.*—If extracts of the lining of the stomach are made and injected, gastric secretion is stimulated. The active principle has been called *gastrin*. It is apparently a chemical substance known as histamine. *Secretin* is a hormone produced by the lining of the upper intestine which causes the pancreas to secrete its very important digestive secretion. Cholecystokinin is a hormone produced by the upper intestinal lining, when acids and fats are eaten, which causes the gall bladder to contract and evacuate. Enterogastrone is a chalone which is produced chiefly by the intestinal lining when considerable fat and sugar is eaten. This chalone depresses gastric secretion and motility, i. e. it slows down gastric digestion apparently so that fat and sugar will not be delivered to the intestine at too rapid a rate.

It should be obvious from this very brief review that the endocrine glands play a very important and essential role, a vital role in many instances, in regulating the processes occurring in the internal environment of our body. We know considerable about the subject at present, but more is to be learned. In numerous instances we can produce, prevent and control defects of the endocrine glands in animals, and much of this knowledge has been, and more in the future, may be applied successfully to human beings afflicted with grave disturbances of endocrine function. Many lives have been saved, prolonged, and made happier. The future outlook is even brighter.

(This lecture was illustrated with sixty lantern slides.)

---

---

**MEMOIRS**

---

---



## WALTER GAVIN BAIN, M. D.

PRESIDENT OF THE ILLINOIS STATE ACADEMY OF SCIENCE, 1925

1876-1935

Scientist, patriot, citizen. Those three words express more accurately than any others the dominating attributes of Walter G. Bain whose useful life was terminated unexpectedly at the age of 59 years on Christmas eve, 1935, as a result of a surgical operation. He was a physician, an educator, a soldier and a gentleman whose word was his bond. He looked at life through the eyes of a realist, had always a definite purpose in view which he pursued relentlessly in season and out, and patterned his work on a foundation of logic and science that left no room for skepticism or equivocation with respect to the righteousness and useful importance of any cause toward the achievement of which he bent his efforts. Intolerant of hypocrisy, indolence, indifference, intrigue and carelessness, he was himself the epitome of forthrightness and efficiency that was raised to the nth degree through a loyalty and perseverance that made dependability and effectiveness a part of his very personality.

While his efforts were spent chiefly in the field of medicine Dr. Bain's scientific interests were broad and versatile. His principal achievement in the professional field was the building up of a diagnostic laboratory and a training school for nurses at St. John's Hospital in Springfield. The laboratory was his particular work. Through twenty years of effort the laboratory at the hospital was built up and expanded largely through his efforts and vision from a minor to a major unit, which served not only the institution of which it was a part, but likewise the entire community. He became a pathologist of state-wide reputation, while his laboratory enjoyed a confidence that resulted in an expansion of service unsurpassed among private endeavor in central Illinois.

Dr. Bain's interest in education expressed itself through the nurses' training school at St. John's Hospital. Recognizing the importance of a liberal outlook on life for professional people, he succeeded in adding to the curriculum of the school an academic course of study that was taught in a way which commanded college credits. He introduced a system of medical examinations of applicants for nurse training and of annual medical examinations of those accepted.

Dr. Bain's ardent patriotism was expressed through the practical channel of militarism. As a major during the World War he served his country overseas in command of a hospital evacuation detachment.

After the War he identified himself with the medical reserve corps of the United States Army and organized the 55th Evacuation hospital detachment of which he was the commander with the rank of colonel. He spent a great deal of energy in successfully building up the reserve officers association in his community and state. At stated intervals he assembled the commissioned personnel of his own reserve detachment at the hospital for training programs which were carried out in strict military fashion according to army regulations. Each of his three sons were trained in the Citizens Military Training units so that each became a commissioned officer in the reserve army of the United States. One son graduated in the army aviation schools. None, however, selected military service as a career. These observations betray the practical and realistic outlook of a peace-loving man of intense patriotic leanings.

The forthright character and unadulterated honesty of the man is illustrated by an incident which occurred during the era when hit-and-run automobile accidents were regarded with more tolerance than now. He drove into a narrow street one evening about dusk and damaged slightly the fender of an unoccupied car, which was almost blocking the right-of-way. Without an instant's hesitation, as if the action had been completely automatic, he stopped his car, went in search of the owner of the damaged vehicle who was nowhere to be seen, and left the scene only after the incident had been satisfactorily explained. The damage was so slight that the owner dismissed the matter with a wave of his hand. This relatively trifling event gives an insight into a quality of character that explains the meticulous care with which Dr. Bain jealously guarded the integrity of his relations with fellow creatures.

Born in 1876, Dr. Bain graduated from Northwestern Medical College in 1905 and was licensed to practice medicine in Illinois the same year. His associations with professional organizations included fellowship in the American Medical Association and membership in the American Society of Clinical Pathologists, and in the Radiological Society of North America. He held membership also in the State Academy of Science, of which he was president in 1925, the American Academy of Science, the Reserve Officers Association of the United States, the Rotary Club and numerous other civic organizations. Dr. Bain was chief of the diagnostic laboratories of the Illinois State Department of Public Health from 1907 to 1909 after which he became identified with St. John's Hospital in Springfield as head of the diagnostic and clinical laboratory. Aside from building up the laboratory, he developed a record keeping system of unusual efficiency. He served the Sangamon County Medical Society and the Springfield Chapter of the Reserve Officers Association as president in 1925 and 1924, respectively.

B. K. RICHARDSON

## THOMAS LEROY HANKINSON

1876-1935

The Academy lost one of its charter members on December 3, 1935, when Thomas Leroy Hankinson died at Ypsilanti, Michigan after a short period of severe illness. For several years his health had gradually failed. He is survived by Mrs. Hankinson, and by their daughter Janet (Mrs. Richard Ford) of Detroit.

He was born at Valparaiso, Indiana on April 12, 1876. His parents died while he was a young boy; he was brought up at the home of his uncle at Hillsdale, Michigan, later living for a time at Skaneateles, New York. His interest in natural history developed early, no doubt stimulated by the lakes and woods near Hillsdale, as we learn from the obituary notice by Dr. Carl L. Hubbs in *Science* of January 3, 1936 (vol. 83, p. 8). Other items here included have been obtained from Dr. Hubb's article.

Thomas Hankinson attended the Michigan State College, receiving a degree from that institution in 1898, and one from Cornell in 1900. His studies at Cornell continued for two additional years. In 1902 he began teaching zoology at the Eastern Illinois State Normal School at Charleston. While there he married Nettie Belle Dickson. During a number of summers he served as investigator for the Michigan Biological and Geological Survey, for the Illinois Natural History Survey, and after 1915, the Roosevelt Wild-Life Experiment Station of Syracuse, New York. His publications on Walnut Lake, Michigan (1907, 1910), on the vertebrate life near Charleston (1915), and Oneida Lake (Adams and Hankinson, 1928), are results of this work. Summer studies were carried on also in North Dakota in 1922, in Michigan (for the state department of conservation), 1923 to 1925, and Ohio (division of conservation), 1930.

From 1919 to 1921 Professor Hankinson was a member of the staff of the Roosevelt Wild Life Experiment Station. From 1921 until he died he was professor of zoology at Michigan State Normal College at Ypsilanti. During the last few years he was also affiliated with the Museum of Zoology, University of Michigan, as research associate.

Professor Hankinson was one of the most active members of the Illinois State Academy of Science from its inception until his removal from the state, thereafter retaining his membership and his interest in its work. He was treasurer of the Academy from 1917 until 1919. Some of his papers were presented at the annual meetings and published in the Academy's Transactions, notably in volumes 3, 10, and 12. He belonged to a number of other science organizations: American Asso-

ciation for the Advancement of Science, Ecological Society (vice-president, 1919), Society of Ichthyologists and Herpetologists (treasurer, 1930), Fisheries Society, Society of Mammalogists, Microscopical Society (treasurer 1910-15, vice-president, 1916), Wilson Ornithological Club (secretary, 1915, president, 1922-24), Michigan Academy of Science.

His published works deal with ecology and vertebrate faunas of freshwater habitats, and to a lesser extent land vertebrates. Distribution, habits, and life-histories of fishes, in later years with emphasis upon cyprinids, were his central interests. His enthusiasm left its impress upon his students, and his helpful attitude toward his colleagues endeared him to them.

A. G. VESTAL

STATE OF ILLINOIS  
HENRY HORNER, Governor

---

TRANSACTIONS  
OF THE  
ILLINOIS STATE  
ACADEMY OF SCIENCE

---

VOLUME 29

DECEMBER, 1936

NUMBER 2

---

Papers Presented in the Twenty-ninth  
Annual Meeting, Quincy, Illinois,  
May 1 and 2, 1936



EDITED BY DOROTHY E. ROSE

DEPARTMENT OF REGISTRATION AND EDUCATION  
STATE MUSEUM DIVISION, CENTENNIAL BUILDING  
SPRINGFIELD, ILLINOIS

PRINTED BY AUTHORITY OF THE STATE OF ILLINOIS

---

PUBLISHED QUARTERLY

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

STATE OF ILLINOIS  
HENRY HORNER, *Governor*  
DEPARTMENT OF REGISTRATION AND EDUCATION  
JOHN J. HALLIHAN, *Director*  
STATE MUSEUM DIVISION  
ARTHUR S. COGGESHALL, *Chief*

---

ILLINOIS STATE ACADEMY OF SCIENCE  
AFFILIATED DIVISION OF THE  
STATE MUSEUM

OFFICERS FOR 1936-37

*President*, CLARENCE LEE FURROW,  
Knox College, Galesburg, Illinois

*First Vice-President*, HAROLD ROLLIN WANLESS,  
University of Illinois, Urbana, Illinois

*Second Vice-President*, EVELYN IDA FERNALD,  
Rockford College, Rockford, Illinois

*Secretary*, WILBUR M. LUCE,  
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 January, 1937



(16982)

## CONTENTS

## PAPERS IN AGRICULTURE

	PAGE
EXTRACT FROM THE REPORT OF THE SECRETARY.....	27
WALKER, ROBERT J., AND DUNK, MILTON R.—Preliminary Studies in milk .....	29

## PAPERS IN ANTHROPOLOGY

EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN.....	31
BARLOGA, F. L.—Evidences of Woodland Culture at Mossville.....	33
KING, FAIN W.—Archeology of Western Kentucky.....	35
KNIGHT, KENNETH L.—Preliminary Factors in the Use of Tree Rings to Date Mounds of the Mississippi Valley.....	39
HUDELSON, C. W.—Indian Camp Sites Along the Mackinaw River Near State Route 51.....	41
KNOBLOCK, BYRON W.—Evolution of Banner-stones.....	44
RUYLE, J. B.—The Teeth and Bones of the Mound Builders as Related to Their Diet.....	47
SIMPSON, A. M.—Archeological Survey of Peoria County.....	50
VAN MALE, W. C.—An Interesting Anthropological Find From the Lake Michigan Region .....	52
WOLFE, L. H.—The Evolution of the Mouth.....	54

## PAPERS IN BOTANY

EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN.....	57
GALLIGAR, GLADYS C.—Influence of Certain Organic Substances Upon the Growth Behavior of Excised Root Tips.....	59
MARBERRY, W. M., MEES, J. D., AND VESTAL, A. G.—Sample-plot Statistics in University Woods.....	69
NOÉ, A. C.—Floral Zones in the Mountains of Southern Mexico.....	72
STEVENS, NEIL E.—Was There an Outbreak of Bacterial Wilt of Corn in Central Illinois in 1891 and 1892?.....	73
STOVER, E. L.—An Interesting Preservation of Color in the Algae and Certain Fungi .....	76
TURNER, LEWIS M.—Reduction in the Number of Trees in Maturing Pine Forest .....	77
VESTAL, ARTHUR G.—Barrens Vegetation in Illinois.....	79
VOSS, JOHN—A Comparative Study of Bogs on Cary and Tazewell Drift..	81

## PAPERS IN CHEMISTRY

EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN.....	83
BENNETT, C. W.—Some Interesting Methods of Balancing Oxidation-reduction Equations .....	85
DYKINS, FRED A.—Chemistry in Highway Construction.....	87

	PAGE
FINGER, G. C., AND REED, F. H.—Some Anomalous Properties of Organic Fluorine Compounds .....	89
FRYLING, CHARLES F., AND TOOLEY, FAY A.—Corrosion Characteristics of $\text{SiO}_2\text{-Al}_2\text{O}_3\text{-CaO-MgO}$ Glasses .....	92
NECKERS, J. W.—The Natural Chemical Resources of Southern Illinois..	95
NICHOLSON, D. G.—Titanium-Hydrogen Peroxide Compounds.....	97
PHIPPS, H. E.—Present and Future Energy Sources.....	98
REES, O. W.—Some Remarks on the Coal Testing Laboratory as Related to Modern Coal Industry.....	101
SLOBUTSKY, CHARLES, AND AUDRIETH, L. F.—Acid Catalysis in Liquid Ammonia .....	104
SVEDA, MICHAEL, AND AUDRIETH, L. F.—Demonstration of Cold Light.....	106
WOODRUFF, SYBIL, AND MACMASTERS, MAJEL M.—Effects on Corn and Wheat Starch Gels Produced by Pretreating the Starches with Freezing or With Chemical Reagents.....	107
ANDERSON, EVERETT S.—Putting Thrills into Laboratory Experiments.....	110
GOUZA, JULIUS J.—The Position of Organic Chemistry in a General Chemistry Course .....	111
SAMMIS, J. H.—Photography as a High School and College Course.....	113
SCHILZ, CARL E.—Presentation, Correlation and Demonstration in Laboratory Work .....	115
WOODWORTH, M. E.—The Place of Projects in High School Chemistry....	117

#### PAPERS IN GEOGRAPHY

EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN.....	121
WARD, HAROLD B.—Exceptional Weather of Recent Years.....	123
HARRIS, RALPH S.—Geographic Aspects of the Fruit Industry of Illinois..	125
HUCK, EMILIE—Geographic Aspects of Meat Production in Illinois.....	129
VOSKUIL, W. H.—An Atlas of the Geography of Illinois.....	132
JAHNS, RICHARD H.—The Relation of Dams and Reservoirs to Water Supply of Southern California.....	133
BLANCHARD, W. O.—Some Problems of Egyptian Agriculture.....	136
AIRD, C. CLIFTON—Alaska-Yukon: Unique Adjustments, Yet Unsung.....	139
KWAN-TE, LIN—Some Aspects of Geography of the Foochow Basin.....	142
ZELLER, ROSE—Santa Marta, the Banana Port of South America.....	145

#### PAPERS IN GEOLOGY

EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN.....	147
CADY, G. H.—The Classification of Illinois Coals under the Operation of the Guffey Bill.....	149
BOLEY, C. C., AND McCABE, L. C.—The Separation and Concentration of Vitrain, Clarain, and Fusain in Illinois Coals.....	153
NOÉ, A. C.—A Collecting Trip into the Jurassic of Southern Mexico in 1935 .....	156
CADY, G. H.—The Occurrence of Coal Balls in No. 6 Coal Bed at Nashville, Illinois .....	157
SCHOPF, J. M.—Preservation of Plant Material in Coal Balls from Nashville, Illinois .....	159
COHEE, G. V.—Petrology of Marine Sediments off the Mid-Atlantic Coast..	161
ELDER, STANLEY G.—The Contact Between the Glenwood and Platteville Formations .....	164
JAMES, A. J.—A Study of a Remarkable Meteor.....	167

	PAGE
LAMAR, J. E.—The Economic Utilization of the Burlington Limestone in the Quincy Region.....	170
LEIGHTON, M. M.—The Glacial History of the Quincy, Illinois, Region....	172
QUIRKE, T. T.—A New Means of Demonstrating Optical Figures.....	177
QUIRKE, T. T.—New Nepheline Syenites From French River Canyon, Ontario .....	179
RIGGS, ELMER S.—A Pleistocene Bog Deposit and its Fossil Fauna.....	186
SHEPHERD, G. FREDERICK—Volcanic Phenomena in the Craters of the Moon, Idaho .....	190
WELLER, J. M.—Progress of Geologic Mapping of Illinois, 1839-1936.....	192

### PAPERS IN MEDICINE AND PUBLIC HEALTH

EXTRACT FROM THE REPORT OF THE SECRETARY.....	195
GOODFELLOW, LOUIS D.—Recent Research in Vibro-tactile Sensitivity.....	197

### PAPERS IN PHYSICS

EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN.....	205
BROWN, H. A., AND PAINE, E. B.—Electrical Discharge Phenomena in Insulation Under High Continuous Potentials.....	207
KNIPP, CHARLES T.—A Cold Cathode Rectifier (Demonstration).....	209
KNIPP, CHARLES T., AND HOLCOMB, JAMES E.—Origin of Positive Rays in Cathode Ray Discharge Tubes having Hollow Cathodes (Demonstration) .....	211
LARSON, K. G.—A Convenient Method for Measuring the Speed of a Gyroscope .....	214
MCCLENAHAN, F. M.—Heat Insulation.....	215
REICH, HERBERT J.—Electronic Transient Visualizers.....	217
SCHROEDER, J. HENRY—Does the Crystal Structure of Solid Single Crystal Bismuth Exist after the Bismuth Crystal is Melted?.....	220
SMITH, CLARENCE R.—A Laboratory Switchboard of Low Cost.....	222
TYKOCINER, J. T., AND WOODRUFF, M. N.—Flexural Vibrations of Piezoelectric Quartz Bars.....	225
YOUNG, O. B.—Merits of a National Radio Fraternity in a Non-technical College .....	228

### PAPERS IN PSYCHOLOGY AND EDUCATION

EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN.....	229
BEALS, FRANK L.—Problems Connected with Administration and Supervision of Special Schools and Classes.....	231
CONDON, DAVID—Preparing the Adolescent Mind for Living.....	234
KOPEL, DAVID—Motivated Remedial Reading in the High School.....	237
KRANZ, L. G.—Contributions of Physical Education to Adolescence.....	239

### PAPERS IN ZOOLOGY

EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN.....	241
BAKER, FRANK COLLINS—Remains of Animal Life From the Kingston Kitchen Midden Site Near Peoria, Illinois.....	243
BEAVER, PAUL—Notes on <i>Stephanoprora polycestus</i> (Dietz) from the American Crow .....	247

	PAGE
BURKS, B. D.—The Illinois Species of <i>Brachymeria</i> (Hymenoptera, Chalcididae) .....	251
CRAWFORD, W. W.—Descriptions of Two Larval Nematodes of Family Camallanidae Found in Damselfly Naiads ( <i>Enallagma</i> sp.) .....	255
FLINT, W. P.—Effect of Winter Temperatures of 1935-1936 on Some of the Common Illinois Insects.....	256
HOFF, C. CLAYTON—Studies on the Lymnaeid Snail <i>Fossaria parva</i> (Lea) —Part I: Winter Habits.....	259
ROSS, HERBERT H.—The Nearctic Sawflies of the Genus <i>Fenusa</i> (Hymenoptera, Tenthredinidae) .....	263
SOMMER, JOSEPH B.—Notes on the European Starling in Illinois.....	267

## PAPERS IN AGRICULTURE

---

### EXTRACT FROM THE REPORT OF THE SECRETARY

No formal program was announced for the Agriculture Section. A brief session was nevertheless held at which the following two papers were presented.

*Preliminary Studies in Milk*, by Robert J. Walker, Illinois State Normal University, Normal.

*Homogenized Milk*, by Milton H. Dunk, Illinois State Normal University, Normal.

C. W. Hudelson, 206 South Main Street, Normal, Illinois, was elected chairman of the Agriculture Section for the 1937 meeting.

(Signed) W. M. LUCE, *Secretary*



## Preliminary Studies in Milk

Robert J. Walker and Milton R. Dunk

*Illinois State Normal University, Normal, Illinois*

This work was carried on in the bacteriology laboratories of Illinois State Normal University. The experiments were performed as class work in a course of General Bacteriology under the instruction of Dr. Lamkey.

The experiments for the most part are concerned with the size of the fat globules and their relation to the digestibility of milk. The fat globules of viscolized and ordinary milk were measured by diluting the milk and placing a drop on a hanging drop slide and then measuring with the micrometer eye piece in a microscope. From our measurements we found that the viscolizing process reduced the size of the fat globules eight times. Milk that had been standardized at 4 per cent butter fat and then viscolized was tested for butter fat content and the viscolizing process was found to have no effect on the butter fat content.

Next, samples of viscolized and ordinary milk were plated out to get the bacterial count of the respective milks. To do this, 1 c.c. of the milk was placed in 1000 c.c. of sterile water. Then  $\frac{1}{2}$  c.c. of the water was plated out in litmus agar. One c.c. of water was also plated out in litmus agar. Viscolized milk has a higher bacterial count than unviscolized milk. This fact was to be expected because the more times the milk is handled after pasteurization the greater the chance for contamination. The viscolization process is carried on after pasteurization. It is also possible that the viscolization had broken the bacterial clumps into various parts and that these parts had resulted in a higher count. Other counts were made on other samples of milk and the above results were borne out.

Digestion tests were then performed on the milks. Steapsin was the enzyme used and 5 per cent solution of litmus was the indicator.

(I) 50 c.c. of viscolized milk + 750 m.g. of steapsin boiled.

50 c.c. of viscolized milk + 750 m.g. of steapsin.

(II) 50 c.c. of pasteurized milk + 750 m.g. of steapsin boiled.

50 c.c. of pasteurized milk + 750 m.g. of steapsin.

The milk was heated to body temperature and the steapsin that had been dissolved in 5 c.c. of water was added. Four c.c. of 5 per cent solution of litmus was also added to each sample.

To one sample of viscolized milk boiled steapsin was added. The boiling killed the action of the enzyme.

To one sample of viscolized milk unboiled steapsin was added.

To one sample of ordinary milk boiled steapsin was added.

To one sample of ordinary milk unboiled steapsin was added.

The boiled samples were checks on the action of the steapsin in the milks. The boiled samples also indicated that it was not formation

of lactic acid [souring process] that changed the litmus from blue to red. A known standard of red was used as the end-point in the digestion. When the litmus had changed to the standard red the experiment was ended. We had no way of testing for completeness of digestion but were only testing for rapidity of digestion. The viscolized milk turned the litmus to the red standard in  $\frac{1}{3}$  of the time it took for ordinary milk to change the color of litmus. The steapsin digested the fat, forming fatty acids and glycerine. The fatty acids changed the litmus from blue to red.

We have run many digestion experiments with viscolized and ordinary milk and have found that the steapsin digests the viscolized milk three times faster than ordinary pasteurized milk.

Our next experiment was the comparing of the size of fat globules of Holstein and Guernsey milk and testing the rate of digestion of Holstein and Guernsey milk.

Representative samples of Holstein and Guernsey milk were diluted with water, placed on a hanging drop slide, and examined under the microscope. The size of the fat globules was measured with the micrometer eye piece of a microscope. The average size of the fat globules of Holstein milk was 6.7 microns. The average size fat globule of Guernsey milk was 7.7 microns. The Holstein had the smallest fat globule by about one micron or the fat globules of the Guernsey were 12 per cent larger than the fat globules of the Holstein milk.

In the digestion tests of Holstein and Guernsey milk, each test contained the following: 50 c.c. samples of milk; 750 m.g. of steapsin; 4 c.c. of 5 per cent litmus or 20 drops brom cresol green.

The milk used was composite samples of raw whole Holstein and Guernsey milk. The pH of the two milks were determined and found to be the same: a pH of 6.3 or slightly acid. Half of the milk was pasteurized at 60° C. for 20 minutes and the other half was left raw.

	<i>Milk</i>	<i>Condition</i>	<i>Indicator</i>
(I)	Holstein	Raw	Litmus
	Guernsey	Raw	Litmus
(II)	Holstein	Pasteurized	Litmus
	Guernsey	Pasteurized	Litmus
(III)	Holstein	Raw	Brom cresol green
	Guernsey	Raw	Brom cresol green

As in the case of the other digestion tests, an end-point was set for the color changes of the indicators. Again we were testing not for complete digestion but for rapidity of digestion. The samples were kept in an incubator while the experiment was in process, the temperature being 37 $\frac{1}{2}$ ° C. No appreciable difference was found in the time it took Holstein and Guernsey milk to digest. On a check experiment the same results were obtained. However, not enough tests have been made to draw definite conclusions as to the qualities of digestibility of the two milks.

## PAPERS IN ANTHROPOLOGY

---

### EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN

The program of the Anthropology Section carried fourteen papers, nine of which are here represented. The others are:

*Some Anthropological Aspects of Western Illinois*, by O. D. Thurber, Senior High School, Quincy.

*A Cache of Unusual Flint Blades*, by Frank W. Aldrich, Bloomington.

*Deformation of the Mound Builders Skulls*, by John F. Barrett, University of Illinois, Urbana.

*Anthropology of Western Illinois*, by W. C. Williams, Pittsfield.

*Rock Carvings in Southern Illinois*, by Bruce Merwin, Southern Illinois State Normal University, Carbondale.

The meeting was well attended.

The present chairman, Dr. J. B. Ruyle, 9 Main Street, Champaign, Illinois, was reelected chairman of the Anthropology Section for the 1937 meeting.

(Signed) J. B. RUYLE, *Chairman*



## Evidences of Woodland Culture at Mossville

F. L. Barloga

*Peoria Academy of Science, Peoria, Illinois*

The village site described in this paper is located one mile due west of the village of Mossville in Peoria County, Illinois (Fig. 1). A gravel highway passes through the village site at the present time. Three branches of a small spring converge in the center of the campsite, the resultant larger stream flows to the Illinois River about  $1\frac{1}{4}$  miles to the east. The site covers about five acres and is on the west edge of the Illinois River terrace. At this point hills rise sharply to an approximate height of 200 feet.

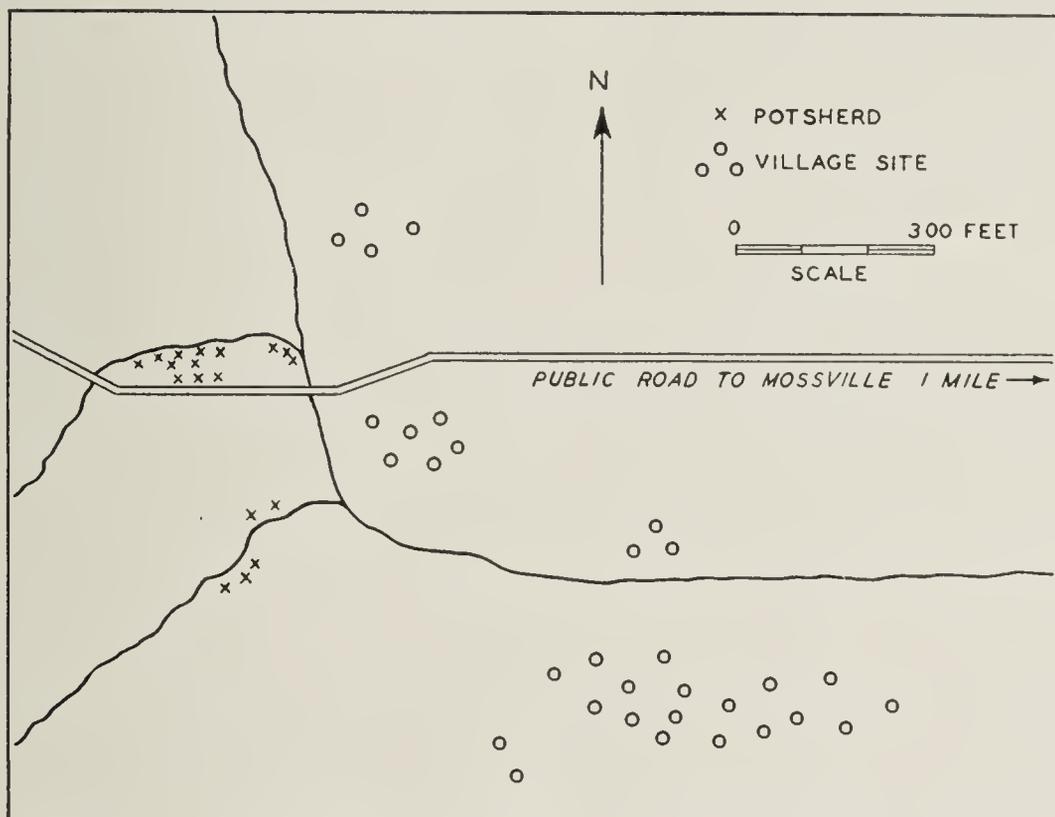


Fig. 1.—SKETCH MAP SHOWING LOCATION OF VILLAGE SITE NEAR MOSSVILLE.

A workshop site about 1000 feet south of the main stream was discovered while the owner was planting apple trees. Most of the artifacts (shown on the slides) were found on the workshop site. Several hundred broken points and scrapers were found.

All pottery sherds excavated to date have been found on the south side of the middle or west fork of the stream and on either side of the south fork. No sherds have been excavated along the main stream or the north fork. Eleven pots have been reconstructed from the sherds,

most of which had crenulated lips inside and out. The sherds were plain, cord impressed, rouletted, or stamped. All potsherds were grit-tempered and were excavated from a depth of 3 to 5 feet below the present surface, the original surface having been from 2 to 4 feet below present surface. The wash from the hills on the west edge of the camp-site has made this deposit since the time of the early inhabitants.

Bones, shells and miscellaneous items were found in addition to potsherds. The clam shells were from the Illinois River perhaps but the origin of the shell beads is less easy to determine. Bones were of deer, wapiti, dog, beaver, and fish. Near a disturbed child's skeleton were two piles of clam shells, 47 in one pile and 85 in the other. In the second pile it was interesting to note that all of the 85 shells were left valves. In addition to the shells two small triangular points and a small smooth piece of galena were found. A monitor pipe was found on a subfloor and a semitubular pipe lay beneath a large crushed bowl. No storage pits have been found but many firepits with contents of charcoal and burnt shell have been unearthed.

The location of the site, the type of pottery, the lack of storage pits and the fact that the great majority of tools are of stone, indicate quite strongly a Woodland culture.

## Archaeology of Western Kentucky

Fain W. King

*Wickliffe, Kentucky*

That portion of Kentucky called the western part is more often called the "Purchase", due to the fact that this territory was purchased by Jackson one hundred and eighteen years ago from the Chickasaw Indians for \$300,000, including eight counties in Kentucky and twenty counties in Tennessee. General Jackson reached an agreement with Chief Paduke, head of the Chicasaws and after whom the city of Paducah is named, in October, 1818, in the year 1819 January, the contract was ratified by Congress, the same year saw the Chicasaw Indians trek southward and the pioneers pushing into the new territory. The "Jackson Purchase" is completely surrounded on three sides by water, bounded on the east by the Tennessee River, on the west by the Mississippi, on the north by the Ohio River, and on the south by the State of Tennessee. Due to the fact that this entire district has such a great mileage of rivers within and bordering it, to use the words of Funkhouser and Webb, "It was Good Indian Country".

Many of the early reports of Collins and Rafinesque, also the reports of Miller and Weir, list a number of Indian sites in western Kentucky and a number investigated in McCracken and other parts of western Kentucky are well known. Clarence B. Moore reports for 1915-16, Philadelphia Academy of Natural Science, list much work done in actual excavations and also list other sites. It is evident from these reports that much progress has been made in the last few years in method, technique, and study of living conditions of the early groups. Moore in his report of finds in Arkansas states that in one mound they found about six hundred pieces of plain pottery, but did not wish to keep this material and most of it was given away. In studying reports of the early Archaeologists one is forced to come to the conclusion that most of the work was done to secure artifacts and the important part of the story was overlooked as being of very little interest. In recent years the artifacts have ceased to be paramount, the story in the soil is being searched out with the aid of various branches of science, botany, chemistry, zoology, geology and tree-ring study.

The work of Funkhouser and Webb of the University of Kentucky, at Tolu, Crittenden County, on the Ohio River, also work of excavating elsewhere in the state indicates great improvement over the earlier work. The work of Dr. Cole of the University of Chicago, just across the river from Paducah, in Illinois, is a model of method and perfection

from the standpoint of present knowledge and experience. The Kincaid site, as this is known, although in Illinois is showing from the two seasons work much in common to the cultures in western Kentucky.

Probably the best known mounds in the Mississippi Valley are those located at Wickliffe, Kentucky, due no doubt to the fact that the find is unusual and also that the material is left in situ, likewise the great extent of the work done and yet to do. Each season work is carried on in actual excavating, all the year work is going on in research of some kind. This work is open to the public at all times and has had much to do with acquainting the great masses with Mississippi Valley Archaeology.

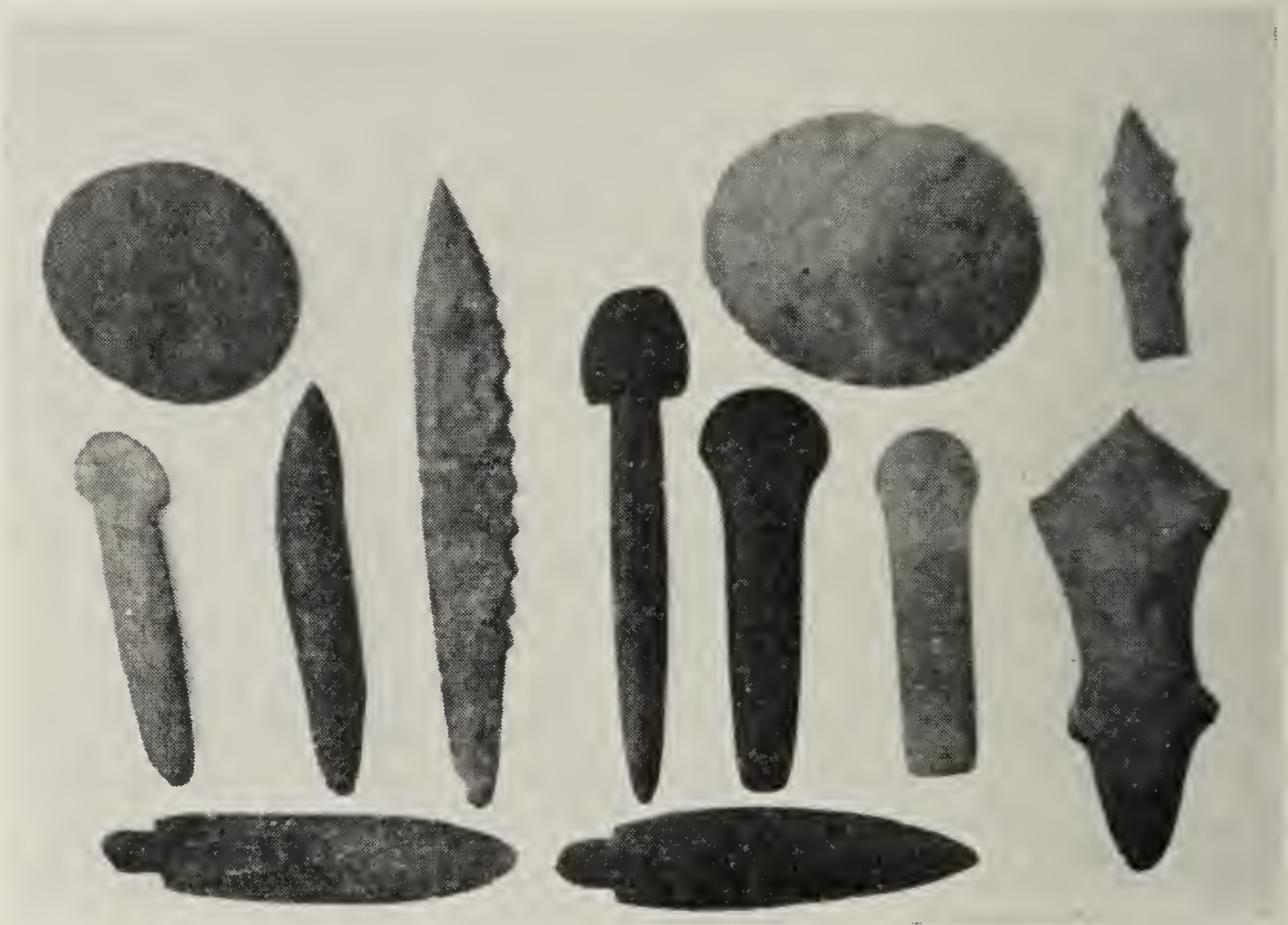


Fig. 1.—RARE AND UNUSUAL FLINT AND STONE CEREMONIALS.

Within the city limits of Wickliffe, on a high bluff over looking the meeting point of the Mississippi and Ohio rivers is the remains of what once was the most important center for trade, commerce and religion in this district. On this natural fortification, which commands both rivers, are located nine mounds and kitchen midden to the depth of several feet over more than twenty-five acres. Work has been in progress more than three years and it is estimated that it will take four or five years to complete this investigation.

At the present time we are working on Mound D which will be known as the infant burial mound as we have to date found fifty-two infants; four adults were found at higher levels and only one half of the mound has been uncovered to date. The universal five-foot square method is being used with floor plan showing location and material, and vertical cross-section showing the stratigraphy. This mound has differed

in that it is made of kitchen midden no doubt scraped from the surface near by, built in stages to a height of about seven feet and a length of 170 feet. The other three mounds excavated to date are composed of almost sterile soil, each basket load of earth showing but little bone or broken pottery. Sherds from one 15-foot cross-section of Mound D filled several very large boxes which were sent to Dr. Guthe, U. S. Repository for Broken Pottery, and an even larger amount from an other section was sent to the University of Chicago for study in Dr. Cole's work. Great quantities of bone material of animals and fish have been recovered.

This will enable us to give a very graphic picture of the kinds and amounts of food consumed over the period of the construction of this mound. The sherd count per foot is showing some very interesting facts for comparison.



Fig. 2.—GROUP ADULT BURIAL WITH POTTERY, SHELL, AND OTHER ARTIFACTS.

Each mound opened to date has differed from the others. Mound A shows two burned buildings at two levels with dirt apparently thrown on the buildings while they were in the process of being burned after they had collapsed. Three altars, hard burned, connected, were uncovered in the upper building with offerings near by. The cane and charred material is well preserved. Tree-ring work was conducted by Dr. Hawley during one season but is not complete. This mound is called the Temple Mound because its contents are religious or ceremonial.

Mound B proved to be interesting as at the base we found the complete outline of a building indicated by post-molds, doorway, and loose earth just outside of the line of post-holes indicating a drainage ditch. Three circular fire places were located at the floor level, two of which were only four inches apart, and the third thirty inches away from the other two. Nine pieces of pottery, two bone turkey callers, and a bushel of very small undeveloped corn cobs that had been reduced to charcoal

were encountered in the first test. Very few artifacts were found elsewhere. This mound is called the Council House Mound as the building is twenty-one by twenty-five feet in size and would indicate a shaman's or Chief's building or a building where council was held.

Mound C has been excavated to one tenth of its contents from measurements and test holes. One hundred fifty-three burials with pottery, bone implements, copper ornaments, flake mica, lead and hematite fashioned into various shapes are in place as uncovered. Some very interesting burials were disclosed. One no doubt represented the leather worker, as with the burial were a number of bone implements of various sizes and types used for working leather. In an other place we found the pottery maker, for at the head of this female were six pottery trowels, a small piece of coal shaped to a fine edge, and a gravel also of the same general shape. In one group we have male, female, and a small infant, no doubt a family group. In another place is a twin burial, and in another an old woman who had lost all of her teeth prior to her death. In all a very interesting group of burials.

## Preliminary Factors in the Use of Tree Rings to Date Mounds of the Mississippi Valley

Kenneth L. Knight

*Illinois State Normal University, Normal, Illinois*

The talkative tree rings have revealed knowledge to science that was supposed to have perished long centuries ago. By the use of the annual weather records so reliably kept by the trees, man has pushed the historical horizon of the Southwest back nearly eight centuries before Columbus discovered America, a time comparable in European history to the reign of Charlemagne.

This enlargement of our historical concept was accomplished by Dr. A. E. Douglass<sup>1</sup> of the University of Arizona. Dr. Douglass, who is an accomplished astronomer, originally began a study of tree rings in an effort to see if sun-spot periodicity had any effect upon the climatic conditions of our earth, which in turn would supposedly have an effect upon the yearly growth of the trees. This work progressed most satisfactorily and he soon became convinced that sun-spot periods could be traced out in the tree rings. To get large series of tree rings he began using ancient timbers from the pueblo ruins of the Southwest and from there it was only a step to the application of his tree ring calendar to archaeology. Through the use of this calendar nearly every ruin of importance in the West has since been dated.

Ever since this monumental work by Douglas appeared, the thought of applying a tree-ring chronology to the dating of the Mississippi Valley mounds has intrigued archaeologists.

Because the climate of the Mississippi Valley differs so widely from that of the West, it is absolutely imperative that we find out the exact influence which this climate has on tree growth. That is, has the amount of growth for each year been dependent enough on one specific factor, for example, precipitation, that it will be characteristic for the trees of that one region? If such a condition does not exist, then it will be impossible to set up a tree-ring chronology.

As yet no work has been published on this subject for the Illinois region. However, in 1935, Diller<sup>2</sup> published some positive data and conclusions concerning the correlation of tree ring width to temperature and precipitation for a series of beech-maple woodlands in northern Indiana. Some work by Lyons<sup>3</sup> in 1935 for the New England area, shows that a similiar conclusion may be drawn from that region.

With a desire to help in this regional study of factors controlling tree growth, I have done some work in central Illinois which I believe may be used in interpreting the general conditions existing throughout this portion of the Mississippi Valley.

In my work, sections were taken of three elm stumps from north of Normal, Illinois. The trees were selected with careful consideration

being given to all ecological factors which might interfere with the records kept by the trees. There are a number of such factors which may influence the amount of a tree's annual growth so that the dendrologist must constantly be on the alert for errors in his data.

For the sections from each stump, the width of each of the yearly growth rings was measured and recorded. The widths of all of the rings for each tree were then averaged; and to put each tree on a common basis with the others, the percentage deviation from the average was calculated for each ring. The next step was that of averaging the three percentage deviations for each year represented, and then plotting these averages on coordinate paper. To correlate this record with precipitation, it was necessary to secure a set of official rainfall measurements from the nearest weather bureau station which happened to be the Peoria station about sixty miles away. The rainfall yearly totals for each of the years represented by tree-ring records were then reduced to percentage deviations from the normal and plotted beside the tree-ring line on coordinate paper.

The conclusions drawn from this study are: that the two lines, one representing rainfall and the other tree-ring growth, correlate very definitely in the positions of their extreme highs and lows. That is, an extremely heavy yearly rainfall is coexistent with a noticeable increase in tree growth and vice versa. Moreover, the work of Diller was corroborated by the observation that, in general, drought years had their greatest effect upon the tree growth for the succeeding year; while extremely wet years affected the tree-ring growth of the same year.

These data very definitely show that tree-ring growth is due to some common factor which will make possible the recognition of a specific year through a series of trees over a comparatively wide area. In turn this fact makes it possible to set up a tree-ring chronology through which a mound may be dated by the fragments of wood or charcoal found there.

Recently the University of Chicago under the direction of Dr. Fay-Cooper Cole has begun such a task in the Mississippi Valley. Practically all of the research is being carried on in the region covered by the Tennessee Valley Authority. A letter from Dr. Cole states that a great deal of material has been assembled and is being worked up. However, none of this has been released up to date because Dr. Douglass, who has charge of the releasing of all such material, feels that the series for this region were not sufficiently long to justify a statement. However, we may look forward to some very interesting developments in the near future. It will certainly be a mile-stone in American archaeology when the dates are known for some of our Mississippi Valley mounds.

---

<sup>1</sup> DOUGLAS, A. E.—Tree Growth and Climatic Cycles: *Sci. Mo.*, Dec. 1933, pp. 481-495.

<sup>2</sup> DILLER, OLIVER D.—The Relation of Temperature and Precipitation to the Growth of Beech in Northern Indiana: *Ecology*, Vol. 16, Jan. 1935, pp. 72-81.

<sup>3</sup> LYONS, C. J.—Tree Rings in New England: *Science*, Vol. 81, No. 2101, pp. 340-341.

## Indian Camp Sites Along the Mackinaw River Near State Route 51

C. W. Hudelson

*Illinois State Normal University, Normal, Illinois*

For the past fifteen years the writer has followed the hobby of hunting over Indian camp sites during the late fall and early spring in search of Indian artifacts or other evidences of Indian habitation. This paper describes briefly those camp sites found along the Mackinaw

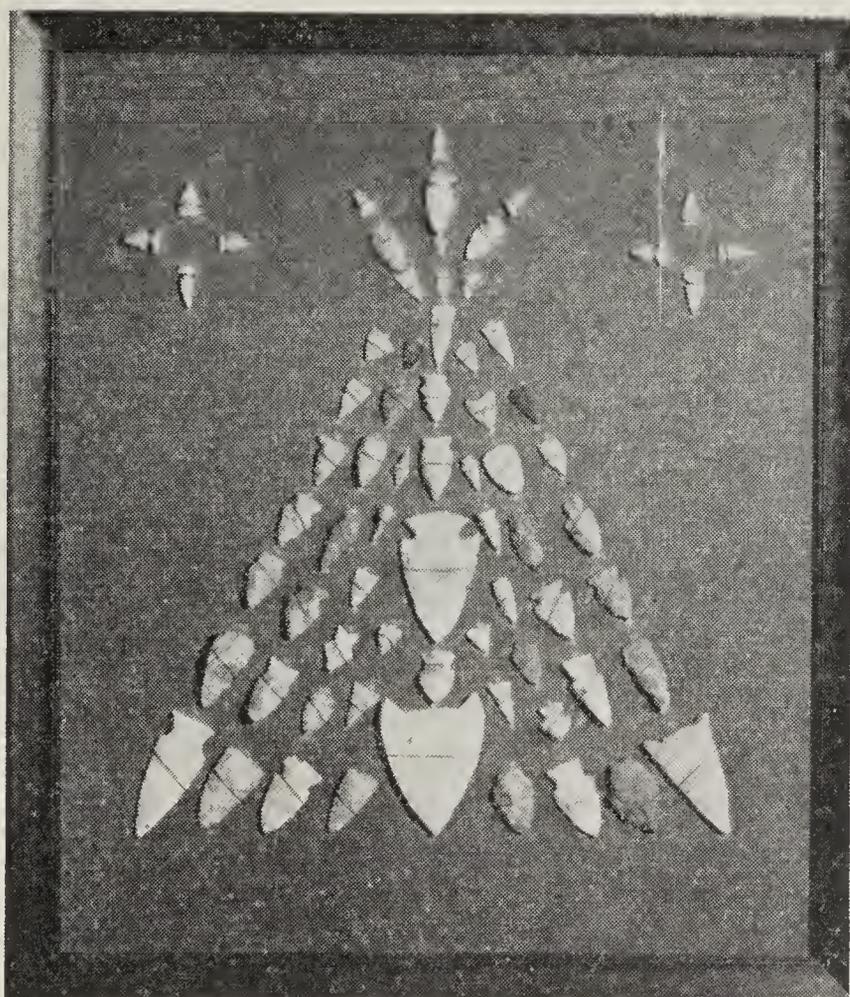


Fig. 1.—ARROWHEADS FROM CAMP SITE ALONG SIX-MILE CREEK.

River within a range of five miles on either side of State Route 51. In this region Route 51 extends north-south except for a slight curve on the north side of the river. The Mackinaw River flows in a westerly direction over the entire ten mile stretch except for a number of short curves.

The area includes two northwest-flowing tributaries that enter the Mackinaw from the south and along which a number of camp sites have been found. The larger tributary, called Money Creek, lies about three

miles east of Route 51. A few years ago the city of Bloomington constructed a dam across this creek to create Lake Bloomington as a source for city water. The various activities and enterprises which followed, such as the building of the pumping plant, settling reservoir, and dwelling houses, and the general rise of water in the valley to form the lake, obliterated a number of camp sites. The smaller tributary, called Six-Mile Creek, lies on the west side of Route 51 and flows into the Mackinaw River about two and a half miles west of the bridge on Route 51. According to pioneer reports and records, the Potawatomie Indians made their last stand against the white men in this region along Six Mile Creek approximately one mile northwest of the present village of Hudson. In 1920, an engraved boulder was erected as a memorial to this



Fig. 2.—VIEW OF ONE OF THE CAMP SITES (FOREGROUND) IN THE MACKINAW RIVER REGION.

struggle by the Letitia Green Stevenson Chapter of D. A. R. of Bloomington, Illinois, on what is now Route 51 at the cross-roads intersection about half a mile west of Hudson. Six Mile Creek flows within about one hundred yards of this boulder. Downstream and within two miles of the boulder the writer has hunted over four camp sites a number of times and has found approximately two hundred arrowheads and spearheads, as well as a number of other artifacts. Seventy of the arrowheads and spearheads are shown in figure 1.

The river valley ranges in width from about one-quarter of a mile to nearly one mile in some places. The stream itself in normal times often ranges from 30 to 75 feet in width. The Indians located practically all of their camp sites on a point of ground having good drainage and on a little higher elevation than the surrounding land, out of danger of flood and with a commanding view of the possible approach of their enemies from all sides. They were, however, reasonably close to the

stream which provided water for use in preparation of food as well as for drinking and other domestic purposes.

Fall-plowed land which has been compacted and slightly eroded by rains and melting snow is the best type of ground on which to search for artifacts. Typical evidences which an experienced person may see on such sites are rough broken and darkened fire stones and broken chips and bits of flint. The better artifacts are usually found at the outer edge of the camp site or even a short distance further away.

Artifacts other than arrowheads and spearheads include axes, celts (both granite and flint), pitted stones, hammerstones, drills, scrapers, polishing stones, etc. One bear's tooth was found, identified by the authorities at the State Museum in Springfield. Bear's teeth were often worn as ornaments or charms.

As much pleasure may be gained around Indian camp sites in picking up kitchen middens such as large broken animal bones, broken pottery, discarded inferior arrowheads and spearheads, firestone, burned clay, charcoal, flint chips, flint percussion points, and flint cores, as in finding a perfect artifact.

Flint is a curious material, intensely hard, yet rather elastic. When it is struck by a hammerstone, the blow generally detaches a flake. The implements resolve themselves into two types. The first type is made from the core of flint itself, flakes being removed to give the desired shape. The larger implements like celts, axes, and hammers are shaped cores. The second type of implement such as knives, lances, arrowheads, spearheads, scrapers, etc., were fashioned flakes. In thinking how these different artifacts were made, we must remember the extraordinary patience of the Indians. One writer says that a North American Indian would spend all the leisure time of his life making one stone tomahawk. Try to make a flint implement yourself, but wear motor goggles to safeguard your eyes, and you will gain a new respect for these expert old handicraftsmen.

## Evolution of Banner-stones

Byron W. Knoblock

*LaGrange, Illinois*

The skillfully carved relics of the mound building people show a remarkable workmanship and display an art and a simplicity of design surprisingly similar to the so-called "modern art" of today. Most of these relics can be definitely classified and their uses determined, yet there are problematical forms that can not be connected with any practical use. Banner-stones come under this heading. There is no doubt but that they were of vital importance to the Indians for their range of distribution indicates that they were very widely adopted tribal or ceremonial symbols.

I shall advance a few observations which lead me to believe that banner-stones had their origin in the southern states and which may help to prove that the southern states were the first area east of the Mississippi River to be occupied by the Indians. First may be cited the stone and copper relics, found in scattered sections of these southern states, that are typical of Mexican cultures and that were evidently carried into this area by migratory Indians from Mexico. Second is the fact that so many simple shaped banner-stones are found in Alabama, Georgia, and South Carolina. Or, to state it differently, in tracing banner-stones back through their "blending forms" to the simple forms from which they were developed, we are led back to this particular area.

It seems evident that the origin of all banner-stones began in the simple perforation of water-worn pebbles. Some of the early specimens show no attempt to alter the shape of the pebble, others show a slight amount of work but only to true up the shape. As the use of banner-stones became more popular, the Indians began to work the pebbles down into shapes that were more attractive, and from a few simple designs all banner-stones of the culture were developed.

As the southern tribes migrated in different directions they left a trail of scattered specimens in the territories that they occupied. These specimens not only establish a means of tracing their origin and evolution, but also establish, fairly well, the migratory routes of the Indians from the southern area.

Some writers have advanced the theory that the crescent shaped banner-stones so common throughout the New England states originated as effigies of the tail of the whale. As a matter of fact, crescent-shaped banner-stones of granite also occur in the lower Ohio and Mississippi

Valleys, too far from the seaboard for such an origin. To consider them as symbolic of the moon would be more reasonable. It is more logical to consider the crescent-shaped banner-stones from these two widely separated areas as having all been derived from the early crescent shapes which originated in Alabama, Georgia, and South Carolina. Their separate occurrence thus may well represent two northward migrations from a common center, one along the Atlantic coast and the other into the lower Mississippi Valley and hence gradually into the lower Ohio River valley.

I have come to the conclusion that the specimens of bannerstones showing the highest stage of development in design should be referred to as "types"; all other specimens that lead up to the "types" are referred to as "blending forms".

My entire theory of the evolution of types and the means whereby the varied shapes of banner-stones can be classified is based wholly on the similarity of lines and planes. On this basis there are but 24 distinct classes that developed 32 "types," which can be classified by certain characteristics. This number includes four new types that, as far as I know, have never been named or described in any book. Many other specimens may appear to be independent but are not and merely belong to some particular class in which they are but blending forms that establish the evolution of some type. Of course further research may uncover other authentic types which should be added to this list.

The highly specialized types of the 24 classes developed from approximately eight "primary" forms that, in turn, were developed from simple perforated pebbles. A dozen or more specimens can be arranged to form the blending series of many classes of banner-stones. For purposes of classification I have divided the blending series into three classes, called "A", "B", and "C" classes, or the A, B, C system. "A" class designates the simplest forms; "B" class designates the blending forms that show the evolution of types; and "C" class designates the type specimens.

From the constructional angle there are but two groups of banner-stones, the "bi-faced" and the "single-faced" groups. All bi-pennate, or winged, specimens belong to the "bi-faced" group. Their lines and planes are symmetrically balanced. The wings, extending from each side of the hole, are the same in outline, with both sides of the same construction, and double-faced or "bi-faced".

Single-faced banner-stones are those that are not symmetrical in lines or balance, but are constructed in such a manner that one side is of one shaped plane while the other side is entirely different. For example, consider the "hour-glass" banner-stone. The one side is a flattened plane and the other side is shaped to a sharp ridge, giving this side of the stone two planes. The flattened plane may be called

the "back". The ridged side, with the two planes, may be called the "face". The fact that these shapes have but one face places them in the "single-faced" group.

In my opinion, the so-called "saddle-back" types were wrongly named years ago. According to my method for naming the planes, the flat plane of these particular specimens is the "back", the ridged or "saddle" surface is the "face". On this basis they should be called not "saddle-back" but "saddle-faced" banner-stones.

The foregoing conclusions have been reached after exhaustive study of many large collections and are based on facts. The courteous and helpful cooperation of the museums, universities, and private collectors over the country has aided me materially by allowing me to study many specimens and hundreds of fine photographs.

# The Teeth and Bones of the Mound Builders as Related to Their Diet

J. B. Ruyle, D.D.S.

*Champaign, Illinois*

## ABSTRACT

For the past two years, through the courtesy of Curator Frank C. Baker, of the University of Illinois Natural History Museum, the writer has had the privilege of examining and studying the skeletal material reposing in the Archeological Laboratory—material collected in central and southern Illinois over a period of several years, by Drs. A. R. Kelly and Warren K. Moorehead, formerly of the University. The study of this material was supplemented by similar work done on material available at the Dickson Mounds near Lewistown, and at the Field Museum in Chicago. The writer was also granted access to several excellent private collections in various parts of the State. The entire project involved the observation and measurement of hundreds of skulls and thousands of teeth.

Throughout the course of the investigation two noteworthy observations remained predominant. Evidence of dental caries, or decay of the teeth, was practically non-existent and was almost totally confined to teeth of aged individuals. This latter fact is established by the fact that such jaws had lost teeth before burial, the remaining teeth were tipped or spaced, or both, thus creating pockets wherein food material was easily retained. Subsequent fermentation caused the formation of organic acids that tended to soften the enamel rods, allowing the ingress of destructive mouth fluids. In spite of the fact that caries seemed to be a characteristic of the skulls of the elder individuals, they made up a total of only seven per cent of the skulls studied. In addition to the fact of comparative freedom from caries, the skulls showed remarkably fine development of the alveolar arches. The arches exhibited almost ideal proportions of length, breadth and height. The mandible was correspondingly well developed.

The problem of satisfactorily explaining this immunity from caries, and the marvelous development of the osseous structures of the mouth, was attacked from the standpoint of the influence of diet on such conditions.

Extensive excavation of village sites, camp sites, kitchen middens, refuse mounds, etc., carried on in recent years, has given us a wealth of

knowledge regarding what must have comprised the bulk of the diet of the aboriginals of Illinois. A noteworthy example of this type of study is the careful work done by the members of the Peoria Academy of Science, in excavating the Kingston Pits. The material collected at this site was forwarded to the University of Illinois and to the Smithsonian Institution for examination and classification. At the 1930 meeting of the Academy Dr. Baker presented the results of his work on it, revealing that the Mound Builders ate certain specific types of mollusca, fish, birds and mammals. He identified, among other things, the bones of the Sand Hill crane, the trumpeter swan, the whooping crane, the Virginia deer, black bear, and beaver; now, for the most part, extinct in the Illinois Valley region. The dog was evidently eaten to some extent, as well. A large percentage of the bones were found to have been cracked open, showing that the bone marrow was eaten after the meat was consumed.

The Mound Builders also practised agriculture in a crude sort of fashion. The early French explorers, during their voyages along the streams of Illinois, noted fields of corn adjacent to the Indian villages. Pumpkins were also grown. In their planting procedure they poked a sharpened stick into the soil, dropped the seed into the hole thus formed, and then covered it up, leaving it to germinate and produce crops without further human aid. When the game supply became depleted in any one area, the tribe would move to another locality. Thus their agricultural efforts were always carried on in virgin soil. Recent studies have shown conclusively that agricultural products derived from virgin soil possess a much higher mineral content than those secured from soil that has been utilized for a number of years. This fact is important in the study of dietary results.

Vegetable foods prepared from corn and pumpkins were supplemented in season by wild strawberries, gooseberries, blackberries, wild plums, wild onions, and undoubtedly, other tree and plant produce as well. The Mound Builders prepared their cooked foods by only brief exposure to fires of low temperature; hence the victuals retained most of the natural mineral and vitamin content. This fact is also important. Furthermore, the common method of cooking resulted in the addition of more mineral matter derived from the abrasion and decomposition of the heated stones used to supply the necessary heat, and from the unfiltered water which was used. Gritty materials were introduced into their cornmeal, also, as the stone grinding implements wore down during use.

Taken as a whole, then, the diet of the Mound Builders was exceedingly rich in the minerals and vitamins necessary for the proper growth and development of the teeth and bones. Compared with the average diet of the modern American it was more than five times richer in calcium and phosphorous compounds, and more than fifteen times richer in copper, magnesium and iodine-containing substances.

The above facts seem to supply an adequate explanation for the well-developed teeth and oral bones that characterize the skulls of the Mound Builders, taking for granted the fact that the skulls examined in the current study were typical of the race. Not only were their foods rich in important basic substances, but the introduction of gritty materials tended to remove scale from the teeth, and to scour out the fissures of the occlusal surfaces, thus preventing the retention of food at such spots. It is true that such involuntary tooth-cleaning was more effective than necessary, thus resulting in extreme wear of the teeth with age. The proximal surfaces of the teeth in time became squared off, inducing packing and subsequent decay of the teeth of the older members of the tribes.

The dentition of the Mound Builders was markedly superior to that of the present day civilized person. The differences in dietary practices undoubtedly accounts for the contrast. The average forty-year-old individual of today, if he does not have "false teeth", has, or should have, in most cases, more or less bridgework. Otherwise, his mouth exhibits typically numerous fillings and crowns. His alveolar arch is typically high, short, and narrow—imperfectly developed. His teeth are usually crowded; the third molars are commonly impacted, and his teeth more often than not show incipient or active pyorrhea. Our modern diets, rich in carbohydrates and starches, are generally poor in mineral and vitamin content. They do supply food for the flesh of our bodies, but they should also supply food for thought and corrective action.

# Archaeological Survey of Peoria County

A. M. Simpson

*Peoria Academy of Science, Peoria, Illinois*

One objective of the Ethnology Section of the Peoria Academy of Science, the past season, was the mapping of prehistoric habitation sites in Peoria County. Sixteen sites and 24 mounds have been located, photographed, and artifacts on each site tabulated. The location of the sites and the camp refuse found on the surface and subsurface give evidence of two basic cultures in this county.

The *Woodland* people, so far as surface material indicates, chose their village sites on high bluffs that approach the river, on narrows between, and on bluffs of spring-fed streams of the Illinois River.

A Woodland culture site is located on a narrow terrace between the Illinois River and the bluff on the Gauwitz farm. It is about five acres in extent and shows some signs, on the subsurface level, of a different culture below. Much camp refuse consisting of flint chips, large celts, stemmed points, burned rock, chert blades and grit-tempered sherds which show rouletting, stamping and cord markings, were found. A cache of 100 flint blades was found here. All other bluff sites produced about the same surface finds except one, in which there were many small triangular points of the Mississippian type.

From the bluffs to the Illinois River bottoms, the scene changes. Here we find the *Mississippi* culture predominates in four sites along the thirty miles of river front. The *Kingston* site, the most extensive, covers about ten acres. It has included four mounds which have been destroyed. The artifacts found on this site were taken mostly from the sub-floor and storage pits. Fire pits produced but few. Storage pits were from 5 to 6 feet deep and half as wide. Over 3,000 specimens were collected from them, representing 45 varieties of artifacts. The pits contained, besides the camp refuse, layers of black earth, gravel, ash and shell. The shell was intentionally placed in many pits. As to other fillings, whether placed for seasonal reasons, for sanitary purpose or to be from high water, has not been determined.

## DESCRIPTION OF A FEW FINDS

Awls made mostly from deer bones. A few made from the bones of turkey, bird, dog and fish. One fashioned from the lower jaw of a long nosed gar. In most cases the bones were split, one end sharpened and the shaft left in the rough. Many were made from the calcaneous bone of the deer.

*Paint Stones* made of sandstone, circular in form, from 5 to 8 inches in diameter and from  $\frac{1}{2}$  to 1 inch in thickness. Only one face was used for grinding of paint.

*Bone Fish Hook* from  $1\frac{3}{8}$  to 2 inches in length, shaft rounded with a knob or groove cut near the end of the shaft. None were barbed. All were made from deer bones.

*Game Bones* fashioned from the small bones of deer feet. The larger joint was cut off and the smaller was perforated either by drilling or by making a diagonal cut through the joint.

*Clay Disks* made from potsherds and shale. Some were perforated, many were left blank.

The contents of one pit, two feet deep and fourteen inches in diameter, included the shells of nine large river clams, resting on a hard clay floor and covered with four inches of clay burnt to a brick red. Black dirt long since had taken the place of the clams. No doubt a forgotten "clam bake" of decades ago.

#### ARTIFACTS TAKEN FROM PITS AT THE KINGSTON VILLAGE SITE

Small triangular projectiles	Woven fabric
Knives	Corn carbonized
Celts	Nuts
Pitted stones	Paw Paw seed
Sandstone sharpeners	Squash seed
Discoidals	Mushroom clay trowel
Anchors	Cooper beads
Sinkers	Bone awls
Anvils	Bone needles
Paint stones	Bone fish hooks
Scrapers	Bone ornaments
Slate disks	Beamers
Hammerstones	Bone beads
Stone pipes	Bone arrow points
Stone balls	Game bones
Shell spoons	Deer jaw hoes
Shell hoes	Bone chippers
Shell ornaments	Beaver-tooth chippers
Shell beads	Bone plaques (turtle plastron)
Ear ornaments	Elkhorn chisels
Clay disks	Skull trophies
Clay bowls	Bone of mammals, birds, fish, and shell
Shell-tempered clay (not fired)	

And several undetermined objects

#### CONCLUSIONS

- (1) Site location in one determinant of culture.
- (2) No indication of European contact.
- (3) No storage pits were found in *Woodland* culture sites.
- (4) Mississippi sites produced a majority of bone and shell tools while *Woodland* produced a majority of stone tools.
- (5) It was not determined whether storage pits were inside or outside of huts.
- (6) The plant *Gonolobus laevis* (Angle Pod) was found growing on Indian sites but has not been located elsewhere in the county. (Noted by Virginia Chase, Peoria.)

## An Interesting Anthropological Find From the Lake Michigan Region

W. C. Van Male

Waukegan, Illinois

The antiquity of man in America always has been a topic for much discussion. Until recently it has been supposed that man was a comparatively late arrival upon this continent.

This belief has been much altered by several discoveries of human remains and man-made tools in association with the skeletons of Pleistocene mammals. The most notable of these was made at Folsom, New Mexico.

The discovery at Folsom gave conclusive evidence that the region was inhabited by man at the close of the great ice age. At a depth of four to thirteen feet, spear or javelin points were found among skeletons of an extinct species of bison. After a careful study of these remains, Dr. Barnum Brown, Curator of Fossil Reptiles of the American Museum of Natural History, placed them at the close of the Pleistocene period. It is highly probable that these Late Pleistocene mammals were hunted and killed by the men who used the points on their weapons.

Typologically, these points are very much unlike the characteristic surface finds, left by the later American aborigines. The typical "Folsom point" is too large to have been used on an arrow, but instead was affixed to a small spear or javelin. It is thought by some authorities that these javelins were hurled with considerable force by means of the throwing stick. The point itself tapers towards its concave base, the widest part being nearest

the anterior end. There is a smooth longitudinal groove, formed by the removal of a single long flake, on each side. The materials used for this weapon are jasper or chalcedony.



Fig. 1.—POINT OF "FOLSOM" TYPE FOUND IN LAKE COUNTY, ILLINOIS.

Several years ago an artifact that had all the Folsom characteristics, was found by the author in Sec. 11, Libertyville Township, Lake County, Illinois. It is made of chalcedony and is an almost exact facsimile of those found at Folsom, N. M. The pointed end is missing, but the largest part of the piece is still intact. It was excavated by a ditch digging machine; so unfortunately, the exact depth of the find could not be determined. The field in which it was found is of yellow-gray silt loam and had been under cultivation for years. Several arrow points and other artifacts of the Middle Mississippian culture had been found on the surface here, but there was nothing else that could have been associated with the "Folsom type".

This find may be of little consequence, but is, nevertheless, worthy of mention. The fact that there were no other remains in association with it, and that it was not found *in situ*, decreases its scientific value. However if typology were given the significance it has in Europe, there would be little doubt that some connection exists between the Lake County point and those found at Folsom. It would, therefore, be a reasonable conjecture that Northern Illinois had human inhabitants in Late Pleistocene times. On the other hand, the finding of a point identical to the late ice age points of Folsom may be merely a coincidence.

## The Evolution of the Mouth

L. H. Wolfe, D.D.S.

Quincy, Illinois

The teeth show an adaptive modification of structures to change in bodily functions and have been modified during the various stages in development from the lowest organisms to the highest forms. Osmosis is the process of alimentation of the ameba. There is no special collection of cells at the orifice of the alimentary canal of the *coelenterata* or the annuloida for the preparation of food. In the arthropoda and crustaceans, there are cells at the beginning of the canal which partially prepare the food. In the suctorial mouth of the *Petromyzon marinus* there are corneal modifications of the epidermis which serve as teeth. Their attachment to the maxillae and mandible are acrodont, pleurodont and thecodont. In the rays there is a sexual difference in the shape of the teeth. The authority for the above statement is Hopwell-Smith, and as this paper is being prepared, the writer is planning to verify this statement with research in this particular field. Some amphibians have no teeth, as the *Bufo americanus*, while others, as the *Rana castesbiana*, have teeth not unlike the pisces, at least always on the maxillae but the mandible of the *Rana castesbiana* is edentulous. Most reptilia have teeth and the mandible is jointed at the symphysis and articulates with the skull through the quadrate bone. The poison fangs of the crotalus, etc., are in the maxilla and in the *Heloderma suspectum* the venom conducting fangs are in the mandible. The chelonidae have a horn-like covering for the border of the jaw. The aves have no teeth, the beak being a horny sheathing of the ends of jaw bones and some with serrations. The first type of tooth of interest other than a fang is the molar of the ungulates which are herbivorous and granivorous. The molar teeth of the *Equus caballus* are good examples of teeth in a jaw with a marked lateral excursion of the mandible. This is practically the only motion of the mandible and makes the serrations of the molar's run antero-posteriorly; which is exactly the reverse of the form of molars of the rodentia, in which a postero-anterior movement of the mandible is responsible for the grinding necessitating a different arrangement of the occlusal surface of the teeth. In the rodentia, we find the persistent pulp and the tooth grows out as it is worn off. The carnivorous animals differ from the class just described in the character of their teeth and also in the manner of the movement of the mandible. The skulls of a *Procyon lotor* and *Odocoileus hemionus* show a vast difference in the grinding teeth as shown in their mandibles. The carnivorous molars comminute while the herbivorous molars triturate. There is a marked difference in the tempormandibular articulation of

these two animals. The herbivorous have a flat glenoid fossae to render possible the lateral excursion of the mandible. The carnivorous animals have no lateral excursion. The condyles fit into the fossae so tightly as to make a hinge joint, and in some instances the distal part of the eminentia articularis so far over hangs its glenoid fossa that it cannot be seen. In some cases it is necessary to fracture the skull to remove the condyles.

In the apes, dentures are found which are approximately like the human. In the new world monkey almost exactly the same type of denture is found as that of man, except that there are three bicuspids instead of two. There are two incisors, a cuspid, three bicuspids and three molars on each side. The old world monkey is the first animal representing exactly the dental formula of man. There is, however, a space between the upper lateral incisor and cuspid which is to admit the lower cuspid. These animals are largely frugivorous.

The human oral cavity has in front a transverse aperture, the rima oris; behind, it communicates with the pharynx through the isthmus faucium. An outer, the vestibulum oris, bounded externally by the lips and cheeks, and internally by the teeth and gums which cover the outer aspect of the alveolar process of the jaws. The maxillary arch is elliptical, the mandible is parabolic in outline. The teeth of man do not, normally occlude by means of their cusps, but by a perfect system of interdigitation. This is enharmsis.

In primitive man the upper incisors came into opposition edge to edge with the lower incisors, and were frequently worn flat in consequence. While in modern man there is a tendency for them to over bite. The third molars are the last to erupt and among the first to be lost and some never erupt. In prehistoric man they erupted and functioned in mastication. A fourth molar may be observed occasionally in the gorilla and much more frequently in the orang in which a fifth tooth has been noted in rare instances. Accessory molars are very infrequent in the gibbon and in the old world monkeys. This anomaly is found occasionally in American monkeys ateleus. In modern man we find supernumerary incisors and molars, and the jaws are generally short and not as prognathous, and the teeth are inclined to be irregular and crowded.

Owing to the effects of civilization, the teeth of the high classes of both the American and European people are often carious, which is not so much the effect of a weakness of structure of the teeth as it is the result of unnatural foods and habits.

Wiedersheim reports upon evidence of caries of the teeth, after an examination of a large number of skulls from various museums as follows: Esquimaux 2.5 per cent; Indians 3.10 per cent; Malays 3.20 per cent; Chinese .40 per cent; Europeans 80-100 per cent.

For several generations man has been endeavoring to trace a resemblance between human beings and apes. The earliest trace of fossil man

yet discovered in Europe is that of the jaw of *Homo heidelbergensis*. The main features were the massive character of the long frame work, which at first sight seemed more anthropoid than human, that the masticatory muscles must have been more highly developed here than in any known human race. The jaw is believed to have been 1,000,000 years old. The Neanderthal skull (*Homo mousteriensis*) was unearthed near Dusseldorf in 1856, a few years before the publication of Darwin's "Origin of Species". This skull had an extremely flattened cranium with largely developed superciliary ridges. In 1910, on the south coast of Jersey after the removal of 25 feet of material nine teeth were discovered, which without doubt belonged to an individual of the Neanderthal race, but in certain features are more primitive than the teeth of the Heidelberg mandible. In 1886, two skulls were found at Spy in which the third molars were larger than the second and these than the first, all having three roots. It is probable that the Heidelberg and Neanderthal are survivals of a very ancient type and in no way indicative of the stage reached by *Homo sapiens*. In 1891, a skull was brought to Europe from Java (*Pithecanthropus*) which appeared to be intermediary between man and ape. The skull of a Pre-Boulder clay man was discovered which is thought to be 100,000 years old or more. The jaws were lost, but the isolated teeth were preserved and found to be small in size, very much worn down, not materially different from the modern type of tooth, and totally dissimilar to those of Neanderthal man. The next oldest, as far as yet ascertained, is the skull found in excavating for the Tilbury Docks in 1883, which is probably 30,000 years old. The Indians of America are generally macrodonts, the teeth being large, strong and well set in a round arch. There is a considerable variety among the divers races of North and South America, large, medium and small teeth are found. Deformities are not infrequent and fourth molars and third incisors sometimes occur. The mound-builders had fine teeth in a round arch, and were yellow. The ancient Aztecs had small arches and small fine teeth. The Indians of the United States of later times had large fine teeth, but with the degeneracy and disease incident to the vices acquired from the white man, they became degenerate and defective.

In conclusion, as animal life progressed from the higher forms of invertebrates to the lower forms of vertebrates, a specialization of the digestive tract evolved bringing with it the inauguration of special organs for mastication. As higher forms of vertebrates evolved, so the dentition became more efficient to take care of the needs of the digestive tract and food habits of the animal. So we see that dentition may differ considerably from species to species and different genera within a single family show how completely dissimilar one dentition may be from another.

## PAPERS IN BOTANY

---

### EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN

Of the eleven papers on the program of the Botany Section meeting, the following three are not here represented:

*Response of Some Sensitive Stigmas*, by Harry J. Fuller, University of Illinois, Urbana.

*A Demonstration (microprojection) of the Lily-type Embryosac as Redefined by D. C. Cooper*, by E. L. Stover, Eastern Illinois State Teachers College, Charleston.

*The Unit of Instruction in General Botany*, by Jerome Isenbarger, Wright Junior City College, Chicago.

About fifty-eight persons attended the meeting.

Dr. Neil E. Stevens, Department of Botany, University of Illinois, Urbana, was elected chairman of the section for the 1937 meeting.

(Signed) HARRY V. GIVENS, *Chairman*



# Influence of Certain Organic Substances Upon the Growth Behavior of Excised Root Tips

Gladys C. Galligar

*James Millikin University, Decatur, Illinois*

## INTRODUCTION

The idea that certain organic substances may exercise an influence upon the amount and type of plant growth has been a controversial question for many years. Some work of this nature has been done with excised root tips as the subject. Kotte found that root tips were affected beneficially by the addition of meat extract to Knopf's solution. Robbins found beneficial effects from the addition of peptone and autolyzed yeast to a modified Pfeffer's solution. Other organic substances used by both men had no beneficial effect. In this study legumin-tryptagar, brain heart infusion, yeast-dextrose agar, and different concentrations of dextrose and peptone were tried on different species of excised root tips with varying degrees of positive results.

## MATERIALS AND GENERAL METHODS

The procedure to secure sterile root tips involved several steps and in the main followed that of Robbins (2). The seeds were soaked for 4 hours in a solution of Zonite diluted 1-30. They were then transferred by means of steel forceps to Petri dishes containing a thin layer of 0.75 per cent sterile agar agar, where they were allowed to germinate. The ends of the forceps were passed through a Bunsen flame and cooled in sterile water each time before touching the seeds. When the roots had grown approximately one inch, the tips were cut off in uniform lengths of 1 cm. by a steel scalpel, which was flamed and cooled before each operation. The excised root fragments were transferred by means of a sterilized wire loop to Pyrex Erlenmeyer flasks of 125 ml. capacity carrying 50 ml. of sterile nutrient media. The inoculated flasks were kept in a laboratory with curtains drawn, where they received very weak diffuse light and where the temperature varied no more than 3° F. (68-71° F.) during the experiment.

The nutrient solution was a modification of Pfeffer's formula to which was added dextrose and peptone.\* Immediately after being made, the solution was measured into the flasks, which were closed with cotton plugs and autoclaved at 15 pounds pressure for 20 minutes.

* Ca(NO <sub>3</sub> ) <sub>2</sub>	2.0 gm	KCl	0.25 gm.	Dextrose 2.0%
KH <sub>2</sub> PO <sub>4</sub>	0.5 gm	MgSO <sub>4</sub>	0.5 gm.	Peptone .04%
KNO <sub>3</sub>	0.5 gm	FeCl <sub>3</sub>	0.005 gm.	Distilled H <sub>2</sub> O 6000 C.C.

TABLE I.—A SUMMARY OF DATA ON 100 ROOT TIPS OF CORN CUT AT ORIGINAL LENGTHS OF TEN MILLIMETERS AND GROWN IN THE MODIFIED PFEFFER'S SOLUTION WITH VARYING CONCENTRATION OF PEPTONE

Peptone per cent	Average daily increment in mm. of length of 10 root tips for 1st 10 days										Average total length in mm. at end of 28 days	Range in lengths in mm. of individuals	Average number lateral roots	Range in number of lateral roots among individuals	Average dry weight in gms. per 10 roots
	1	2	3	4	5	6	7	8	9	10					
	0.04.....	4.6	3.4	3.4	0.2	5.6	2.6	2.3	3.6	6.6					
0.1.....	1.2	2.6	3.0	2.0	4.8	1.4	2.4	2.5	1.3	1.6	115	55-210	59	24-103	.212
0.2.....	2.0	1.0	1.5	1.3	2.2	1.4	1.8	0.2	2.8	1.2	62	38-160	9	0-27	.200
0.3.....	1.6	0.6	1.5	1.6	1.7	1.8	1.6	2.4	1.6	1.2	54	31-70	5	0-21	.215
0.4.....	1.4	1.6	1.0	0.8	0.7	1.0	1.2	1.5	1.0	1.0	44	30-65	4	0-13	.180

Daily increments in length were measured by placing a mm. rule under the flasks. Final data on dry weight, total length and number of laterals were tabulated and summarized for reference.

Deviations from the general method are stated in the discussion of results for each separate treatment.

### DISCUSSION OF RESULTS

(1) Influence of increasing the amount of peptone in the nutrient solution upon the character of growth of root tips of dent corn.

In a preliminary experiment a mistake was made by the addition of too much peptone to a quantity of the basic solution. This solution was used as made up to determine its influence upon the growth behavior of excised root tips of corn. Their growth differed so markedly from that of the same kind of root tips grown with the normal amount of peptone in the basic solution that a series of experiments was performed to determine what concentration of peptone initiated the effect. The root tips became quite thickened in diameter, grew less in length and produced fewer branches, which were also quite thickened.

The basic solution was made up with five concentrations of peptone as follows: 0.04 per cent as in the normal solution, 0.1 per cent, 0.2 per cent, 0.3 per cent, and 0.4 per cent. Root tips of corn were allowed to grow in these solutions for four weeks.

Figure 1 shows clearly a noticeable change in growth habit as soon as the concentration of peptone was increased to 0.2 per cent. There was a preponderance of shorter and thicker roots with fewer laterals. This tendency became more marked as the concentration was increased to 0.4 per cent of peptone, where all the roots were short and thick with very few to no laterals at all.

Table I, however, shows no noticeable difference in average dry weight until the concentration of peptone reached 0.4 per cent. There was a distinct inhibition of elongation within the first ten days, when the concentration reached 0.2 per cent.

It might be said that the effect is due to increased osmotic concentration of the solution. To test this possible factor, the osmotic concentration of the basic solution was increased by adding more dextrose and maintaining the normal concentration of peptone. The phenomena of osmosis is dependent upon numbers of particles in solution and not upon weight. The empirical formula of dextrose is known, while that of peptone is not known definitely. Peptone, whatever its empirical formula may be, is composed of molecules which are much larger than those of dextrose. It follows that a given weight of peptone

TABLE II.—A SUMMARY OF THE DATA ON 50 ROOT TIPS OF CORN CUT AT ORIGINAL LENGTHS OF 10 MILLIMETERS AND GROWN IN THE MODIFIED PFEFFER'S SOLUTION WITH VARYING CONCENTRATIONS OF DEXTROSE

Dextrose per cent	Average daily increment in mm. of length of 10 root tips for 1st 10 days										Average total length in mm. at end of 28 days	Range in lengths in mm. of individuals	Average number lateral roots	Range in number of lateral roots among individuals	Average dry weight in gms. per 10 roots
	1	2	3	4	5	6	7	8	9	10					
	2.....	2.6	4.5	4.7	3.2	2.0	3.2	2.3	6.0	2.0					
2.5.....	3.0	2.0	4.5	1.4	3.3	2.3	3.7	4.2	4.3	3.0	141	41-251	87	10-121	.208
3.....	3.2	4.0	2.3	4.7	5.9	2.5	3.5	2.1	1.0	4.0	136	45-268	97	0-128	.224
3.5.....	3.70	2.15	4.92	3.02	5.01	4.00	5.35	3.77	5.89	4.27	129	38-189	72	3-97	.170
4.0.....	2.71	3.20	3.23	2.94	1.20	2.74	3.93	1.33	2.63	2.91	78	32-91	20	0-54	.185

would have a smaller number of osmotically active particles than the same weight of dextrose. Neither substance ionizes in solution. The concentrations of glucose used, namely, 2 per cent, 2.5 per cent, 3 per cent, 3.5 per cent and 4 per cent, produced an increase of osmotically active particles per unit volume far beyond the range produced by the increased concentrations of peptone.



Fig. 1.—GROUPS OF CORN ROOTS, WHICH HAVE BEEN GROWN IN THE BASIC SOLUTION WITH VARYING CONCENTRATION OF PEPTONE. Upper left: normal concentration of peptone (0.04 per cent). Upper right: 0.1 per cent peptone. Lower left: 0.2 per cent peptone. Lower center: 0.3 per cent peptone. Lower right: 0.4 per cent peptone.

Figure 2 shows that there was no particularly great difference in character of growth until a concentration of 4 per cent dextrose was reached. There was the usual wide variation in each group of roots; thickened roots with few or no laterals occurred throughout the series, and not until a concentration of 4 per cent dextrose was reached was there a marked reduction in average total length, in average number of lateral roots, and in average dry weight (Table II.) This is hardly in accord with Robbins' (3) findings that corn root tips grew to greater lengths and produced more laterals in the dark in twenty-four days in 4 per cent dextrose than in 0.2, 0.5, 1, 2, or 6 per cent dextrose. However, a comparison of results cannot be made directly with those of Robbins, because Robbins used a modified Pfeffer's solution six times

TABLE III.—SUMMARY OF DATA ON 35 ROOT TIPS OF CORN GROWN IN THE MODIFIED PEFFER'S SOLUTION WITH 2 PER CENT DEXTROSE, 0.04 PER CENT PEPTONE, AND 0.1 PER CENT LEGUMIN TRYPTAGAR

Species	Average daily increase in mm. of length of 30 root tips for first 10 days										Average total length in mm. at end of 10 days	Average final total length in mm.	Range in final lengths in mm. among individuals	Final average number lateral roots	Range in final number of lateral roots among individuals	Average dry weight in gms. per 10 roots
	1	2	3	4	5	6	7	8	9	10						
Corn.....	3.65	2.93	2.04	3.86	4.75	5.23	3.05	2.17	2.00	3.25	32.93	179.3	55-210	221	78-330	.312

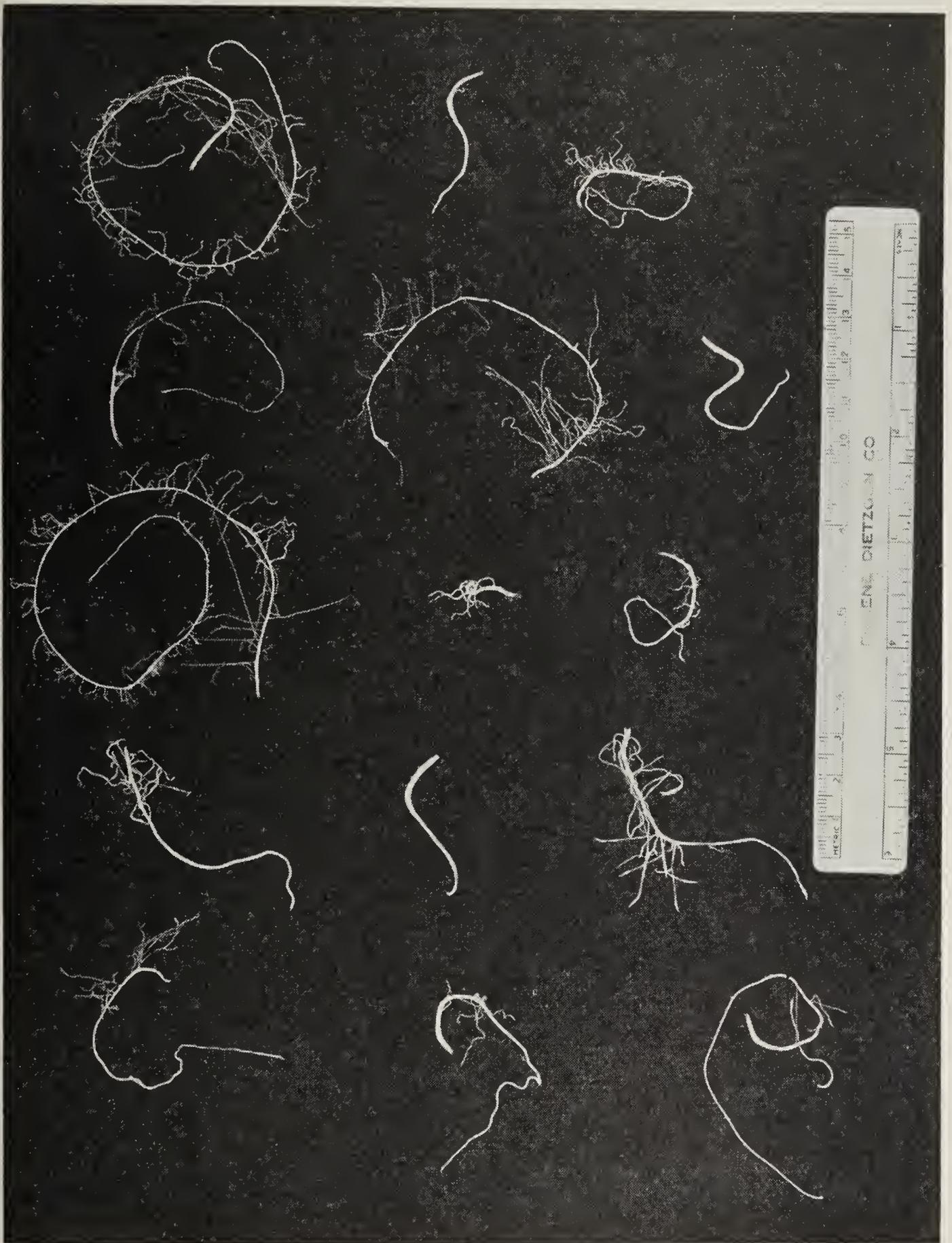


Fig. 2.—REPRESENTATIVE ROOT TIPS OF CORN GROWN 28 DAYS IN PFEFFER'S SOLUTION AND PEPTONE WITH DIFFERENT CONCENTRATIONS OF GLUCOSE. Top row, 2 per cent glucose; second row, 2.5 per cent glucose; third row, 3 per cent glucose; fourth row 3.5 per cent glucose; fifth row, 4 per cent glucose.

the original strength and added no peptone. The presence of peptone used in the present experiments and the weaker concentration of salts might have had a combined effect to alter the behavior of root tips grown in such a solution, to which increasing amounts of dextrose were added.

(2) Influence of legumin-tryptagar, brain-heart infusion, and yeast-dextrose agar upon the growth of excised root tips of dent corn, pea and cotton.

To the basic solution was added as much of the yeast-dextrose agar as would keep the concentration of peptone in the final solution at 0.04 per cent, in order to avoid the influence of additional amounts of peptone, which would have seriously complicated the results, as has already been pointed out earlier in this paper. In the second series of experiments brain-heart infusion was added to the basic solution with the same precaution. In the third series of experiments 0.1 per cent of legumin-tryptagar was added to the basic solution. In the latter case no peptone was present in the compound added; therefore, no calculations were necessary to keep within bounds in regard to peptone, since it was added separately in the normal amount. The three compounds were obtained from the Digestive Ferments Company, Detroit, Michigan.

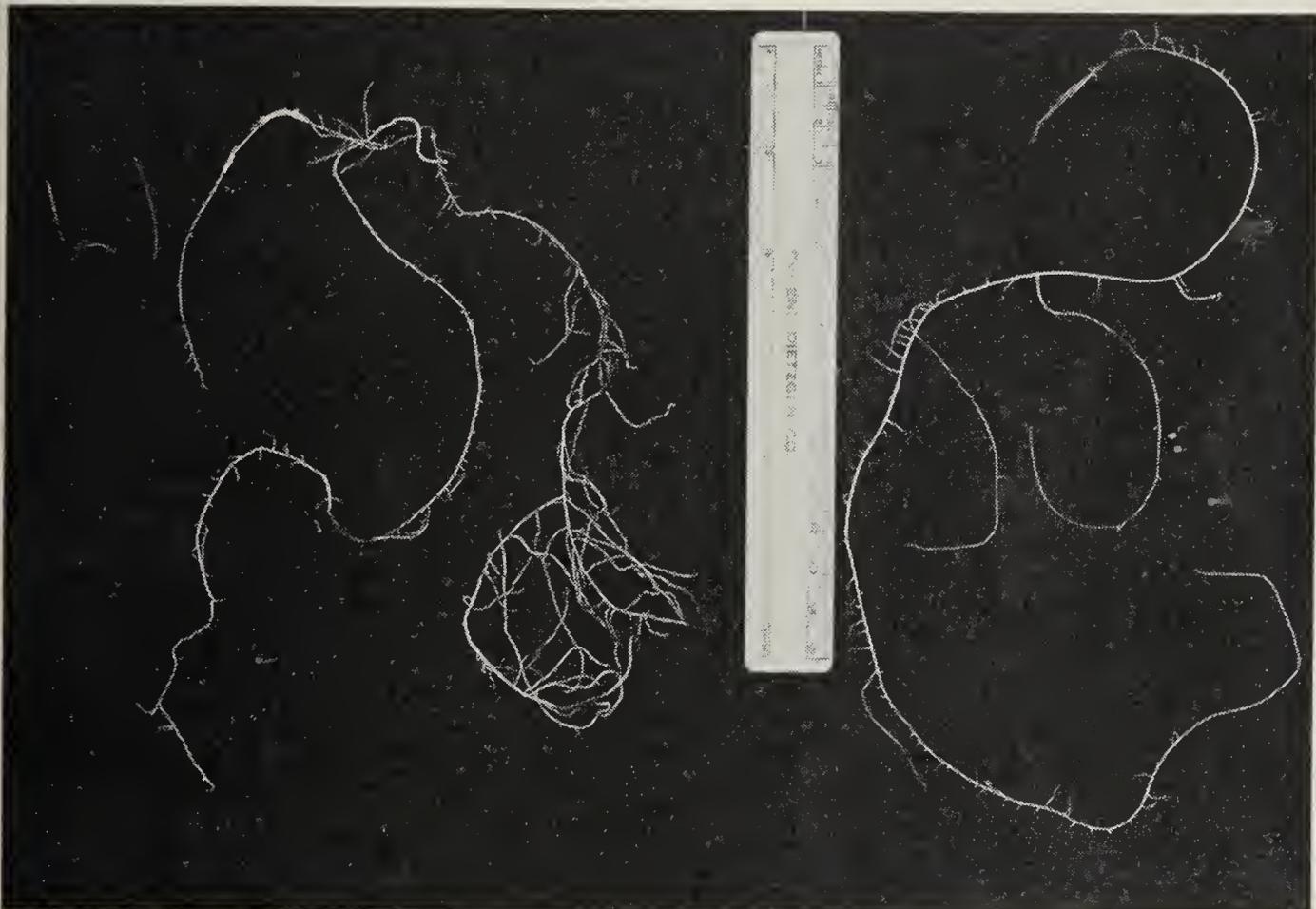
Thirty ten-millimeter root tips, in three series of ten individuals each of cotton, corn, and pea were grown for eight weeks in each of the three solutions. Daily observations of increment in length were made for a period of about two weeks. At the end of the experiments the usual final data were recorded.

Since no difference in behavior were secured from the use of brain-heart infusion and of yeast-dextrose agar in the three species of root tips used the results are not reported here in tabular form. They were too nearly like those obtained in the first experiments reported in this paper with the use of the basic solution alone to warrant space for recording.

However, the legumin-tryptagar acted as a marked stimulant to the growth of corn root tips and in a few isolated cases to the growth of pea root tips, but no effect was noticeable in cotton.

Figure 3 shows one corn root, which was obtained entire and which shows very well the uniformly thickened root with its well-developed laterals thickened in the same manner. This one root was typical of about sixty-five per cent of the root tips that were grown in the legumin tryptagar. There was in every case a comparatively short root with an abundance of long and very well developed laterals. The entire root system was quite uniformly thickened. This robust appearance was never observed in well developed roots of corn grown in the original basic solution. In the latter case the roots were more slender and the

laterals were usually smaller in diameter than the main axis of the root. One individual corn root tip grew to astounding proportions, attaining a dry weight of 0.254 grams with a length of 143 millimeters, having 332 laterals and subbranches ranging from 9 to 97 millimeters, making a grand total of approximately 9920 millimeters of root, representing an increase of 992 times the length of the original fragment. This root could not be photographed because in washing it out for examination it broke apart due to the bad entanglement within a 125 millimeter flask.



**Fig. 3.**—UPPER LEFT, PEA ROOT GROWN IN LEGUMIN TRYPAGAR; LEFT, CORN ROOT GROWN IN LEGUMIN TRYPAGAR; RIGHT, CORN ROOT GROWN IN DEXTROSE SOLUTION.

The root tips of pea, which seldom developed lateral roots under any circumstances and then only very short stubby ones of one or two millimeters length, grew to greater length about forty per cent of the time and produced from one to five laterals, ranging from three to twenty-nine millimeters (Fig. 3).

Although no differences in general behavior were noted in cotton, three of the roots deviated far from their ordinary habits. In these three roots the epidermis split longitudinally in one place and through this slit there emerged small outgrowths of the parenchymal tissue of the cortex, which reached the size of a cabbage seed. The cells were very large and loosely arranged as in certain peculiar proliferations secured in a few cases from one-millimeter tips of sunflower. These outgrowths were easily discerned because of their contrasting tan color to the black epidermis.

(3) The effect of dextrose and distilled water on the growth of root tips of dent corn.

In this experiment ten root tips each ten millimeters in length were grown eight weeks in a 2 per cent solution of dextrose to determine their behavior in the absence of mineral salts. These roots exhibited the same uniformly thickened appearance as that caused by legumin tryptagar, but there were few laterals (Fig. 3). In several cases there was liberal pigmentation due to anthocyanin, although anthocyanin never developed in root tips of corn grown in the original basic solution. The root pictured in Fig. 2 was the longest in the series. None of the others in the series were half as long.

#### SUMMARY

(1) Peptone in concentrations of 0.2 per cent or more inhibited the growth and formation of laterals in root tips of corn.

(2) A concentration of 4 per cent of dextrose was reached before noticeable changes were observable in corn root tips.

(3) No noticeable harmful or beneficial effects were secured from brain-heart infusion nor from yeast-dextrose agar on the growth of root tips of dent corn, pea, and cotton.

(4) Legumin-tryptagar acted as a stimulus to the growth of excised root tips of dent corn and pea, but had no effect on cotton. The stimulus caused an increased development of lateral roots.

(5) Corn root tips grown in the presence of 2 per cent dextrose without mineral salts developed into short thick roots with few laterals.

#### BIBLIOGRAPHY

1. KOTTE, W., Kulturversuche mit isolierten Wurzelspitzen. Beitr. Z. Allgem. Bot. 2:413, 1922.
2. ROBBINS, W. J., Effect of autolyzed yeast and peptone on growth of excised corn root tips in the dark. Bot. Gaz. 74:59, 1922.
3. ———, ———, and W. E. MANEVAL. Effect of light on growth of excised root tips under sterile conditions. Bot. Gaz. 78:424, 1924.

## Sample-Plot Statistics in University Woods

W. M. Marberry, J. D. Mees and A. G. Vestal

*University of Illinois, Urbana, Illinois*

Data for this study of the University Woods east-northeast of Urbana were obtained in 1935 by M. E. Barnes, Everett Green, Dawn Neil, and the authors. Tabulations from 42 scattered circular plots of one-eighth acre size studied by John Hanley in 1931 were also available. The 1935 plots comprise 64 tenth-acre squares arranged in a grid (528 feet square), south of the middle of the 60-acre forest. Of the 30 tree species observed in this mixed mesic forest, 24 are represented in the plots. Abundance data were plotted separately for trees of the different species for 36 of Hanley's circles, for the 64 contiguous squares, and for a composite sample totaling 10 acres. For the latter we find the leading species represented as follows: Hard maple, 36.5 trees per acre; American elm 15.7, white ash 15.5, red elm 11.9, linden 9.4, buckeye 7.0, hackberry 5.3, papaw 3.7, northern red oak 3.5, walnut 3.3, blue ash 2.9. Yellow oak, *Q. Muhlenbergii* (No. 16 in order of abundance, but with larger trees than most other species) 1.3 per acre; bur oak (No. 17, also large trees) 1.0; trees of all species, 125.6 per acre.

The relation between size of plot and number of species represented in a plot was studied by arranging neighboring squares of the grid into groups of graduated sizes, 0.1 to 1.6 acres, according to patterns giving as nearly regular shape and arrangement of groups of squares as was permitted. Thus the 64 squares were arranged successively into 32 2's, 21 3's, 16 4's, 12 5's, etc., up to 4 16's. Other rearrangements gave somewhat less dependable data for plots aggregating 24, 32, and 48 squares. From the mean numbers of species for the successive sizes of the aggregates, a species-area curve was constructed. Mean species numbers for different-sized plots:

0.1 acre	5.4 spp.	0.7 acre	13.5 spp.	1.4 acre	15.8 spp.
0.2	8.1	0.8	14.0	1.6	16.3
0.3	9.8	0.9	14.0	2.4	17.6
0.4	11.1	1.0	14.8	3.2	18.8
0.5	11.3	1.1	15.0	4.8	19.8
0.6	12.3	1.2	15.6	6.4	21.0

In this species-area curve, which is logarithmic in form, the change of direction is greatest at about 0.8 acre. An 0.8-acre plot, 8 per cent of the 10-acre sample, contains 14 of the 24 species of that sample, or 58 per cent. It is evident that further additions of species require

larger increases in sizes of plots; 0.8 acre is taken to be the *minimal area* (for trees) in mature mixed mesic forest in east-central Illinois. This minimal area is the smallest practicable unit which by itself may be taken as representative of its community.

The influence of shape of plot upon constancy of numbers of individual trees and species in a plot was studied by comparing four groupings of 0.8-acre plots within the 6.4-acre grid, as shown in the following table:

No. and Shape of Units	Trees per unit	Species per unit	Variance: S.D. as %
5 Circles .....	67-122	13.6	5.9
8 Compact plots .....	70-118	14.0	7.2
8 N-S strips .....	72-103	} 14.13	8.2
8 E-W strips .....	63-111		10.1

The figures for variance of species-number in the table represent the standard deviation of the mean species-number for each grouping, expressed as percentage of that mean. The smaller the variance, the more nearly alike are species-number results for different plots or units of one particular shape. It is seen that the most compact units (circles) give least variable species-numbers. The least compact units (strips, 66 by 528 feet) are considerably more variable. For greatest dependability, circular plots are recommended, but where the units must be contiguous, squares or short oblongs are nearly as good.

The differences in mean species-number per unit when units vary greatly in shape or degree of compactness, are believed to be real. Any tendency toward aggregation of several or numerous trees of one species into a clump might give such a clump heavier representation within a compact unit than within a narrow strip, thus tending to make less room for other species inside the compact unit. For reconnaissance surveys, line or strip methods thus seem to offer an advantage in disclosing a larger proportion of the total number of species.

A great and unpredictable variability in number of individual trees in different units of whatever shape, shows in one of the columns. It is presumably due to uneven distribution of size-classes in an all-aged mixed stand, particularly since some species are mostly very small trees (e. g., papaw). Species-number is thus a more tractable object of statistical study than is the number of individual trees.

A search for the species of *general* distribution throughout the areas sampled was made by selecting the species of 100 per cent frequency in 0.8-acre units of the four groupings tabulated above. Only five species were found in *all* 0.8-acre plots. These are: hard maple, the two elms, linden, and blue ash. Correlation with order of abundance is not very good. White ash (No. 3 in abundance) is missing from fair-sized areas in the woods. Blue ash, though in every 0.8-acre plot, is only No. 11 in abundance.

So far as adequacy and economy of sampling are concerned, it was very evident that many scattered small plots are superior to a consider-

ably larger number of contiguous plots (or in other words, to one large plot of greater total area). Dispersion of sample areas is indispensable for an adequate representation of the stand. The 0.2-acre size is recommended for small plots, since it gives a much better representation of species (mean no. for 0.2 acre 8.12, range 5 to 11; for 0.1 acre, mean 5.38, range 2 to 9). Also, 0.2-acre plots are much less variable.

The 10-acre total (one-sixth of the stand) is considered inadequate as a sample of the woods as a whole. Twelve acres dispersed in 60 plots may be suggested. The unexpectedly large size of an adequate sample, and the greater size of minimal area than was expected, are considered to be an expression of great variability in composition of this highly mixed forest community. It is submitted that a forest with numerous tree species is very different from the supposedly uniform association which from a distance it may appear to be. Ecologists frequently credit such forests with too high a degree of uniformity.

High content of soil organic matter, dominance in an earlier stage of bur oak, elm, and yellow oak, and complete *absence* of white oak, are attributed to a history of development from prairie upland only a few hundred years ago. Such forests in this part of Illinois are thus very different from those usually referred to the oak-hickory type.

# Floral Zones in the Mountains of Southern Mexico

A. C. Noé

*University of Chicago*  
*Illinois State Geological Survey*

## ABSTRACT

During a collecting trip in southern Mexico in September, 1935, I had an unusual opportunity to observe the zones of the living floras of those regions. I went by bus from Mexico City to Puebla and Tehuacan in the state of Puebla, hired a Ford car in Tehuacan and went in it as far as Huajuapam in the state of Oaxaca, from where I proceeded, on horseback, to the former property of the Oaxaca Coal and Iron Company on the Rio Consuelo. This locality had been visited before in 1909 by G. R. Wieland, who made an extensive collection of fossil plants in the state of Oaxaca. During this trip it was possible to pass through cultivated tropical vegetation in the valleys (about 5000 feet above sea-level), through extensive cactus forests at an elevation of 6,000 to 7,000 feet above sea-level, to oak forests at 7,000 to 8,000 feet altitude, to a tropical alpine zone between 8,000 and 11,000 feet. The cultivated tropical vegetation in the valleys consisted primarily of banana trees, sugar cane, rice, avocado pears, bamboo, pineapple, cocoa nut palm, and tropical garden flowers. In the cactus zone we find a great variety of species of *Opuntia*, *Cereus*, *Cephalocereus*, *Echinocactus*, *Euphorbia*, *Yucca*, *Prosopis*, and *Beaucarnea*. The oak zone is primarily occupied by *Quercus mexicana*, near rivers also *Taxodium mucronatum*. Mixed with these are *Arbutus* and various species of ash tree. In the pine zone the predominance is of *Pinus montezuma*, often with *Tillandsia tricolor*, a Bromeliacea, growing on it.

Of the fauna I saw comparatively little in the mountain land of southern Mexico. There were plenty of lizards on the ground, but I saw no snakes. Coyotes could be heard during the night, and I saw, at short distance, a big wolf. One night a lynx crossed the road in the automobile lights. Among birds was noticeable the *Scolecopus fornosus*, with a back of emerald color, belly of dark blue, and throat of bright orange. There were also blue jays and turkey buzzards.

## Was There an Outbreak of Bacterial Wilt of Corn in Central Illinois in 1891 and 1892?

Neil E. Stevens

*University of Illinois, Urbana, Illinois*

An apparent correlation between the temperature of the winter months at various stations in the northeastern United States and the prevalence of bacterial wilt of corn in this region was pointed out in a paper published in October, 1934. In the course of the study on which this publication was based, the writer had a number of conferences with Dr. W. H. Larrimer, then of the Division of Cereal Insects of the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture. During one of these, Dr. Larrimer called attention to the following statement regarding the distribution of *Chaetocnema pulicaria*, on pages 109 and 110 of the Twenty-third Report of the Illinois State Entomologist, S. A. Forbes, published in 1905, which, because of its brevity and special interest is quoted nearly in full:

“In various years, but especially in 1891, reports of marked injury to corn by this flea-beetle came to us from many Illinois localities, in twelve different counties. About Jacksonville it appeared in corn fields within a radius of thirty miles from town. Whole fields were wilted more or less, and some hills entirely killed. As many as forty beetles were counted on one hill. An infested field near Manchester, in Scott county, was visited by an assistant July 19, 1892. The beetles were quite abundant in it, and the corn was very small (not over ten inches high) and pale and unhealthy looking. In 1891 similar injuries were recorded in Missouri and Indiana. In Maryland, in 1897, the first plantings of corn were ruined in parts of six counties. This flea-beetle seems especially fond of sweet corn, and also injures broom-corn and millet.”

To anyone familiar with the disease, the description at once suggests bacterial wilt. The appearance of the fields, the fact that the sweet corn was most affected, and the fact that in Maryland the “first plantings” were ruined, all suggest this disease. Moreover, it has since been proved that this insect, *Chaetocnema pulicaria*, is one of those which carry *Aplanobacter stewarti*, the organism which causes bacterial wilt of corn. The accuracy of the records regarding the abundance of this insect in these years is, of course, unquestioned; the suggestion is merely that then, as now, it was carrying the bacterium and that part of the damage to the corn was due to bacterial wilt. Moreover, since the report above quoted was published in 1905, it seems fair to assume from the

statements that this insect was much less abundant in central Illinois in the years between 1892 and 1905 than it was in the years 1891 and 1892. The undoubted ability of Forbes and his associates as field observers, makes it all but certain that if *C. pulicaria* had become very abundant during any of the later years they would have seen and reported it.

Further indication of the probability of an epidemic of this disease having occurred in central Illinois in 1891 may be found in the weather records. The writer has elsewhere called attention to an apparent correlation between winter temperatures and the abundance of bacterial wilt.<sup>1</sup>

In these earlier publications it was suggested as a working hypothesis, that bacterial wilt would usually be absent following winters with a temperature index below 90 and present in destructive amounts following winters with an index above 100, with intermediate conditions following winters with an index between 90 and 100, and that a series of warm winters would be worse than a single one. Winter temperature index, as used here, is a simple summation of mean temperatures for December, January, and February. The following table gives this index for each year, 1890 to date for Springfield, Illinois.

TEMPERATURE INDICES (SUMS OF MONTHLY MEANS) AT SPRINGFIELD, ILLINOIS FOR THE WINTERS PRECEDING THE GROWING SEASONS OF THE YEARS INDICATED

Year	Index	Year	Index	Year	Index	Year	Index
1890	122	1902	74	1914	94	1926	93
1891	98	1903	84	1915	87	1927	95
1892	94	1904	70	1916	87	1928	92
1893	70	1905	69	1917	82	1929	80
1894	86	1906	94	1918	67	1930	90
1895	76	1907	97	1919	105	1931	105
1896	96	1908	94	1920	78	1932	117
1897	93	1909	98	1921	104	1933	101
1898	92	1910	76	1922	92	1934	97
1899	74	1911	95	1923	93	1935	94
1900	89	1912	74	1924	93	1936	67
1901	88	1913	92	1925	89		

It will be noted that the winter preceding the summer of 1890 was the warmest for the entire period, that the index for the next winter was almost 100, and for the winter preceding the summer of 1892, was well above 90, while the next winter was notably cold, having the lowest index prior to 1904. In accordance with the hypothesis mentioned above and recent experience in the eastern states, one would have expected bacterial wilt to be bad during 1890, probably even worse in 1891, still abundant in 1892, and negligible in 1893. This is in accor-

<sup>1</sup> Stevens, Neil E., Stewart's Disease in Relation to Winter Temperature: Plant Disease Reporter, 18:141-149, 1934.

dance with the facts so far as known. Moreover, the whole picture corresponds closely with what occurred in the northeastern states a few years ago, as shown by the accompanying tables.

RELATION BETWEEN WINTER TEMPERATURES AND ABUNDANCE OF FLEA BEETLE  
IN CENTRAL ILLINOIS

Year	Winter index at Springfield	Abundance of Flea Beetle
1890.....	122	(No record)
1891.....	98	Highest of any year
1892.....	94	High but less than previous year
1893.....	70	Probably scarce

RELATION BETWEEN WINTER TEMPERATURES IN SOUTHEASTERN NEW YORK AND  
ABUNDANCE OF BACTERIAL WILT

Year	Winter index at West Point	Abundance of Bacterial Wilt
1932.....	108	Very bad
1933.....	99	Highest of any year
1934.....	70	Only a trace—No commercial loss

It is tempting to speculate on the possibility that winter temperatures affect the abundance of the flea beetle directly and that this accounts at least in large part, for the fluctuations in bacterial wilt. There is, however, as yet no evidence of that. In fact, we have been unable to find any adequate eastern record of the abundance of *Chaetocnema pulicaria* during the critical years of 1932, 1933, and 1934, which is one of the unfortunate results of the fact that those of us who do field work, habitually confine our observations to so few natural phenomena. This is almost pathetic, as is the fact that the student of the history of plant disease is driven to use such fragmentary clues as these here discussed.

# An Interesting Preservation of Color in the Algae and Certain Fungi

E. L. Stover

*Eastern Illinois State Teachers College, Charleston, Illinois*

Every teacher of botany is interested in preserving the natural color of plants that must be used as specimen materials when living specimens are not available.

Several years ago I showed that certain colors of fungi may be preserved by using pure glycerine as a preserving fluid. Species of red algae and red and green *Discomycetes* have retained their natural colors for months and even years. The best results with this solution were obtained with *Peziza* spp., *Plectania occidentalis*, *Sarcosypha floccosa*, and *Leotia chlorocephala*.

Recent experiments have shown that weak solutions of formaldehyde and paraformaldehyde may be used to better advantage because of lower cost and because they do not have the clearing effect of glycerine.

Living sea algae removed from the sea water and placed in a two and one-half per cent solution of formaldehyde will retain their natural colors, green, brown, and red for varying periods of time. All will remain brilliantly colored for days and even weeks. *Agardhiella* sp., *Ceramium* sp., *Polysiphonia* sp., *Lophosiphonia* sp., *Ulva*, *Monostroma*, and *Fucus* have kept their colors in such solution for more than a year. Several fungi have been tried but not with marked success.

A five per cent solution of paraformaldehyde promises to be an even better preserving medium for the above mentioned forms, and even the fresh-water green algae have retained their natural green color for several weeks in this solution. *Spirogyra* sp., *Cosmarium* spp., *Oedogonium* sp., and *Hydrodictyon* sp. have all been treated with this solution. Examination shows practically no plasymolysis of the cells of these green fresh-water forms.

Bright sunlight causes certain forms to gradually lose their color, however, if they are not allowed to remain in bright sunlight they retain their natural colors for weeks and months.

Experiments with the leaves and flowers of the higher plants have so far not been successful except for short periods of time. Further experiments are now being made with all of these plants.

It is hoped that this report will interest other botanists and that they will try various concentrations of the paraformaldehyde with various species of all groups of plants.

The paraformaldehyde (C. P.) may be obtained as a white powder and dissolved in distilled water at room temperature. It is very slowly soluble and requires frequent shaking.

---

Ref: STOVER, E. L., A Method of Preserving the Natural Color of Certain Fungi. Trans. Ill. Acad. of Science, Vol. 21, p. 187, Feb., 1929.

## Reduction in the Number of Trees in Maturing Pine Forest

Lewis M. Turner

*University of Arkansas, Fayetteville, Arkansas*

There are relatively little quantitative data on the annual or period reduction in the number of trees in developing forest. It is well known, of course, that many trees die, succumbing to the effects of competition, during the time of forest maturation. In the case of tree species which bear many viable seeds and produce many seedlings, the number of trees which come to maturity may be an exceedingly small percentage of the original number of young trees in a given area. This paper summarizes the results of an investigation of this question in relation to a single species, the southern shortleaf pine.

Competition among individuals within a species is well illustrated by the southern shortleaf pine, *Pinus echinata* Miller. Throughout Arkansas, exclusive of the river overflow areas, pure stands of various ages of this tree may be found. Most of these pure pine forests are doubtless on areas that were once cleared, for agriculture, in lumbering operations, or on sites in which the original (usually mixed pine-deciduous) forest was destroyed by tornadoes. Such stands are essentially even-aged. It is a characteristic of both shortleaf and loblolly pine to invade and pre-empt bare areas quickly. Such areas are stocked with seedlings, in numbers permitted by the factors of the sites, in from one to five years.

**Method of study.**—In this investigation, counts were made of trees in twenty-three unmolested stands of shortleaf pine of various ages. All plots of trees 35 years of age, or older, were  $\frac{1}{4}$  acre in area; younger trees were counted on  $\frac{1}{16}$ -acre plots. Average height, diameter, and age of dominant and co-dominant trees was secured with the usual instruments. All plots were on Hanceville sandy loam with a slope of approximately 20 per cent. The character of the soil is significant since the rate of growth is materially influenced by soil features, and possibly the number of trees per unit area at any given age would also be influenced by this factor. Hanceville sandy loam, with slope around 20 per cent, affords a relatively poor pine growing site, having a site index of about 50, or an average height growth of about a foot a year during the first 50 years. Superior sites for this species afford a growth rate of about two feet a year.

**Results.**—The following table shows the relationship of age of the shortleaf pine stands to the number of trees per acre, and to the average height and diameter, of dominant and co-dominant trees:

TABLE I.—THE RELATIONSHIP OF AGE OF STAND TO THE HEIGHT, DIAMETER, AND NUMBER OF TREES PER UNIT AREA OF SHORTLEAF PINE ON HANCEVILLE SOIL

Number of stands from which averages were determined	Average age of trees	Diameter* breast height	Height of trees	Number trees per acre	Per cent annual reduction of trees during periods
1.....	9 yrs.	1.9''	6.0'	19,008	.....
2.....	16 yrs.	2.8''	14.0'	8,783	8.0
2.....	35 yrs.	6.0''	40.0'	1,638	2.0
4.....	40 yrs.	8.5''	44.0'	744	0.9
5.....	60 yrs.	9.6''	60.0'	415	0.08
3.....	70 yrs.	12.0''	66.5'	180	0.12
5.....	116 yrs.	14.3''	78.0'	120	0.07
1.....	152 yrs.	17.0''	85.0'	80	0.058

\* Diameter and height averages are of dominant and co-dominant trees.

As would be expected the greatest mortality of trees occurs in the early years of the life of the stand. The period of seven years, from the ninth to the sixteenth, brought about a reduction of 54 per cent of the number in the nine-year-old stand, or an average annual diminution of 8.0 per cent. The next 19 years show an average annual loss of 2 per cent of the nine-year-old stand, and the next five years an average annual loss of 0.9 per cent. From the age of 35 years on to the time of maturity the average annual losses were small, compared to those of the early stages, being only 0.058 per cent per year, during the period between the 116 and 152 years. The number of individuals in the 152-year-old forest was 0.42 per cent of the number in the nine-year-old stand.

## Barrens Vegetation in Illinois

Arthur G. Vestal

*University of Illinois, Urbana, Illinois*

In a recent search into descriptions of early conditions in Illinois, the writer was impressed by the frequency of mention of the *barrens*, and although very little botanical information about them was found, their former generality of occurrence was evident. One wonders what they may have been like and what became of them.

It is now recognized that the extensive barrens of Kentucky were in most cases outlying areas of prairie vegetation, and it seems plausible that some of the prairie uplands of southern Illinois, cut off from larger prairies by dissected and forested stream valleys, were sometimes labeled barrens instead of prairies, particularly if they were being invaded by sumac or hazel or by young trees. Very open stands of post oak with grassy ground-cover (there is reason to believe that post-oak flats were commonly of this character) might also have been known as barrens. Although cultivation has obscured part of the vegetational history, there are in Cumberland County and elsewhere, upland areas which (judging from soil-types) at one time were tree-covered, later perhaps (this before the days of white settlement), swept by fire, and then occupied by grassland plants. These however failed to include some of the most characteristic prairie herbs, such as the *Silphiums*. These areas also differ from normal prairie by the frequency or local dominance of plants usually occurring in the herbaceous ground-cover of open forest or of glades, for example *Danthonia spicata*. This is definitely a grassland, but a grassland with an unusually high proportion of forest herbs, and lacking many prairie plants. Such vegetation might have been recognized by discriminating early residents and travelers as barrens rather than prairie. There seems to be no good reason why present-day remnants of it should not today be recognized as a survival of at least one kind of barrens vegetation.

With the several types of mixed forest and prairie vegetation representing replacement of disturbed prairie by forest, and with varieties of areas in stages of reforestation following burning or clearing, we are not primarily concerned, though many of these were given the term barrens.

We therefore concentrate upon treeless upland areas dominated by grasses or by grassland containing numerous dicot herbs, which for one or another reason differs from prairie vegetation as commonly recognized in the early days and at present. Rolling hill areas in the south-

ernmost counties as well as in Marion county were described as barrens by Henry Engelmann in the 1860's. Their progressive replacement by forest was considered by him as likely to be completed within relatively few years. One reason for the former common recognition of barrens and the present unawareness even of their former existence may thus be that such barrens have long ago passed out of the picture, partly from extension of agriculture, partly from encroachment of forest as witnessed by Engelmann. His "tall barren grass" is believed by some botanists to be an *Andropogon*.

Lewis C. Beck, between 1823 and 1828, described barrens near St. Louis, some on the Illinois side of the Mississippi. Forest (and prairie) herbs listed by him as occurring in barrens include some of the plants which today can be observed as common species of forest openings, forest borders, cut-over areas of xeric forest, and of forested narrow spur-tops exposed to sun (also to wind: thus kept free from a cover of dead tree-leaves). These also come to occupy strip-mine ridges, road-cuts, cut-over sunny hillsides, and railroad rights of way in forested country. They are common in some abandoned fields, particularly on hill-tops of the Illinois Ozarks. Many such areas will become forested, but many others give indications of continuing as a semi-natural grassland of indefinite tenure. These are the present-day barrens.

The plant list includes perennial sunflowers, asters and goldenrods, *Antennaria*, numerous other composites, prairie grasses (which are grasses of the forest region also in most cases), *Ceanothus*, *Baptisia leucantha*, *Potentillas*, *Lespedezas*, *Tephrosia*, *Desmodiums*, *Gerardias*, *Frasera*, *Pycnanthemums*, *Pteris*, xeric sedges.

Attention of botanists is invited to modern barrens. Economic ecologists will also do well to study them. Here is already at hand a selection of the hardiest native plants for use in soil conservation, particularly in erosion control.

## A Comparative Study of Bogs on Cary and Tazewell Drift

John Voss

*Peoria, Illinois*

### ABSTRACT

Pollen diagrams of the Valparaiso bogs practically reveal a complete picture of the forests of post-Valparaiso times in Illinois. Unfortunately, the forest history of the post-Bloomington period is less complete, due to the absence of satisfactory pollen records in the upper layers of the Tazewell bogs.

The succession of forests as shown by the pollen diagrams of bogs of both substages apparently is the same in most cases: (1) Increase and dominance of the conifers; (2) decline of the conifers and the advance of the deciduous forest. If the oldest layers of the Tazewell peat formed very slowly, the period of conifer dominance of that stage may coincide with the period of conifer dominance following the retreat of the Valparaiso ice. On the other hand, the post-Bloomington conifer forests might have been superseded by the deciduous forests before the advance of the Valparaiso ice-sheet, and the succession of forests in central Illinois since Bloomington times may have been as follows: (1) northern conifer, (2) deciduous, (3) northern conifer, (4) deciduous.

Evidence supporting the theory of a xerothermic period during postglacial times is lacking.



## PAPERS IN CHEMISTRY

---

### EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN

Twenty-three papers were presented in a two-section meeting of the Chemistry group. The six that are not here represented were as follows:

*New Analytical Reagents* (demonstration), by G. F. Smith, University of Illinois, Urbana.

*The Application of Chemical Research to the Problems of the Illinois Mineral Industry*, by F. H. Reed, Illinois State Geological Survey, Urbana.

*An Improved Apparatus for the Demonstration of the Fixation of Atmospheric Nitrogen* (demonstration), by W. S. Haldeman, Monmouth College, Monmouth.

*The Application of Modern Valence Ideas to the Teaching of Chemistry*, by John DeVries, Knox College, Galesburg.

*Some Recent Models of the Periodic Table*, by B. S. Hopkins, University of Illinois, Urbana.

*Some Home-made Apparatus for the Teaching of the Ionization Theory*, by H. P. Leighly, Rantoul High School, Rantoul.

Attendance at the meeting was about one hundred and twenty-five. Dr. W. F. Bailey, MacMurray College, Jacksonville, Illinois, was elected chairman of the Chemistry Section for the 1937 meeting.

(Signed) J. H. REEDY, *Chairman*



## Some Interesting Methods of Balancing Oxidation-reduction Equations

C. W. Bennett

*Western Illinois State Teachers College, Macomb, Illinois*

During the past few years the writer has made a sort of hobby of the subject of balancing equations. During the years 1931-1934 there was a continuous series of correspondence on the merits of the various methods in the *Journal of Chemical Education*. Nothing was settled as to the best method of balancing equations, but it is the opinion of the writer that the valence-change method (1) is the most rapid and dependable while the ion-electron (2) method is the most in keeping with our modern knowledge and the most instructive, but a little tedious. A third method which is always interesting to students and teacher alike is the algebraic method (3). The latter method is hardly suitable for use but has in it an element of surprise because few people realize that complex equations may be accurately balanced by mere algebra without recourse to valence considerations of some kind.

Let us select a sample equation such as:  $\text{Cu} + \text{HNO}_3 \rightarrow \text{Cu}(\text{NO}_3)_2 + \text{NO} + \text{H}_2\text{O}$  and balance it by each of the methods.

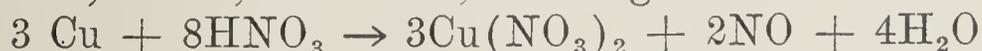
**Algebraic method.**—This method is based on the assumption that there is a certain number of Cu atoms which we may designate as  $a$ ; then  $b$   $\text{HNO}_3$ , etc. Our equation becomes:  $a \text{Cu} + b \text{HNO}_3 \rightarrow c \text{Cu}(\text{NO}_3)_2 + d \text{NO} + e \text{H}_2\text{O}$  now for:

$$\begin{array}{ll} \text{Cu} & a = c \\ \text{H} & b = 2e \\ \text{N} & b = 2c + d \\ \text{O} & 3b = 6c + d + e \end{array}$$

Since  $b = 2e$ , for the N equation, we have:  $2e = 2c + d$  and for the O equation  $6e = 2c + d + e$  or  $5e = 6c + d$ . Subtracting the first equation from the last, we have:  $3e = 4c$ , whence  $e = 4/3c$ .

Let  $c = 1$ , then:  $a = 1$ ,  $e = 4/3$ ,  $b = 8/3$ , and  $d = 2/3$ .

To remove fractions multiply all coefficients by 3. Then:  $a = 3$ ,  $b = 8$ ,  $c = 3$ ,  $d = 2$ , and  $e = 4$ , resulting in the orthodox equation:



As H. G. Deming (4) points out much time can be saved by eliminating two of the unknowns at the start since  $a = c$  and  $b = 2e$ .

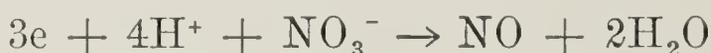
**Valence-change method.**—The valence-change method is so commonly used that there is little need to go into detail beyond the statement that a mutually consistent set of valences is assigned to the ele-

ments and from these and the change these valences undergo, a relationship can be set up between the number of molecules of oxidant and reductant. These valences, while not always consistent with our modern knowledge, do lead to rapid, accurate results. In our chosen equation the valence of Cu changes from 0 to 2 in  $\text{Cu}(\text{NO}_3)_2$ , a gain of 2, while that of N changes from 5 in  $\text{HNO}_3$  to 2 in  $\text{NO}$ , a loss of 3. To equalize this gain and loss, 3 coppers and 2 nitrogens which change valence are needed. The remainder of the equation is quickly balanced by inspection.

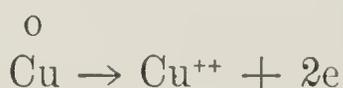
**Ion-electron method.**—The ion-electron method, while very complicated, has great teaching value. The equation is divided into two partial equations, one for the oxidant, and one for the reductant, using only the ions which are really concerned in the equation. These must be balanced first atomically and then electrically:



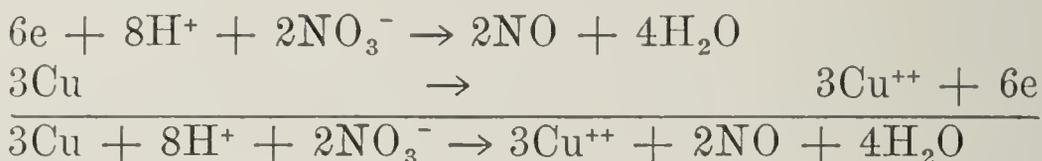
There are now 4 pluses and 1 minus on the left, making an excess of 3 pluses which may be balanced electrically by the addition of 3 electrons:



Similarly for the reductant:



Since we have 2e and 3e, we must reach the lowest common multiple 6 by multiplying the oxidant equation by 2 and the reductant equation by 3 and then add:



The equation is now balanced but to be orthodox it should have 6 more nitrate ions on each side. It is seen by the example that the ion-electron method makes no arbitrary assumptions of valence and stands the test of our modern thinking. It may fail to achieve the popularity it deserves due to the fact that it is cumbersome.

#### BIBLIOGRAPHY

1. BENNETT, J. Chem. Education 12, 189 (1935).
2. JETTE and LA MER, J. Chem. Education 4, 1021 (1927).
3. ENDSLOW, J. Chem. Education 8, 2453 (1931).
4. DEMING, J. Chem. Education 11, 125 (1934).

# Chemistry in Highway Construction

Fred A. Dykins

*Engineering Chemist  
Division of Highways, Springfield, Illinois*

The Division of Highways of the State of Illinois, in its Bureau of Materials at Springfield, maintains a completely equipped chemical laboratory. The principal work of this laboratory is the analysis of the materials used in the construction and maintenance of the highways. The laboratory also develops procedures for testing materials, investigates new types of material, and assembles data for use in the preparation of specifications.

The new laboratory building, constructed in 1934, is modern in every respect and has six well appointed laboratory tables. The general equipment includes Chainomatic balances, constant temperature ovens, electric muffle, centrifuge, Barnstead still, constant temperature water baths, combustion apparatus, constant humidity cabinet, microscope, refractometer, potentiometer, tintometer, Soxhlet extractors and electrolytic apparatus. Equipment for testing refinery products includes thermostatic viscosimeters, ductility machine, New York Testing Laboratory penetrometer, Tag closed tester, gasoline distillation apparatus, Dulin rotarex and Union colorimeter. Recent additions to the laboratory equipment are a Precision penetrometer, a Hubbard Field asphalt stability testing machine, and a Frigistat for cloud and pour point determinations which can reduce the temperature to  $-70^{\circ}\text{F}$ .

All materials purchased by the Division of Highways are required to comply with carefully prepared specifications which are published as the Standard Specifications for Road and Bridge Construction. Chemical analyses are made of representative samples of all of the materials which are to be used for construction and maintenance. These samples are classified into four groups and the types of tests are designated as Quality Tests, Preliminary Tests, Acceptance Tests, and Check Tests.

Samples for Quality Tests are representative specimens of material which are subjected to detailed investigation in order to obtain as much information as possible concerning the quality of the product. Samples for Preliminary Tests are representative specimens of materials submitted by manufacturers and producers in order to secure information concerning the suitability of their products for the work of the Division of Highways. The results of these tests are useful in locating possible sources of supply for quality products.

Samples for Acceptance Tests are representative specimens of materials which are to be used in the construction and maintenance of the

highways. These samples are always taken by an official representative of the Division of Highways and are tested for compliance with the particular specifications under which they were purchased. Analyses of such samples are the major part of the work of the laboratory. Samples for Check Tests are representative specimens of materials which may not appear satisfactory when received at destination. Check Tests are also made on materials which have been stored for some length of time, and on materials which have been accepted at the place of manufacture by an inspector working away from the Springfield laboratory.

During the past year nearly four thousand samples were tested by the laboratory, representing 300 types of materials (Table I).

TABLE I.—CHEMICAL LABORATORY, CALENDAR YEAR 1935

Material	Number of samples					Quantity tested
	Quality	Prelim.	Check	Accept	Total	
Asphalt—Cement.....	87	6	25	548	666	8,300 tons
Cut-back.....						1,350,000 gals.
Bituminous Joints and Planks.....		1		204	205	850,000 lin. ft.
Bituminous Mixes.....	26	1	4	298	329	14,000 tons
Calcium Chloride.....				33	33	1,100 tons
Cement.....	1		374	24	399	1,900,000 bbls.
Creosote Oil.....		1	3	96	100	500,000 gals.
Galvanized Materials....	5		135	10	150	2,000 tons
Lubricants.....	9		4	378	391	62,000 gals.
Paint Materials.....	9	4	1	330	344	46,000 gals.
Road Oils.....	4	1	1	978	984	11,600,000 gals.
Tars.....	1	1	41	125	168	800,000 gals.
Miscellaneous.....	47	7	3	146	203	
Totals.....	189	22	591	3,170	3,972	

When materials such as refinery and paint products are purchased in large quantities during a short period of time, an inspector goes directly to the plant and tests the product during the progress of the manufacture. Such a procedure is convenient for the Division of Highways, the contractor and the materials producer and gives assurance that all the materials produced and shipped to the construction site comply with the specifications under which they were purchased. Check Tests on these materials are made in the Springfield Laboratory.

In addition to the materials tested for the Division of Highways and State Aid work, samples are also tested for other State Departments and the various counties, townships and cities of the State. Recently the laboratory has tested materials used for roads built under the N. R. A., the P. W. A., and the W. P. A. The laboratory cooperates with the Highway Laboratories of other States and the U. S. Bureau of Standards.

## Some Anomalous Properties of Organic Fluorine Compounds

G. C. Finger and Frank H. Reed

*Illinois State Geological Survey, Urbana, Illinois*

The abundance of fluorine is three times that of copper and fifteen times that of lead in the earth's crust. In spite of this abundance, the chemistry of fluorine compounds is the least understood of the common elements because of the extreme reactivity of the element and the extremely toxic and corrosive properties of many of its inorganic compounds. A number of inorganic fluorides are very well known but practically nothing is mentioned in the average college textbook on the organic compounds.

The advent of Freon (dichlorodifluoromethane) as a new refrigerant in 1930 signalized a new epoch in synthetic organic fluorine chemistry, especially in the commercial world as it refuted the traditional concept that all fluorine compounds are either corrosive or toxic or difficult to prepare. Other refrigerants, new non-fading dyes, solvents, electrical condenser insulators, etc., containing fluorine have made their appearance and for certain purposes are superior to anything else that is available. Unfortunately the chemistry of these compounds is scattered throughout the scientific and patent literature and has never been correlated or compiled in any single publication.

Very few of the general methods of synthesizing organic halides are applicable to fluorine compounds. Direct fluorination takes place with explosive violence and with the disruption of the molecule due to the high heat of reaction which is much greater than that of the "Thermite" process. The usual products of direct fluorination are a mixture of organic fluorides, carbon, and hydrogen fluoride although an excess of fluorine gives carbon tetrafluoride. The treatment of an alcohol with hydrogen fluoride gives an equilibrium mixture of the alkyl fluoride and ether. The reaction of  $\text{PF}_3$  with an alcohol gives phosphorous esters. The addition of HF to an olefine has not been reported in the research literature, however, a patent has been issued using propylene as an example to give a propyl fluoride. This leaves two general methods of synthesis, (1) the replacement of a halogen atom by fluorine through reaction with certain anhydrous metallic fluorides ( $\text{AgF}$ ,  $\text{Hg}_2\text{F}_2$  or  $\text{HgF}_2$ ,  $\text{TlF}$ ,  $\text{ZnF}_2$ , and  $\text{SbF}_3$ ) depending upon the compound desired,



and (2) the introduction of fluorine into an aromatic nucleus by the



sulfuric acids. The acid fluorides are very much like the aromatic sulphonyl chlorides in stability. The organic fluorine compounds resist reduction to an almost unbelievable degree. For all practical purposes they do not corrode such metals as copper, monel, nickel, iron, and they will not form the Grignard reagent, and with sodium in liquid ammonia they form sodium fluoride which is used as a basis for analysis. In some cases the fluorine atoms may be activated by other substituents such as in the case of chloroacetyl fluoride which hydrolyzes very rapidly due to the chlorine substitution. Benzotrifluoride ( $C_6H_5CF_3$ ) can be nitrated almost quantitatively to the meta nitro benzotrifluoride, which in turn will not hydrolyze even under strenuous treatment. Since the  $-CF_3$  group in an aromatic compound has a similar effect as a nitro group on color this type of compound is commercially used in a few non-fading dyes. Some of the highly substituted chlorofluorine liquid compounds are excellent electrical insulators due to their extreme stability, high di-electric constants, and low viscosity changes with ordinary temperatures.

The analysis of organic fluorine compounds is very difficult and the best known methods still leave much to be desired as far as accuracy, applicability, and ease of manipulation is concerned. There are about as many modifications on analysis as there are original papers on new fluorine compounds. The determination of carbon and hydrogen in a compound necessitates packing the combustion tube with special materials for complete oxidation and also for the retention of the fluorine. Fluorine is usually analyzed by two methods, (1) the  $Na_2O_2$  bomb fusion method, and (2) the sodium-liquid ammonia method of Nieuwland. Both methods require highly refined technique for accuracy although the latter is rapidly gaining favor because of its simplicity and non-hazardous manipulation. After the organic fluorine has been converted to an inorganic fluoride, the problem evolves into choosing a method with the smallest correction factor.

## Corrosion Characteristics of $\text{SiO}_2\text{-Al}_2\text{O}_3\text{-CaO-MgO}$ Glasses

Charles F. Fryling and Fay V. Tooley

*Illinois State Geological Survey, Urbana, Illinois*

**Introduction.**—Preliminary to the recent work on the rock wool resources of Illinois carried out in the Geological Survey laboratories<sup>1</sup>, a series of four component ( $\text{SiO}_2\text{-Al}_2\text{O}_3\text{-CaO-MgO}$ ) silicate melts were prepared, utilizing the pot fusion method of Peddle<sup>2</sup>. An accurate investigation of glass, as shown by Morey<sup>3</sup> and others<sup>4</sup>, requires the use of platinum apparatus, but the work is slow because only one sample can be prepared at a time. Peddle has demonstrated, however, that much useful information on glass characteristics can be obtained from glasses prepared by fusion of batch mixtures in clay pots<sup>2</sup>. As an initial step toward a more thorough and accurate investigation, the clay pot fusion method can be said to embrace practical advantages, as it is possible by such means to prepare more glasses simultaneously, and these in larger quantities, than is allowed by the high cost of large platinum ware, and the small size of crucibles usually available.

The chief difficulty encountered in the pot fusion method is the corrosive effect of certain batch compositions on the pot, a condition which of course disturbs radically the original composition in the finished melt. Pot corrosion is a function principally of three inter-related factors: (1) phase equilibrium relationship involving the components in the batch and pot; (2) viscosity of the melt of the original batch composition and the change in viscosity with change in melt composition due to corrosion, and (3) the duration of time that the melt is kept in a fluid condition. The porosity of the pot and surface tension of the melt are additional factors in the corrosion process. Our data can be discussed to only a limited extent on a basis of above factors because phase equilibrium data on the four-component system under discussion are not as yet complete in the literature, and all the melts were prepared under the same conditions and hence depart from true equilibrium in different degrees. Some observation on a basis of viscosity is afforded, however, as some of the original batch compositions studied were similar to the composition of certain basic slags utilized in viscosity studies by McCaffery<sup>5</sup> and his co-workers.

We have found, as a result of preparing a great number of silicate melts of the system cited, that batches containing in excess of 70 per

cent  $\text{SiO}_2 + \text{Al}_2\text{O}_3$ , or in excess of 1.15-1.20 gram mols  $\text{SiO}_2 + \text{Al}_2\text{O}_3$  per 100 gm. batch, can be melted in fireclay pots without excessive corrosion.

**Experimental procedure.**—Batch compositions were compounded from the raw materials (silica, aluminum hydroxide, calcium carbonate and magnesium carbonate) to give one kilogram of raw material per sample. Following thorough mixing, the samples were moistened with distilled water and packed tightly into fireclay crucibles (3 1/2" top diameter by 5 1/2" high), excess sample being discarded. After drying, the crucibles were transferred to a gas-fired kiln, fired to 1375° C, which temperature was maintained constant for two hours. After cooling for 20 hours the kiln was opened, the crucibles were drawn, and the melts were examined visually and analyzed quantitatively.

**Experimental results.**—Chemical analyses revealed that corrosion was excessive only in those samples containing less than 70 per cent silica-plus-alumina and that the corrosion varied fairly regularly with the silica-plus-alumina content (Table I).

TABLE I.—CRUCIBLE CORROSION AS A FUNCTION OF BATCH CONTENT OF SILICA-PLUS-ALUMINA

Batch content $\text{SiO}_2 + \text{Al}_2\text{O}_3$ per cent	Analyzed content $\text{SiO}_2 + \text{Al}_2\text{O}_3$ per cent	A. D. of analyzed $\text{SiO}_2 + \text{Al}_2\text{O}_3$ content per cent	Number of samples analyzed
70	71.7	± 0.9	17
65	68.1	1.3	19
60	65.8	2.0	19
55	65.3	3.1	15
50	64.7	2.3	7
45	65.9	3.4	6
40	68.4	...	1

Expressing extent of corrosion as a function of batch silica-plus-alumina on a mol basis indicated that samples containing in excess of 1.15-1.20 gram mols per 100 gms. of melt can be prepared by the pot fusion method without disturbing the originally desired composition radically.

Some few of the glasses prepared were of such composition that the viscosity both of the melt of batch composition and the melt of changed composition due to corrosion could be compared in a general way on a basis of the viscosity studies of basic slags by McCaffery and co-workers<sup>5</sup>.

Such a comparison taking into consideration the other factors influencing corrosion, indicated the nature of the influence of viscosity. A low viscosity for a particular batch composition does not necessarily imply that excessive corrosion will take place; if that particular glass

composition is saturated with those components which it might dissolve from the pot, it can exhibit a low viscosity and still be comparatively non-corrosive. It is in those instances in which the original glass is unsaturated with respect to components of the pot that viscosity and time are factors of great magnitude. If in such a case the viscosity of the original melt is low and the duration of fusion long, corrosion approaching thermal equilibrium for the components of the pot and melt at the temperature employed will take place.

In conclusion it should be pointed out that while the use of platinum ware is certainly essential to the accurate investigation of such glasses, the batch process, utilizing fireclay pots for melting is of definite worth in the preliminary evaluation of silica-alumina-lime-magnesia glasses of certain restricted compositions as herein described.

#### BIBLIOGRAPHY

1. Rock Wool from Illinois Mineral Resources, Illinois State Geological Survey Bulletin No. 61 (1934).
2. PEDDLE, *Journ. Soc. Glass Tech.*, IV 1920, pp. 3-106, 225-248, 299-366.
3. G. W. MOREY and H. E. MERWIN, "The Relation between the Composition and the Density and Optical Properties of Glass. 1. The Soda-Lime-Silica Glasses." *Journ. Optical Soc. Amer.*, 22:632-62 (1932).
4. F. W. GLAZE, J. C. YOUNG and A. N. FINN. "The Density of Some Soda-Lime Glasses as a Function of Composition." *Bur. Stand. Journ. Research* 9: 799-807 (1932). See also 6:993-1002 (1931).
5. R. S. MCCAFFERY and CO-WORKERS. "Viscosity of Blast Furnace Slags." *Tech. Pub. No. 383, Amer. Inst. of Min. & Met. Eng.*, (1931).

# The Natural Chemical Resources of Southern Illinois

J. W. Neckers

*Southern Illinois State Teachers College, Carbondale, Illinois*

Illinois is widely noted for its agricultural products, but few people realize that its second most important contribution to commerce comes from its mineral resources. "Egypt"—the southernmost quarter of the state—has a greater variety of these resources than the other three quarters combined. From the discovery of salt deposits in Saline County by the earliest pioneers to the recent studies of the future possibilities of Anna kaolin, there has been a steady advance in the development of various minerals.

The most extensive deposits are those of soft coal which, until recently, were not of special chemical significance. However, in December, 1933, a coking plant using the Knowles type oven was put into operation at West Frankfort, the site of the largest soft coal mine in the world. At the present time twenty-six ovens are in operation, using over 330 tons of coal each day to produce 250 tons of a coke, called "Carbonite", several tons of a light tar, and about 750,000 cubic feet of gas which is bought and distributed by the Western United Gas and Electric Company. The coke is used chiefly for fuel purposes but developments may yield a product for metallurgical use.

The fluorspar deposits of Hardin County are noted as among the most productive mines the world over. Discovered in 1839, mining started in 1842 with galena, which was also present, receiving the most attention. After the Civil War the lead ore was gradually superseded in importance by the fluorspar and since 1900 it has been of major importance. During the last decade about 630,000 tons of fluorspar, valued at over thirteen million dollars, were marketed from these mines. Most of the ore is used in the basic open hearth steel process to give greater fluidity to the slag. Considerable quantities are also used by the aluminum industry in the manufacture of artificial cryolite,  $\text{Na}_3\text{AlF}_6$ ; and for the preparation of other fluoride chemicals.

Another mineral of importance to several chemical industries is the fuller's earth deposit along the Ohio River in Pulaski County. Mining was started in 1920 by the Sinclair Oil Company and shortly after that date the Standard Oil Company of Indiana opened a second mine near by. About 150,000 tons of the earth, selling for over two million dollars, have been obtained since that time. The two plants have a

capacity of over 300 tons a day. Again Illinois ranks in the first three states in the Union in this product. It is used almost entirely for bleaching and clarifying mineral oils. Its action in this capacity is dependent upon the porous nature of the earth, due to the fact that it is built up of grains approaching colloidal size which offer a large active surface. (The name "fuller's earth" is derived from its original use in removing grease and fat from woolen cloth during the process of fulling.)

"Egypt" is also noted for its deposits of silica of a very high degree of purity, especially in Union and Alexander Counties. The mineral is ground to the fineness of flour and is used extensively as a filler in paint, wood and soap products, and in the manufacture of metal polishes and foundry molds. Production during the last decade amounted to 135,000 tons valued at over one and a quarter million dollars.

There are also numerous deposits of clays for use in the manufacture of pottery and lower grade ceramics products, and of limestone which, however, is used mostly as crushed stone for aggregate and ballast.

All of these natural chemical resources, with the exception of the by-product lead from fluorspar mining, are of non-metallic nature. They do not receive the publicity of the metal ores in other parts of the country but, nevertheless, they are all of national reputation in their particular fields. They are all contributors to success in important industries.

Two other possible developments are of great interest according to recent investigations of the State Geological Survey. First, the rapidly expanding rock-wool industry has at its demand five deposits of workable wool-rock material of siliceous limestone for the production of high-grade insulating products. Second, Illinois produces one-fourth of the edible animal and vegetable oils used in the United States. If the fuller's earth, previously described, is used for purifying these edible oils they become rancid, so it has been necessary to use English or Californian earths costing from twenty-six dollars to fifty-four dollars a ton with as much as 50 tons a day being used. It has recently been discovered that a kaolin deposit near Anna (Union County) has characteristics which may allow it to compete with these imported products. This Anna kaolin seems to have regenerative powers which excel both the others now in use.

The quality and uses of all these natural chemical resources of Southern Illinois are of a nature that point to an excellent continued demand in supplying the needs of a variety of essential industries. Discovery of new deposits and further developments should also lead to expansion in the productions of these minerals.

# Titanium-Hydrogen Peroxide Compounds

D. G. Nicholson

*University of Illinois, Urbana, Illinois*

“After yellowing” of white paints and enamels has been a problem of importance to the paint and pigment manufacturers. Lithopone paints have a tendency to yellow when exposed to darkness (behind pictures, mirrors, etc.), while titanium dioxide whites have a tendency to yellow when exposed to light.

The yellowing of the titanium dioxide paints is explained by the fact that peroxide linkages formed at the unsaturated bonds in the vehicle during the drying process tend to oxidize some of the titanium dioxide to pertitanate, in which form the titanium is present in a valence form higher than four.

A study conducted using anhydrous ethyl acetate as the solvent with titanium tetrachloride and anhydrous hydrogen peroxide as solutes has shown that an addition product is formed between the two compounds. This addition compound is insoluble in the ethyl acetate solution. Upon standing at room temperature or upon contact with water the material changes from white to the orange red of pertitanate material. The decomposition is accompanied by liberation of oxygen, hydrogen chloride and water. The water formed in this decomposition evidently serves to cause some dissociation resulting in the orange-red colored surface. The white material is very soluble in water producing the red-orange aqueous solution of pertitanate. The white compound is evidently a coordinated compound containing titanium chloride and hydrogen peroxide.

Since paint films are virtually anhydrous in nature, it follows that the yellowing of the titanium dioxide films could be attributed to a peroxide coordination between the peroxide linkages in the vehicle and the titanium dioxide particles in the film, rather than a true oxidation of the titanium dioxide molecule in the semi-solid film. This coordination or yellowing is catalysed by light as well as moisture.

Laboratory tests made using titanium hydroxide and a solution of dry hydrogen peroxide in ethyl acetate show an immediate definite yellowing of the titanium dioxide particles. This same yellowing effect is also observed when air is bubbled through a suspension of titanium hydroxide in turpentine for a period of two weeks or longer.

## Present and Future Energy Sources

H. E. Phipps

*Eastern Illinois State Teachers College, Charleston, Illinois*

The world is now using energy supplies at an almost unbelievable rate. In the last fifty years, the production of coal increased 736 per cent, natural gas, 2166 per cent and oil, 3346 per cent in the United States. Similarly the installed horsepower increased 2016 per cent (1). The figures give but a bare idea of the tremendously increased energy use which has resulted from and accompanied present day mechanization.

Coal is our chief source of energy, supplying 58 per cent of the world's needs. It is estimated that in the United States there is enough coal less than 3,000 feet below the surface to last us two thousand years at the present rate of consumption. Then too, present mining methods remove only 34 per cent of the available coal, leaving the rest behind because it is uneconomical to recover it. Improved mining methods and advancing prices should make it feasible to recover still larger amounts and to lengthen the time estimate.

One possible method of recovering more coal is now being tried by the Russians (2). Controlled amounts of waste oxygen and air are blown into burning drift coal and the resulting gases are drawn off through a ventilator shaft. They reported that 750,000-900,000 cubic feet of gas with approximately one-tenth the fuel value of natural gas were obtained daily while blowing, and about half that amount during subsequent non-blowing periods. This process mined and gasified coal not otherwise easily accessible.

A method of increasing our potential supply of coal is in the further application of fuel research. Already, this has increased the efficiency in burning fuels and resulted in great savings. Two examples will illustrate. It required 254 per cent more coal to produce one kilowatt hour of electricity in 1910 than it did in 1934. In this same year, the British steel industry used six million tons less coal than before, but produced the same amount of steel, a saving of \$21,375,000 (3). If such savings are possible in two great industries, why not elsewhere? They are, but it requires expensive installations and large scale operation to effect these savings. This and reluctance to change, accounts for our present barbarous methods of burning coal.

Coal might be regarded as a raw material, great coking ovens erected near mines and the coal converted to coke and the by-products—

gas, ammonia and coal-tar chemicals. The coke could be used for the generation of electricity and both gas and electricity piped to the consuming centers. This would do away with atmospheric contamination and greatly improve efficiency. Of course, it would mean the construction of transmission cables and pipe lines, and no doubt the demise of certain railroad systems. A major change of this kind in the public utilities would probably mean a rather extensive social readjustment.

Petroleum is the second largest source of energy, furnishing about 23 per cent of the amount used in the United States. Here again, the mining methods are not very efficient for only 20 per cent is removed. The United States produced 910 million barrels of oil in 1934, about two-thirds of the world production (4). Thirteen billion barrels of underground oil were available by present methods in our country on January 1, 1935. At the present rate of consumption, barring new oil field discoveries, our supplies will be exhausted in fifteen years. However, this figure is low, for new fields are being found. The wells are deeper in many places and more expensive, yet oil is being discovered. As prices rise larger amounts will also be recovered from existing wells. Then too, there are vast quantities of oil known to exist in various places in a condition that makes economical recovery at present impossible. For example, a thirty-five foot limestone layer under Chicago contains seven million barrels per square mile (6). Then there are the oil sands, oil shales, etc., none of which are used to speak of at present.

Research work has made possible great savings in oil resources. The cracking process, which makes it possible to produce more gasoline from a quantity of petroleum, saved nine hundred million barrels of oil last year. The waste gases from storage tanks, cracking stills, etc., which were formerly wasted, are now used to make gasoline by a new polymerization process. It is estimated (7) that about one-fifth of all the gasoline used in America in 1934 could be made from natural gas in this way without curtailing the normal supply. This polymer gasoline has a high antiknock value, having octane ratings as high as one hundred.

Various methods are now in use for converting coal into gasoline and other liquid fuels. Germany, France and England are now operating commercial or semi-commercial plants for this purpose. Peat, lignite, cottonseed and alcohol have all been converted to gasoline and lubricating oils on a small scale but their use is uneconomical at present. However, the picture may change in the future. The petroleum supplies in our country are so vast that little interest has been aroused by these attempts, but those countries with limited supplies are vitally concerned.

Natural gas, like oil, is a wasting resource. Its use has increased considerably within the last few years and it now furnishes about 8 per cent of the world's energy. Indications are that our present supplies will last from 50–75 years. Here again, conservation and research can

increase the expected life of the supply. Removal of some of the higher hydrocarbons does not materially affect the usefulness of natural gas but does increase our gasoline supply, as mentioned above. When the gas supply runs low, we shall no doubt turn again to artificial gas from coal.

Water power is an everlasting source of energy. Intensive agriculture, with increased subsoil drainage may somewhat decrease the amount of water available for power but this decrease will be slight. Extensive development of water power sites has lagged behind because the natural power sites are frequently long distances from consuming centers and so require lengthy transmission lines, and the cost of constructing generating stations from water power is four to five times greater than for steam. Recently, however, the government has seen fit to undertake such construction on a large scale and we can expect a considerable increase in available energy from this source.

Power can be developed in other ways too. There are hot springs and geysers which could be used to supply heat and energy. Wells are known which are producing large quantities of water at 190°–230° F.

Volcanoes might someday be made to give part of their heat energy in a useful way. Abbott's solar power plant is a possibility for obtaining energy directly from the sun. The late Passamoquoddy Bay Tide water project offered possibilities from a new source. Then too, there is the wind, alcohol, warm ocean currents, and others—all of which may someday be made to contribute a portion of the needed energy.

All estimates that have been made as to how long the various resources will last are of doubtful accuracy for one very important factor has been omitted. This factor is man's ingenuity. Present day civilization has developed because man was capable of applying himself and overcoming obstacles of all kinds. It is quite unlikely that he will be daunted by certain natural resources playing out when he has modern scientific achievements to guide him and spur him on. The problem will be solved in some way and the world will continue to be a place where human beings live and work.

#### REFERENCES

- (1) WYER, Manual Describing Shift of Civilization. Social Engineering Fund. Columbus, Ohio. Page 2-3.
- (2) J. Ind. Eng. Chem., News Ed. 14, 5 (1936).
- (3) Nature 137, 10 (1936).
- (4) GARFIAS, V. R., Survey of Proven Reserves of Mineral Fuels in United States. Oil and Gas J. 33, (50) 17-18 (1935).
- (5) Chemical Industries, 37, 585 (1936).
- (6) EGLOFF, GUSTAV. Earth Oil, Williams and Wilkins Company, Baltimore, Md. 1933. Page 152.
- (7) Science News Letter, Nov. 30, 1935. Page 344.
- (8) ABBOTT, C. G., Science News Letter, Jan. 11, 1936. Page 23.

## Some Remarks on the Coal Testing Laboratory as Related to the Modern Coal Industry

O. W. Rees

*Illinois State Geological Survey, Urbana, Illinois*

Of the many interesting lines of specialized or applied analytical work, coal analysis is one which is becoming more and more important. This is evidenced by the fact that coal companies are now establishing laboratories for the analysis of their products. The increase in the number of such laboratories may be attributed to two major causes, the increase of coal preparation due to keen competition, which preparation requires control analyses, and to the growing tendency for the public, both industrial and domestic to buy fuel according to analytical specifications. Industry is coming to realize that errors in analytical results may be responsible for losses of thousands of dollars in the course of a year's time. In the case of one large company an error of approximately  $1\frac{1}{2}$  per cent in the calorific value of their coal resulted in penalties which amounted to about \$18,000 in 8 months' time. Thus we see the importance of this line of applied analysis and the necessity of making such analyses as accurately as possible.

The sampling and analysis of coal is complicated by its nonhomogeneous character. Coal is made up of organic material which has undergone varying degrees of coalification. To this are added varying amounts of minerals such as calcite, pyrite, and clay minerals together with varying amounts of moisture. To satisfactorily sample and analyze such a heterogeneous material, therefore, offers its difficulties. Morrow and Proctor<sup>1</sup> have shown that individual lumps of coal  $\frac{1}{2}$ —1 inch which were picked by hand from the same stream of coal varied in ash content from a minimum of about  $1\frac{1}{2}$  per cent to a maximum of about 66 per cent. This serves to emphasize the extreme danger in accepting an analysis of a single lump or a small quantity of coal as being representative of a larger lot of coal.

Sampling of coal must satisfy two requirements, the securing of a satisfactory gross sample and the preparation of this gross sample for analysis. In order that the gross sample shall be representative of the whole lot of the coal its size will vary with the nature of the product being sampled. For example, larger gross samples are necessary for large sized coals. Furthermore, different means of obtaining gross samples are necessary depending on whether face, car, or preparation

<sup>1</sup> "Variables in Coal Sampling" by J. B. Morrow and C. P. Proctor, A. I. M. E. Technical Publication No. 645, Table 3, page 11.

plant samples are to be taken. At present there are standard procedures outlined by the American Society for Testing Materials<sup>2</sup> for obtaining face and car samples, but as yet no standard methods for sampling prepared coals have been adopted. The increased amount of coal preparation has therefore created a great need today for standard methods of sampling these products.

Once a satisfactory gross sample is obtained the problem of crushing and quartering this down to a laboratory sample presents itself. This laboratory sample usually consists of about two pounds of 1/4-inch coal which is further crushed and quartered in the laboratory to about 60 grams of -60 mesh coal for the actual analysis. Previous to this final grinding, however, the sample should be dried for some time, preferably overnight, in an oven through which a current of air is kept circulating at approximately 37° C. This drying brings about the loss of moisture which would readily be lost at room temperature and thus prevents troublesome loss of moisture in the later handling of the sample. Furthermore it provides a drier sample for the final grinding which sample can be readily ground without troublesome caking. This air dry loss is carefully recorded and is taken into account in the final results.

Coming now to the analysis proper we have a 60-gram sample of -60 mesh coal from which part of the moisture has been driven by air drying. The most common determinations made commercially are the proximate analysis including determinations for moisture, volatile matter, ash and fixed carbon by difference. To these may be added determinations for total sulfur, calorific value and ash softening temperature. For research studies and certain classification studies ultimate analyses may be made including determinations of carbon, hydrogen, nitrogen and oxygen. In some cases varieties of sulfur are determined including sulfate, pyritic and organic sulfur. Mineral carbon dioxide is sometimes determined and ash analyses are less frequently made. Certain physical tests are used in certain studies such as shatter tests, agglutinating tests, accelerated weathering tests, etc.

The majority of methods available for use in coal analysis are of the empirical type, that is, those in which all details such as time, temperature and kind and dimensions of apparatus are carefully specified. Since this is true it has been necessary to adopt standard procedures and to insist that all laboratories adhere closely to these standard methods in order that their results shall be comparable. The methods commonly in use are those adopted as standard by the American Society for Testing Materials<sup>3</sup>. In order to emphasize the necessity of close adherence to the conditions specified for these determinations let us consider briefly a few determinations. The determination of moisture in coal offers a good example of the absolute necessity of closely adhering to a standard procedure. It is possible to drive out different amounts

<sup>2</sup> Standard Method of Sampling Coal, A. S. T. M. Designation D 21-16.

<sup>3</sup> "Laboratory Sampling and Analysis of Coal and Coke." D 271-33 American Society for Testing Materials.

of moisture from coal by heating all the way from room temperature up to as high as  $1000^{\circ}\text{C}$ . It has therefore been necessary to set up an empirical procedure by which results for this determination may be duplicated. The moisture value is determined by heating a sample in a double walled oven whose temperature is regulated at  $105^{\circ}\text{C}$  by a boiling solution between the walls and through which oven air is passed at a rate to insure renewing the air two to four times per minute. Any deviation from these specifications will result in different values for moisture. In some cases ordinary drying ovens have been used for this determination. Such ovens do not fulfil the two most important specifications for such equipment, which are that the oven shall have a minimum of air space and shall be uniformly heated. An oven with square corners permits the formation of air pockets which are impossible to sweep properly, and heating units in the bottom of the oven do not effect uniform temperatures throughout.

The determination of volatile matter in coal is another very good example of the empirical nature of coal analysis. The amount of volatile matter lost upon heating a coal sample depends upon the temperature at which it is heated, the time for which it is heated, the type of equipment in which it is heated, etc. It is therefore necessary to very carefully adhere to the standard procedure which has been outlined for this determination.

Not only is it necessary to adhere carefully to standard procedures for the two determinations which have been cited above, but also it is true for other determinations in coal analysis. For instance, in the determination of ash softening temperature it is possible to vary the value obtained as much as  $400^{\circ}\text{F}$ . simply by varying the atmosphere in the furnace from reducing to oxidizing.

The requirements of control, marketing and classification analyses are somewhat different. Control analyses usually must be rapid, in many cases permitting sampling and analysis of many samples each day. Marketing analyses should be more accurate but not so complete as classification analyses where accuracy and completeness are essential. In all cases where possible standard equipment and procedures should be carefully adhered to. In cases where it is necessary to use rapid procedures the relation of results so obtained to results obtained by standard procedures should be determined.

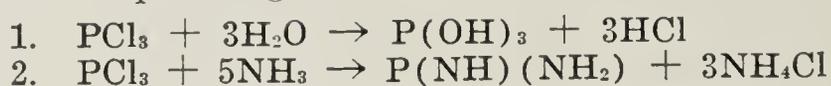
We have shown briefly some of the difficulties which the coal analyst encounters. One must therefore realize the extreme importance of proper sampling, careful standardization, close adherence to standard procedures and acquisition of good technique in such a laboratory. And by no means has the last word been written in coal analysis. Contrary to the idea of some that there is no analytical research left to be done, there is a great need in coal analysis as well as in other specialized lines for new methods and for simplification of existing procedures to eliminate errors as much as possible.

## Acid Catalysis in Liquid Ammonia

Charles Slobutsky and L. F. Audrieth

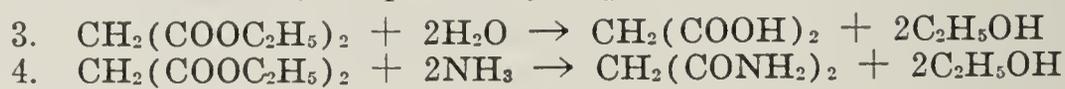
*University of Illinois, Urbana, Illinois*

It has definitely been shown that liquid ammonia possesses unusual properties as a solvent for many inorganic and organic compounds. Like water, it is the parent substance of a system of acids, bases and salts. When dissolved in liquid ammonia, ammonium salts have been shown to behave as acids. Liquid ammonia also acts directly upon many substances to produce solvolytic effects and such reactions are termed "ammonolytic" reactions. Just as phosphorus trichloride is hydrolyzed by water (Equation 1), so it may also be ammonolyzed by ammonia to give the corresponding ammono acid (2).



Many hydrolytic reactions are catalyzed in aqueous solution by acids, or bases. Thus, the inversion of cane sugar is catalyzed by acids and the velocity of the reaction is a function of the concentration of the hydrogen ion. This reaction has been used for the determination of the strength of acids in aqueous solution. Esters also undergo hydrolysis and, in some cases, such reactions have been markedly catalyzed by the hydrogen ion, or in terms of the modern Brönsted concept of acidity, by the solvated proton. It was therefore to be expected that the rate of ammonolysis of esters in liquid ammonia would be accelerated by the presence of ammonium salts.

Preliminary experimental runs indicated that ethyl malonate ammonolyzed at a sufficiently slow rate at 0° to permit of its more extended investigation. Parallel equations, (3) and (4), show the effect of water and ammonia, respectively, upon ethyl malonate.



Weighed samples of ethyl malonate and ammonium chloride were placed in tubes which were cooled in a solid carbon dioxide-acetone bath. A definite volume of liquid ammonia was then introduced and the tubes sealed off and immersed in an ice bath. When the contents had reached a temperature of 0° C. the tubes were shaken and the initial reaction time specified as such. Tubes were removed from the thermostat at varying time intervals, cooled, opened and emptied into filter flasks. The ammonia was allowed to evaporate, the residue washed with ether to remove unchanged ester and the product weighed to determine the yield of malonamide.

The preliminary results of this investigation may be summarized as follows:

(1) The ammonolysis of the pure malonic ester is an autocatalytic reaction, since both of the products, malonamide and ethanol, behave as acids in liquid ammonia. Addition of either of these substances to the initial reaction mixture greatly speeds up the rate of formation of the amide.

(2) The rate of formation of amide is tremendously accelerated by the addition of ammonium chloride. The yield of amide at the end of a ten hour interval is a linear function of the concentration of the catalyst.

(3) Equivalent concentrations of various ammonium salts exert approximately the same catalytic effect.

(4) Neutral salts, such as NaCl, NaBr and NaI, also markedly accelerate the conversion of ester into amide.

## Demonstration of Cold Light

Michael Sveda and L. F. Audrieth

*University of Illinois. Urbana, Illinois*

Many chemical reactions take place with the evolution of heat and light, but only a comparatively small number are known where radiant energy alone is emitted. Most cases of chemiluminescence involve either the use of rare and difficultly obtainable chemicals, or are not sufficiently intense to be suitable for classroom or lecture table demonstration.

The availability of 3-aminophthalhydrazide on the market (1) and the brilliance of and ease of production of chemiluminescent effects by its oxidation in alkaline solutions make the demonstration of cold light a relatively simple matter. If carried out carefully, the oxidation of "luminol" produces sufficient light in a darkened room to make the operator distinctly visible and capable of being photographed. Directions for producing this effect follow.

Dissolve 0.5 g. of 3-aminophthalhydrazide and 15 g. of sodium hydroxide in 5 l. of water contained in a 6-l. Florence flask. Then add 20 cc. of 3 per cent hydrogen peroxide. Gradually introduce small crystals of potassium ferricyanide,  $K_3Fe(CN)_6$  and swirl the contents of the flask. As each crystal strikes the surface of the solution, it will appear to glow, and as the oxidant dissolves a greenish-blue light will be emitted from the contents of the flask. The light intensity can be regulated by adding varying quantities of ferricyanide.

Another striking demonstration is effected in the following manner. Prepare a solution of 0.5 g. luminol and 15 g. of sodium hydroxide in 500 cc. of water (Solution A). An equal volume of a saturated solution of potassium ferricyanide containing 60 cc. of 3 per cent hydrogen peroxide is next prepared (Solution B). Immerse a piece of cloth in solution A, remove it and squeeze out the excess of liquid. Then pour some of solution B on the cloth. It will glow brilliantly. If the cloth is then pressed the excess liquid will fall from it like glowing drops of molten metal.

For further information and demonstrations reference is made to an extended discussion of the subject of chemiluminescence by Huntress, Stanley and Parker (2).

### REFERENCES

1. Synthetic Organic Chemicals Department of the Eastman Kodak Company, Rochester, N. Y.
2. HUNTRESS, STANLEY and PARKER, J. Chem. Education 11, 142 (1934).

# The Effects on Corn and Wheat Starch Gels Produced by Pretreating the Starches With Freezing or With Chemical Reagents

Sybil Woodruff and Majel M. MacMasters

*University of Illinois Agricultural Experiment Station,  
Urbana, Illinois*

A property of starch which makes it useful in food technology is its ability to swell in hot water and to set to a gel on cooling. This capacity, however, is influenced by various factors as has been demonstrated with both corn and wheat starches. Reid Yellow Dent corn or Champion White Pearl corn were sources of starch used in these studies, as well as Fulhio wheat which had been milled especially for certain Experiment Station projects. Suspensions containing five per cent starch by weight were heated to temperatures ranging from 70° to 95° C. and the character of the molded gels was noted after cooling.

## GEL FORMATION BY CORN AND WHEAT STARCHES

**Effect of freezing on cornstarch.**—Corn grown in 1935 yielded its starch from the ground grain somewhat less easily than did 1934 corn. This was thought to be due to physical differences in the kernels of the two growing seasons. This modification of kernel was slightly less pronounced in corn which had been subjected for 24 hours to a temperature of -18° to -20° F. at a time when the moisture content of the kernels was 27 to 32 per cent. Gels of starch taken from 1935 corn, much of which was frosted before completely matured, did not leave the mold clean as was the usual case in 1934 with cornstarch gelatinized at 95° C. This denoted a different manner of holding the water in the gels. Freezing the corn did not noticeably alter the ability of its starch to form a gel, however.

**Effect of sulfur dioxide treatment on cornstarch.**—The usual factory practice of steeping corn for many hours in water saturated with sulfur dioxide was found so to alter the starch that a gel was not obtained unless the suspension was heated to a temperature of about 95° C. Such was the case with both commercially manufactured cornstarch and that made in the laboratory following the steeping of the corn in sulfuric acid. On the other hand, starch obtained from the same lot of corn, but with the sulfur dioxide treatment omitted, gave a well-formed gel after being heated to only 80° C. The same effect of sulfur dioxide

on starch was demonstrated by treating cornstarch, not corn, with sulfurous acid solution.

**Effect of bleaching treatment on wheat starch.**—The commercial practice of so-called bleaching which is applied to wheat flour is somewhat comparable to the sulfur dioxide treatment used in making cornstarch. This chemical treatment is valued as much for its improvement of baking qualities as it is for removing the natural yellow tinge of the flour. Wheat flours bleached by five different methods were found to show no measurable difference in gel forming capacity.

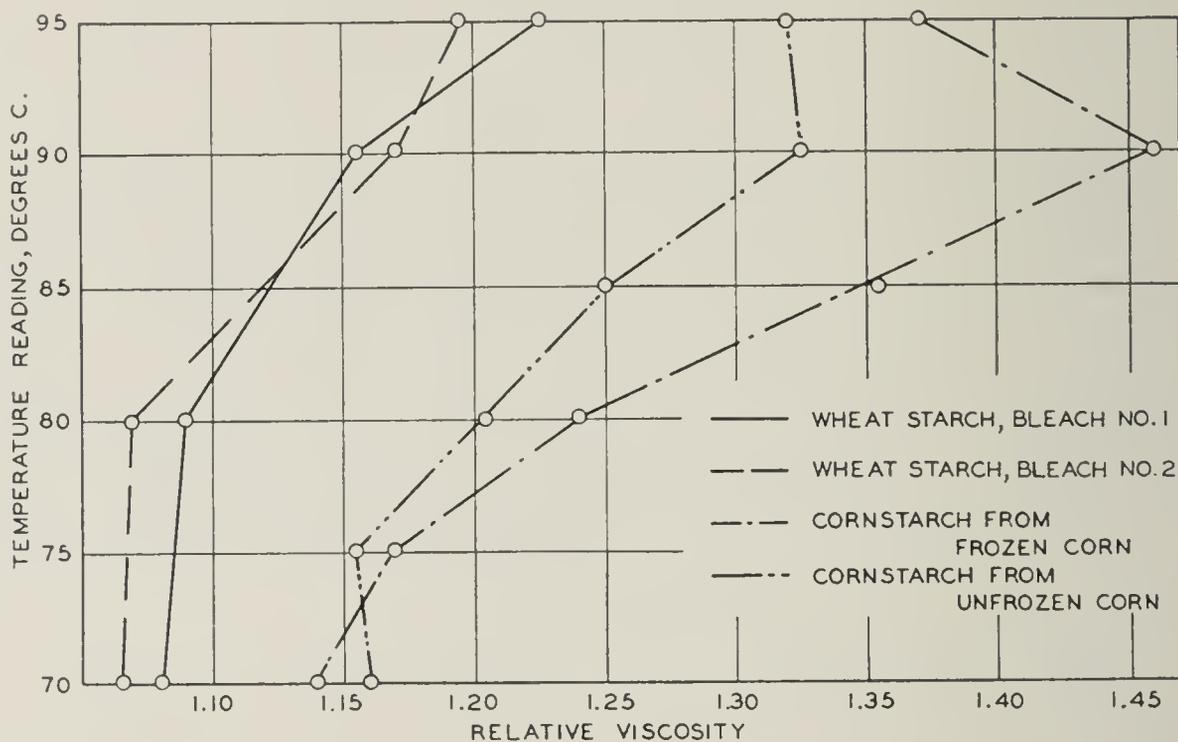


Fig. 1.—VARIATION OF VISCOSITY WITH TEMPERATURE.

**Effect of salts and sugar on corn and wheat starches.**—Sodium chloride was shown to reduce the gel forming capacity of both kinds of starch, though more in the case of wheat starch than in the case of corn starch. The starch was first allowed to stand for two hours in 1.43 M sodium chloride, then water was added to bring the concentration of starch to a 5 per cent suspension which was gelatinized as usual. The final dilution was approximately 0.4 M with respect to sodium chloride. The resulting gels were gray and slightly less firm. Similar treatment with 5 M sodium chloride (approximately 1.7 M on dilution) caused considerably weaker gels to be formed by cornstarch and completely inhibited formation of gels by wheat starch, even on gelatinization at 95° C. Treatment with 0.43 M potassium citrate failed to produce any noticeable effect other than a graying of the gels. Sucrose completely inhibited gelation when 60 grams of it were added to 100 grams of either corn or wheat starch suspensions. This agrees with earlier results reported by Woodruff and Nicoli.<sup>1</sup> Ten grams of sucrose did not visibly change the gel though it was somewhat less firm.

<sup>1</sup> WOODRUFF, S., and NICOLI, L., *Cereal Chem.* 8, 243 (1931).

### VISCOSITY OF STARCH SUSPENSIONS

Viscosity has been used more commonly than gel formation as an index of degree of swelling of starch. Measurements of viscosity were made in the Stormer viscometer, employing suspensions containing 2 per cent starch. The pastes were first gelatinized in flasks, then transferred to the viscometer cup and maintained at the temperature of gelatinization during reading of viscosity.

Starches of frozen and unfrozen corn varied widely and irregularly in viscosity at different temperatures. Unrecorded data showed at times lower viscosity in the starch from frozen than from unfrozen corn. Graphs of two samples of wheat starches bleached by different methods are given as being typical of all results obtained with this starch (Fig. 1). The viscosity of corn starch suspensions was in every case greater than that of wheat starch and was also more affected by added chemicals. Sodium chloride treatment, similar to that used in studying effects on gelation, gave slight differences from normal viscosities, but these were not uniform in character. Potassium citrate or sucrose used in the amounts given in the table increased viscosity more regularly. Small amounts of sucrose increased viscosity greatly, large amounts to a smaller extent.

EFFECT OF CHEMICALS ON RELATIVE VISCOSITY

Chemical added	Concentration of solution added	Relative viscosity at 80°C.	
		Corn starch	Wheat starch
None.....		1.32	1.21
K-citrate.....	0.04 M	1.31	1.21
K-citrate.....	0.08 M	1.36	1.25
Sucrose.....	10 gm.*	1.42*	1.30†
Sucrose.....	60 gm.*	1.26*	1.19†

\* This amount was added to 100 gm. of starch suspension.

† Corrected for viscosity of sucrose solution.

## Putting Thrills Into Laboratory Experiments

Everett S. Anderson

*Quincy Senior High School, Quincy, Illinois*

### ABSTRACT

**Solution of Unknowns.**—Numbered vials containing unknowns are handed out. Coded numbers are used so that the student can be informed of the success of his work at the time of report. The use of coded numbers enables the instructor to hand out a subsequent unknown with one or more of the same ions contained in the previous unknown in case of failure to detect these ions. Findings cannot be reported until vial has been turned in. A student may work as many unknowns as he can in a given period. The competition is keen and the satisfaction great from having solved a large number successfully.

**Electroplating.**—Silver, chromium, copper (alkaline cyanide), and nickel plating solutions are provided in four liter beakers arranged with buss bar, so that articles to be plated can be hooked on without having to make other electrical contact. Students bring buckles, paper weights, metal hair pins, metal horn mouthpieces to be plated.

**Preparation of Ink.**—The formula for the Government Standard Writing Ink is used. In a portion of the ink prepared the soluble blue is omitted. The use of this portion shows the oxidation of the ferrous gallo-tannate to the ferric state. Students are urged to make use of the ink they have prepared.

**Preparation of Soap.**—Sodium soap is prepared from cottonseed oil. This soap is moulded into cakes in aluminum milk test pans or dissolved in alcohol to make a liquid soap. It is used in all laboratory cleaning requiring the use of soap.

**Preparation of Edible Jelly.**—100 ml. of water, 1 g. pectin, 0.5 g. tartaric acid, and 60 g. cane sugar are boiled until the temperature of the mixture reaches 104° C. When the mixture cools it gives a good grade of edible jelly without flavor. A grapelike flavor can be added by putting about ten drops of a one per cent solution of methyl anthranilate in pure alcohol into the mixture before cooking.

# The Position of Organic Chemistry in a General Chemistry Course

Julius J. Gouza

*Edwardsville High School, Edwardsville, Illinois*

Organic chemistry is very often confusing and uninteresting to beginning students, and their attitude may be reasonably considered justifiable. I am now speaking of the organic chemistry as it is presented to our high school and college students taking an introductory course in general chemistry. True, the student is introduced to carbon compounds in these courses but it is the impression that this is done in such a fashion as to leave the student with the idea that organic chemistry is "advanced," and very difficult to absorb. Sufficient organic chemistry should be introduced to round out the beginner's point of view. Organic chemistry should be of more general interest than the material ordinarily included in beginning courses.

One of the principal purposes of teaching chemistry is to have the student appreciate Chemistry's contribution to the services of man. In what field of chemistry has the greatest advancement been made? "Organic chemistry, that is, the chemistry of the carbon compounds, has taken a development far overshadowing inorganic chemistry, or the chemistry of mineral substances. Chemists have prepared or know how to prepare hundreds of thousands of such 'organic compounds' few of which occur in the natural World."

The teacher of today has access to many teaching tools such as projection lanterns, sound motion pictures, demonstration models, blackboards, samples, and references. The most common of these is the textbook, which is largely responsible for the methods and content that is taught in chemistry. General chemistry books are beginning to include more and more organic chemistry that is of interest to the student. The first texts included only a chapter on carbon and its compounds which meant carbon dioxide and carbon monoxide, but today they include several, with a wider range of reactions, methods, and processes. The ideal situation would probably be to present a broad view of the entire field of organic chemistry, which would mean including hydrocarbons, saturated and unsaturated, alcohols, halides, organic acids, esters, ethers, aldehydes, and ketones. In presenting this material no one group can be over emphasized or stressed because of the lack of time. The aliphatic and aromatic compounds should be treated together, however most of the time will be spent with the aliphatic com-

pounds. By use of models and simple organic reactions a coherent picture may be presented. Time should be devoted to the proper nomenclature of organic compounds, then long dangling formulas will not be a terror to the students. However, students will still be confused by trade names of commercial products.

Once the foundation is laid, the practical connection between it and the student's life may best be shown by motion pictures or lantern slides, showing the process of manufacture and the apparent natural sources of products that he uses constantly. A few of the carbon products that the student consumes, wears, handles, and buys may be listed under the following heads: clothing, petroleum products, plastics, fuel gases, sugars, alcohols, rubber, fats, and foods. Besides making the material practical, realism may be added by taking the student through a chemical plant such as a coke plant or an oil refinery.

If the student takes no more chemistry than is offered in a general course, he will have a brief and broad view of the entire field, and if he pursues additional organic chemistry he will have a fair background upon which to build.

#### BIBLIOGRAPHY

- (1) SLOSSON, "Creative Chemistry," Garden City Publishing Co. pp. 7 and 8—1919."
- (2) HALE, "A Decade of Advance in Organic Chemical Manufacture," *J. Chemical Ed.* 10, 464-468 (Aug. 1933).
- (3) ADAMS, "The Introductory Course in Organic Chemistry; Minimum Essentials of Subject Matter," *J. Chemical Ed.* 4 1003-5 (Aug. 1931).
- (4) BENNETT, "Liaison in Organic-Inorganic Chemistry," *J. Chemical Ed.* 10 20-24 (Jan. 1933).
- (5) "How Much Organic Chemistry Should Be Included in the General Chemistry Course," *J. Chemical Ed.* 4 1006 (Aug. 1927).
- (6) HOPKINS, MATTERN, SEGERBLOM, GORDON, "An Outline of Essentials for a Year of High School Chemistry," *J. Chemical Ed.* 13 175-179 (April 1936).

# Photography as a High School and College Course

J. H. Sammis

*Peoria High School, Peoria, Illinois*

In spite of the fact that many of the critics of public education are raising a cry that our curricula are too full of fads and frills there are a few persons who have the temerity to propose a new addition to the already long list of subjects offered in our secondary and higher institutions of learning. That addition is the subject of photography. In a few isolated places the subject is even now being taught, probably due to the enthusiasm of some pioneer soul and the farsightedness of an administrator or two, but the subject is certainly not yet looked upon as a standard course in most schools.

Ten years ago photography was in a state of development that was not far enough advanced to allow it much consideration as a subject. In the last ten years advances have been made that have apparently escaped the notice of the average layman and educator. No longer is it necessary to buy expensive lighting units requiring bulbs of great cost; we now have the inexpensive photoflood and photoflash bulbs. Films are so much faster and finer grained (when such film is chosen) and chromatically corrected that it is now possible for the rankest amateur to do year-round work. Chemical developers are so superior to some of the older ones that tremendous enlargements are now possible without the former grainy results, and the developers today are less toxic and longer lasting. Cameras are no cheaper, to be sure, but in the last five years improvements in cameras and accessories have been so startling as to leave even the seasoned camera enthusiast gasping.

Why should we teach photography? The answers are manifold.

From a consideration of the commercial importance of photography one can easily see that there is justification for teaching it on that score. We teach free hand drawing in many of our schools. There are more people earning their livings at photography than there are at drawing. Furthermore, there are more people taking pictures for the sheer fun of it than there are people amusing themselves by sketching. We hold no brief against drawing and feel that there is a distinct need for it in our schools, but we feel that larger numbers of people could be attracted into a study of and appreciation for the graphic arts through photography than through drawing. That photography may today be considered an established art is seldom contested.

Those of us who are engaged in some form of educational work are continually being told by other educators that it is imperative that we prepare the oncoming generations of young people for intelligent and

profitable use of leisure time. If we are really serious in our statement and acceptance of such teaching, then here is a subject made to order.

Photography appeals to those scientifically inclined and helps to prepare them for other scientific pursuits, since photography so ably assists the sciences. Think for a moment what the following suggest: micrography, telephotography, crime detection, x-ray, spectographs, photocells, photo-timing devices. Anyone contemplating becoming a teacher, architect, doctor, engineer, lecturer, traveller, gardener, artist, scientist, policeman, journalist, publisher, printer, or parent (just to mention a few) could conceivably be of greater service to society and himself for knowing something of photography.

Photography appeals to both sexes equally well. Some of our greatest photographers today are women. Anyone with a critical eye and who looks for the photographer's name when he sees a good picture will recognize such names as Tony von Horn, Margaret Bourke-White, Christine Fletcher, Dorothea Lange, Tony Frissell and Dorothy Wilding.

Photography appeals to those mechanically inclined. There are almost limitless accessories and gadgets that one can construct for himself such as enlargers, lighting units, camera stands, trays, print washers, printing boxes, backgrounds, and copying stands.

Photography appeals to those artistically inclined. There are many people with the urge to create something pictorial but who lack the necessary muscular control and coordination to draw or paint who find in photography the necessary outlet for their emotions. Color blind people are actually fortunate in monochrome work because the frosted glass image in the camera does not mislead them by beautiful color that will subsequently be lost in the picture.

Photography appeals to the traveller or one who contemplates travelling because it offers him an opportunity to capture much of the charm of the things he sees but may never see again. Few of the box camera snapshotters ever approach the fine results obtained by one who has had training or experience.

In photography we find a subject well correlated to many of our other school subjects. Applications of physics, chemistry, mathematics, and art are all obvious.

If photography is ever to become a part of the curricula of our schools it will be through the enthusiasm and initiative of the teachers. Since so much of the technical end of photography is chemical the chemistry teacher will probably have to carry the brunt of the load. As for student acceptance of the subject there should be no fear. In the few instances where it has been tried the students have flocked to the course. It is one of those subjects that can be made difficult enough for the good student to get his teeth into and easy enough for the weaker ones to profit by. At present America leads the world in photography and there is little reason why we should not lead the world in photographic education.

## Presentation, Correlation and Demonstration in Laboratory Work

Carl E. Schilz

*Lincoln College, Lincoln, Illinois*

Observation in several schools over a period of seven or eight years shows that after many decades of advance in chemical science there are two kinds of teachers in the laboratory classes of our schools and colleges, the good and the bad. The purpose of this paper is to help those who have the progress of their students at heart but have only a hazy idea of the various roles that an instructor must play in conducting a laboratory section successfully. Let us take an example that will illustrate two methods of attack, namely, the glass bending skill.

The opening session of the laboratory class usually consists of a group demonstration by the instructor of the seemingly simple operations of cutting and bending glass tubing, followed by a short practice of these arts by the students. Then five or more weeks later the teacher notices several students assembling a gas generator with tubing bends that are neither neat nor serviceable. These students may be left to struggle alone, referred to the opening exercise and told to review it, cheated of a chance to learn by the instructor who quickly bends the tubing for them, or they may each be given an individual demonstration with all the details carefully and slowly explained, each student repeating the process several times under the personal supervision of the teacher who coaches the points at which trouble is occurring until the skill is mastered.

This painstaking and time consuming process of scrutinizing the skills of each student and then patiently correcting all faulty maneuvers is the real purpose of placing an instructor in the laboratory of a beginning course in science. The method of individual demonstration should be applied to such procedures as filtration, washing, decantation, and lighting burners with only one match. (R. E. Horton in *Sixth Yearbook of Department of Superintendence of New York City*, page 351, lists 108 such skills that a student should acquire.) All of this means that the teacher himself must be a good technician; perhaps he will need to spend several long evenings perfecting himself, and perfection it must be for the students are quick to sense a lack of skill or confidence.

Only thus can neatness and accuracy be instilled into a class, and not until all these manipulative skills have become automatic habits can the student fix his attention on the chemical principles and relations that we wish him to become familiar with or do any thinking of an

analytical or constructive nature. It is absolutely necessary that he have both the skills and the understanding familiarity with the principles if he is to progress in the elementary or succeeding courses. The procedures may be shown to him by group demonstrations but in many cases individual instruction must follow.

Another type of group demonstration with an entirely different objective is the performance of a series of tests on a large number of materials of the same type. In such a case the students should have made the same test on several common materials until they are familiar with all the details of the manipulation. Then they can concentrate on observing, recording, and interpreting the results when the teacher runs rapidly through a large number of the tests. This procedure applies the test quickly and cheaply to a larger field than could be afforded from the standpoints of either time or cost if done individually. By covering a wide field we impress more clearly that the law is really general in its application, also we have a greater chance of hitting upon some application that is of interest to a given student. Certainly we show the tremendous extent of the field of chemistry in the world around us.

A third type of demonstration that is very useful may be called the cooperative demonstration. As an example, after having the class make the standard test for free alkali on three soaps, chosen to show the extreme cases, each student is asked to bring a small sample of his favorite soap to the laboratory. A check list is made on the blackboard to eliminate duplicates and enlarge the list of samples. It is also explained that for a satisfactory comparison test, water, which might produce a basic reaction through hydrolysis, is a better solvent to use than alcohol. They are told to dissolve about one gram in twenty ml. of water and add four drops of phenolphthalein, label the sample and place it in a test tube rack provided on the side shelf. The samples are then divided into three classes, good, bad, and medium, as determined by the depth of color. It is interesting to include some of the washing powders and chip soaps.

Here in a few minutes of cooperative work is built a demonstration of ten to twenty or more samples that would involve that many times as much work for each student if performed individually, a saving of as much as 400 times the work for a class of twenty students. Each instructor will find other cases where this method will bring an excellent survey of problems to a satisfactory conclusion.

Summarizing briefly, I have attempted to show that there is a need for four types of demonstration in the laboratory, the two types of group demonstrations by the instructor, the individual demonstration by the instructor, and the cooperative demonstration by the class, which combines the thrill and pride of intimate knowledge gained through individual work with the time and expense saving factors of group work. In addition we also teach the student the advantages obtained by pooling knowledge, a fact vital to our great industrial research departments.

# The Place of Projects in High School Chemistry

M. E. Woodworth

*Pittsfield, Illinois*

A perfect educational process should develop in the boy and girl all the desirable traits which we wish to find in their mental and moral makeup when they are grown. It is impossible to find any one process to meet this demand so that we must resort to a variety of methods in education. One process that has been overlooked more than any other in the past is the use of projects.

The application of this method to science, which is an outcome of the Herbartian school, has been used only sparingly until recently. Widespread increase in its use in this State was encouraged by this academy when it began to sponsor a project contest in the Junior Section. The adoption of this policy was no doubt brought about by the excellent showing a few schools made in the first contest of this sort to be held, which was sponsored by the Illinois State Association of Chemistry Teachers seven years ago at a meeting of this association in Macomb. During this widespread increase many difficulties have been incurred in the application of this method probably due to the small amount of material that is at hand from which the teachers may get their information.

Sometimes the term "project" is misused by being applied too widely to situations that are not projects but only problems. A project is not merely a situation that may be solved by purely mental solution but it requires additional knowledge, understanding, and skill. It is in these last necessities that a great amount of the project's usefulness is founded. I can find no better reason for its use than the encouragement it offers a student in finding and developing these traits while working with a situation that instills into him an interest greater than can be stimulated by any other educational process. In addition to these outstanding achievements, the project method at its best may be credited with the development of more definite concentration of thinking, a greater effort in the use of the subject matter in problem solving and fact finding along with a development of the usage of facts as well as a higher standard of ideals and attitudes.

No educational method is free from errors. Probably one of the greatest handicaps that the project method has to overcome is the fact that so many teachers will allow it to degenerate into a series of poorly

written reports taken from articles or books. Probably this is the reason why projects are often times disregarded in the teaching of science. Certainly projects are not reports culled from magazines and encyclopedias and neither may they be imposed, for as such the spice is lost and with it a great deal of their real worth. Another thing that discourages teachers a great many times in the use of projects is the realization that this method is not easily taught. It demands a great deal of planning, supervision, and encouragement, all of which will demand from the teacher much time and energy as well as resourcefulness.

Since teaching this method is not easy a great many mistakes and failures will attend its use if not handled properly, because students are not able to carry on unaided the problematical work which is demanded. Therefore I must point out that although the project has a definite place in the teaching of chemistry it cannot be classified as chemical education itself.

When introducing projects into Chemistry the first question that arises in the teacher's mind is—"when shall it be taught, how much time shall be allotted to it, and what relation must it bear to the rest of the Chemistry course. These questions cannot be satisfactorily answered with one answer for all schools or situations but must be governed by the characteristics of each class that is to participate in this type of work. However, I might offer some suggestions that I have discovered through the use of this method the past several years. First of all I find that the mere suggestion that some time during the year the members of the class will have an opportunity to work on projects of their own will stimulate an interest within each student in Chemistry from the very first day of the term. It is seldom that I find a student who does not care to originate, plan, execute, and report on a project that he may call his own. Sometimes, however, this does occur and in such a case another kind of work should be provided for the student. This makes more work for the teacher but is necessary, for if the other students received the impression that their projects were forced upon them their interest would die and with it a great many of the valuable benefits. During the time I have carried on projects I have invariably found that they should not be introduced early in the school year since practically each project demands some technique that the new Chemistry student has not yet acquired. Neither can it be expected that he will get the greatest understanding or knowledge from his project until he has attained a background by the use of other educational processes for several months. Projects have done my students more good when they were introduced into the laboratory from the first to the middle of the second semester.

The statement that they are introduced into the laboratory may raise the question as to whether they should be carried on during the regular laboratory time, after school, or at home. To this I reply that the

project method is an accepted educational method, therefore why should it not have a place in the school today together with the other educational methods and processes if it is not allowed to overshadow them.

In Watkin's experiment with controlling classes in Chemistry doing project and nonproject work, the two groups stood about equal by pure factual testing but it must be remembered that a great many of the good points such as resourcefulness, initiative, and interest that we know are developed to a high extent in projects can not be measured by such tests. Neither are they necessarily bounded by the four walls of the class room but may reach to the home community and often farther, working towards ends in which the student can see immediate worth.



## PAPERS IN GEOGRAPHY

---

### EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN

Of the sixteen papers on the program of the Geography Section meeting, only ten are here represented. The other six were as follows:

*Human Geography in Relation to the Zonation of Vegetation in the San Francisco Mountain Region*, by H. O. Lathrop, Illinois State Normal University, Normal.

*Gardening in Fairbanks, Alaska*, by Edna M. Gueffroy, Illinois State Normal University, Normal.

*Answer to the Article Entitled, "Geography the Forgotten High School Subject,"* by Clare Symonds, Quincy High School, Quincy.

*Population Pressure in Puerto Rico*, by Wm. H. Haas, Northwestern University, Evanston.

*Bloomington Under the Geographic Microscope*, by Margaret Means, Bloomington High School, Bloomington.

*A Study of Results in Geography Teaching*, by Lina Webb, Benton High School, Benton.

The meeting was well attended.

H. O. Lathrop, 608 Normal Avenue, Normal, Illinois, was elected chairman of the Geography Section for the 1937 meeting.

(Signed) FLEMIN W. COX, *Chairman*



## Exceptional Weather of Recent Years

Harold B. Ward

*Northwestern University, Evanston, Illinois*

Weather rules humanity to an extraordinary extent. A rhythm of climate is essential for man to achieve a high degree of civilization. Alternate periods of high and low temperatures or dry and wet weather produce a rhythm of climate. In recent years, however, the people of the United States have been treated to such exceptional weather conditions that the rhythmic succession has been disturbed with a magnitude far beyond the wildest forecasts ever conceived.

The year 1933 was much warmer and drier than a normal year. Only three preceding years of record in northern Illinois were warmer but during the summer of 1934 more local temperature records were broken than in any previous year and the absolute maximum for Chicago, 104.8° F., was established on July 24, 1934. The most outstanding feature of 1934, however, was the widespread severe drought. The precipitation in Chicago, 22.78 inches, was .56 of an inch lower than that of the previous driest year, 1930. The year 1935 brought weather that spelled disaster in many parts of the country and for the United States as a whole averaged 1.8° cooler than 1934. The winter of 1935-36 is so recently past that its severity is fresh in the minds of all observers except those of the southwest states where the temperature was normal or slightly above.

Tornadoes, hurricanes, and violent storms of all types are exceptional weather phenomena; they occur with unexpected force, and, unless they are tropical storms, cannot be accurately forecast. In 1933 the tornadoes—197 of them—a number rarely exceeded, were characterized by the U. S. Weather Bureau as plentiful, short-lived, and frightfully fatal. During that year 21 tropical storms, the largest number in 46 years of record, struck the area charted by the Weather Bureau. During 1934 there were few tornadoes and no very intense hurricane reached the coast of the United States, but in 1935, 179 tornadoes were reported and five tropical disturbances, each of full hurricane intensity, were reported in waters adjacent to the United States. Three of these hurricanes struck southern Florida with devastating violence, one was accompanied by the lowest sea-level barometric pressure ever recorded in the western hemisphere (26.35 inches) and two followed erratic unprecedented tracks. The hurricane during the first week of November, 1935, was not only one of erratic movement but also the first of record

to develop hurricane intensity at so late a date in Florida. Early in April, 1936, a series of extratropical tornadoes of exceptional severity devastated many sections of the southern states.

Other exceptional features of recent years have been the dust storms. At least five great dust storms spread over a considerable area of the United States and culminated in the most widespread of all, the storm of May 9 to 12, 1934. These resulted in part from the most extensive drought in the climatological history of the United States.

Exceptional low temperatures of the past winter have not only caused many people to believe that the winters are becoming more severe but that a recurrence of the glacial period is imminent. The nation was in the grip of the most bitter cold that had been experienced in a quarter of a century or more. The heating load for the three winter months in the Chicago area for the past 50 years has averaged 3,470 degree days. For the winter of 1935-36 it was 4,104 degree days.

Extraordinary changes in weather followed the severe winter. High winds and terrific blizzards followed by rapid melting produced floods in northeastern United States that surpassed all previous inundations. For the first time in history, the Ohio River on March 27, 1936, was above flood stage along its entire 981 miles from Pittsburgh to the Mississippi. So much water had fallen from the clouds and had flowed over the lands that no thought of another drought entered the minds of observers. But less than a month later, we learned that the deficiency in rainfall in several localities was sufficient to break the 1934 records and that an area of more than 30 million acres was in the grip of a severe spring drought.

Records continue to be broken; the warmest April 20 was experienced this year in Chicago when the mercury reached 82° at 3:08 P. M. and, because of a shift in the wind, tumbled to 55° in seven minutes.

Time does not permit a recital of the hundreds of minor eccentricities of the weather during recent years. Interest attaches to several problems presented by unprecedented conditions but perhaps the most common question is "can we conclude that the climate today is radically different than that of a century ago?" Meteorologists are not agreed as to the remote causes of the extraordinary weather of recent years but the immediate causes are known and they do not differ except for those that are the results of the changing environment from the causes of extraordinary weather conditions in past decades. A search of the records reveals that in all years unusual weather may occur locally and that certain years have been outstandingly warm or cold, wet or dry. Much more research is needed to solve all the problems but in the light of present knowledge one is forced to conclude that our weather extremes and great departures are the normal type of weather for the interior of this country and that abnormalities have occurred in the past and may be expected in the future.

## Geographic Aspects of the Fruit Industry of Illinois

Ralph S. Harris

*Westport Senior High School, Kansas City, Missouri*

Apples are the most common of the orchard fruits and are grown in every county in the state. Commercial production, however, is limited to the southern part of the state.

We may roughly classify the commercial apple sections of Illinois as the Central Western, the South Central, and the Southern Districts.

The Central Western District centers in Calhoun County, with lesser plantings in Jersey, Greene, Pike, and Adams counties. This section produces the late ripening varieties and is the leading producing district of the state. Taking the single year 1929, Illinois produced 3,025,895 bushels, which was a short crop inasmuch as the five year period 1928-32 showed an average of 5,019,000 bushels. The Central Western District produced a little over 35 per cent of the 1929 crop and Calhoun County alone produced 21 per cent of the total crop of the state. This area has pushed forward in the number of bearing trees from 1920 to 1930. Calhoun leads the procession, for her number of trees of bearing age has more than doubled during the ten year period. With her good climate, rolling topography, and deep, rich loess soil, she has ideal conditions for the growing of apples. A recent test, the results of which were announced in August, 1935, stated that the Department of Agriculture found that Calhoun County apples contained more sugar, better flavor, and higher color than any grown elsewhere in the United States. The test was made on fruit produced in every section of the country. A new highway bridge across the river at Hardin and the railroad extension to East Hardin have broadened her market. Formerly, the apples were shipped to St. Louis by boat.

The South Central District is composed of Cumberland, Jasper, Richland, Clay, and Marion Counties, together with parts of Crawford and Effingham counties. It may be said to be the second most important commercial area in the state, but the industry in this region is now distinctly on the decline. The number of trees of bearing age in 1930, in the seven counties named in this region, was less than 15 per cent of the number in 1900. This area was, in fact, the first important apple producing center of Illinois. Throughout the territory there are no large highly developed apple sections and both the early and winter varieties are grown. Some adverse factors are encountered here, such as spring frosts which cause irregularity in the yield, an impervious subsoil which comes near the surface making the land absolutely un-

suited for orchards, and level land which makes drainage a serious problem.

The Southern District includes Union and Johnson counties, together with parts of Jackson and Williamson. The region is one of the leading early apple sections of the United States. Fruit moving late in June or in early July has the advantage of a fairly open market to the west, north, and east of this district. The number of bearing trees declined in this area between 1900 and 1924, but during the period 1920 to 1930 the total number of trees, both bearing and non-bearing has increased a little over 27 per cent, the greatest increase being in Union and Johnson counties. Thus, we can see that this district, together with the Central Western District has increased rapidly from 1920 to 1930. However, in contrast to the ideal Calhoun centered district, the soil here is of poor physical texture and low in fertility. In some places there is an outcrop of stone. The topography and character of the soil presents an erosion problem. The apples in this section blossom early and there is often considerable damage from spring frosts which check the normal development of the fruit. On the other hand the section has some advantages over others. Early apple movement, good transportation facilities throughout the distributing territory, and abundance of cheap labor and land, coupled with the fact that few crops other than apples and peaches can be profitably produced on this land, are all tending to favor this territory as one of the most important centers for early apple production in the United States.

Considering the average production of apples for the five year period 1928-32, Illinois ranked tenth among the states.

Peaches are the second most important of the orchard fruits of Illinois, but their production is more limited than that of the apple due to the great hazard of winter killing of the fruit buds and often the trees. Low temperatures in the spring months, during bloom, is another great hazard. In Illinois the production of peaches fluctuate greatly with the climatic conditions. There were no peaches in 1918 and 1930 and less than a fourth of a crop in 1919, 1921, 1932, and 1933. The five year period, 1928-32, showed an average production of 1,889,200 bushels, during which time Illinois ranked next to the important states of California, Georgia, and North Carolina.

In spite of the great chances taken, because of weather conditions, commercial orchardists in the extreme south and southeastern part of Illinois are willing to gamble on getting a crop as the state's peaches go on the market about three weeks ahead of the Michigan fruit. Too, the Elberta crop in Illinois fits fairly well into a period when there is a decided dropping off following the end of peach shipments from Georgia.

The total number of peach trees reported in Illinois in 1930 was 4,027,456, nearly three-fourths of which were trees of bearing age. The

number of trees of bearing age declined a little over 64 per cent between 1910 and 1920, with the largest decline in the small farm orchards. However, the total number of trees increased from 1,851,037 in 1920 to 4,139,100 in 1925.

The southern Illinois peach region is a comparatively recent development, the production being rather small in 1924. A survey made in 1925 indicated that 77 per cent of all the peach trees in the commercial orchards of Illinois had been set in 1920 or later. A slight decline in the total number of trees was noted from 1925 to 1930, while only 25 per cent of the trees were of non-bearing age in 1930 as compared with 45 per cent in 1920. The total number of trees in Union, Johnson, Pulaski, and Jackson counties was two and a half times as large as in 1920.

Commercial peach production in Illinois is limited to the Southwestern Section centering in Union, Johnson, Pulaski, and Jackson counties, and the South Central Section centering in Marion and Jefferson counties.

Taking the single crop year 1929, which was almost a million bushels above the average of the five year period, 1928-32, the Southwestern Section is by far the most outstanding production center. It produced 40 per cent of the state's crop in 1929, with Union—the outstanding peach producing county—producing 22 per cent of the state's total, and alone, almost as much as the South Central District. This section has a rolling topography that gives good soil and air drainage.

In the South Central Section there is greater risk of frost damage than in the Southwestern Section as the surface there is fairly flat. Crop failures in this region are common. Marion County had more peach trees in 1900 than any other county in the state, however, the number declined until 1920 when thousands of new trees were set.

The pear is the third most important of the deciduous tree fruits of Illinois. The Kieffer is the principal variety grown, while the more recent plantings include the Garber. However, neither variety is of high quality, consequently, they do not command the price of the better varieties from the Pacific Coast States. Fire blight, a disease, is the limiting factor in the production of the high quality varieties in Illinois.

In 1930, Marion County had nearly one third of the state's pear trees of bearing age. In 1929, she produced nearly one third of the total crop of the state. The 1929 crop, however, was above the five year 1928-32 average which was 445,800 bushels—the 1930 Federal Census figures showing 538,667 bushels for Illinois.

The pear is more resistant to frosts and winter than any other Illinois fruit tree. It will stand wet feet better than any other fruit tree that we grow in Illinois. Since it is quite level in Marion County, making drainage a problem, the pear is not so handicapped with excess moisture as other deciduous fruit trees.

The total number of trees in the state declined quite rapidly from 1910 to 1920 and increased following the war, but declined 21 per cent between 1925 and 1930.

In grapes, Illinois ranks higher than is generally known. Taking the single year, 1929 Federal Census figures, she ranked tenth in grape production among the states. The number of grape vines, according to Federal Census figures, showed her ranking eleventh in 1930.

There is an intensive commercial planting in Hancock County in the Nauvoo district. This county is by far the leader and in 1929 produced a little over 28 per cent of the grapes of Illinois and in 1930 had a little over 26 per cent of the state's bearing and non-bearing vines. Practically the entire crop from the Nauvoo district is ferried across the Mississippi River to Montrose, Iowa, and from there taken by rail to states north and northwest.

Peoria and Madison counties rank second and third respectively in the total number of vines in the state.

The Nauvoo district in Hancock County has ideal conditions with a west exposure on the Mississippi. Here the air and water drainage are good and the soil is moderately fertile. Since the grape vine will not stand wet feet, the water drainage is very important. There are favorable sites and soils in other parts of the state, especially in the southern third and along the Mississippi River in the western part.

In 1900 there were nearly as many grape vines in Pulaski as in Hancock County, but the number in the southern county declined rapidly from 1900 to 1910. In 1900 in the entire state, there were 3,008,888 vines of bearing age and that number declined to 1,750,332 in 1930.

The strawberry is the most commonly grown of all the small fruits of Illinois. They are grown in all counties and in most of the counties there are some commercial plantings to supply nearby towns. The larger commercial plantings are found in the southern part of the state. The acreage of this fruit varies greatly from year to year, due to the short period that individual plantings are allowed to fruit. However, within the past few years a new district in Edgar County has been pushing forward.

The strawberry thrives in widely different soils and climates, but seems well adapted to the good sites of southern Illinois that provide good air and water drainage. Pulaski County produced 13 per cent of all the state's strawberries in 1929.

In the southern part of the state the strawberries are not far from the Illinois Central Railroad which provides good fast transportation for this highly perishable fruit. On short hauls, the trucks are taking their share of the business away from the railroads<sup>1</sup>.

---

<sup>1</sup> Acknowledgement is given to Professors A. S. Colby, R. S. Marsh, and R. L. McMunn, of the Department of Pomology of the University of Illinois, for their suggestions in the preparation of this manuscript.

# Geographic Aspects of Meat Production in Illinois

Emilie Huck

*Community High School, New Baden, Illinois*

The purpose of this paper is to show (1) where the meat animals are produced in Illinois, (2) what the present tendencies are in production, and (3) the reasons for such distribution.

The production of hogs in Illinois is far more important than the combined production of sheep and beef-cattle (Fig. 1). This is partly accounted for by the fact that much of the farm land in Illinois is too expensive for pasture land, consequently more hogs are produced than sheep and beef-cattle, which require more pasture.<sup>1</sup> Mutton and beef also require more feed to produce a unit of human food than does pork.<sup>2</sup>

## DISTRIBUTION

There are comparatively few hogs in the southern one-third and eastern one-half of Illinois, but numbers in the western one-third are as dense as anywhere in the United States. This location of hog raising in Illinois is surprising to those not well acquainted with the state as they ordinarily expect large numbers of hogs to be found in the heavy grain producing prairie sections of central and eastern Illinois.

The geographic distribution of swine in the United States is primarily determined by the distribution of corn.<sup>3</sup> There are, however, several interesting discrepancies between the distribution of swine and corn. Illinois shows one of those discrepancies.

The greatest center of corn production is in east central Illinois, yet comparatively few swine are raised there, principally because of the high price of corn and the small amount of clover grown. The farm price of corn in east central Illinois averages a few cents per bushel higher than in western Illinois, owing in part to the nearness to the Chicago market where a large amount of corn is made into glucose, shipped to other parts of the United States, or exported to other countries. The freight rates to Chicago on corn from points in western Illinois are enough higher than from nearby points in east central Illinois to make the feeding of corn to hogs and the shipment of the hogs to Chicago more profitable than the shipment of corn. Pork is worth several times as much per pound as corn, furthermore it represents only about one-fifth of the weight of corn, and hence can bear better the cost of trans-

<sup>1</sup> Rusk, H. P. *Rept. Ill. Farmers' Inst.*, Vol. 20, 1915, p. 112.

<sup>2</sup> Baker, O. E. *Graphic Summary of Am. Agr.* Misc. Pub. 105, U. S. D. A., p. 96.

<sup>3</sup> Finch, V. C., and Baker, O. E., *Geog. of the World's Agr.* U. S. D. A., p. 130.

portation. In western Illinois also more clover and other kinds of hay are grown, owing in part to soil and topographic adaptation. These combined with corn make a more complete feed than corn alone.

The distribution of beef-cattle and sheep in Illinois is more uniform than that of hogs, but, again the concentration is greater in the north-west and west than in the south, and for the same reason as for swine.

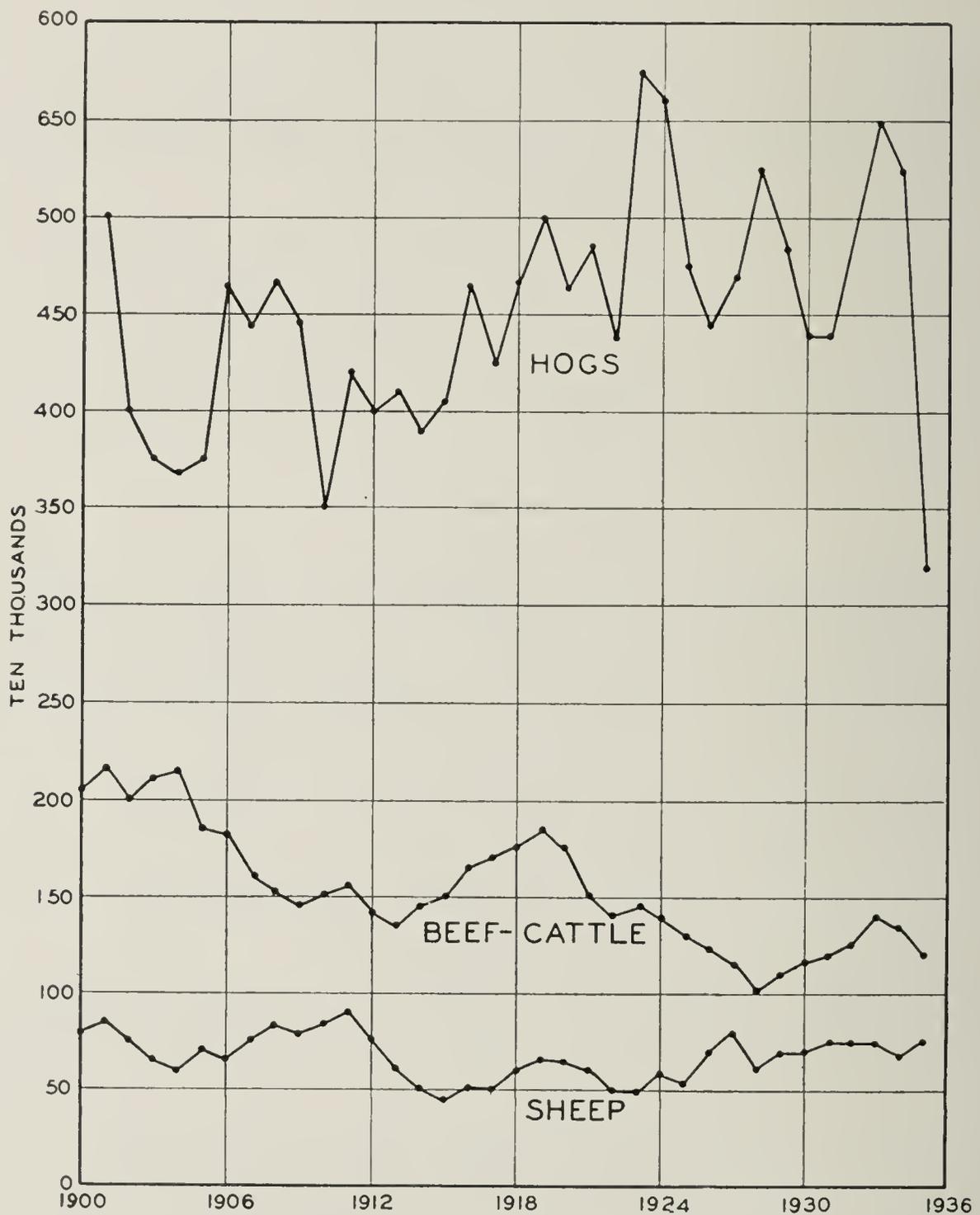


Fig. 1.—GRAPH SHOWING PRODUCTION OF HOGS, BEEF-CATTLE, AND SHEEP IN ILLINOIS.

#### TRENDS

The general trend of hog production in Illinois from 1900 to 1935 has been upward (Fig. 1). There are sudden and sharp fluctuations in this period, but each high mark exceeded the previous high, with but one exception, the post-war high of 1923. The 1933 peak, however, was only

4 per cent below the 1923 peak. From 1931 to 1933 hog population increased rapidly until the Hog Control Program of the federal government made a drastic curtailment in production, the 1935 crop being more than 50 per cent below the 1933 crop, and the lowest since 1910.

The number of beef-cattle in the state has steadily declined since 1904 (Fig. 1). The increase during the war period was only a temporary condition, for the downward trend set in again in 1920, and production reached its lowest mark in 1928. Since then there has been a slight upward rally until 1934 and 1935 when numbers were greatly reduced by the severe drought of 1933 and the consequent feed shortage. The general decline in production in the early part of the century is due to a change in the complexion of the cattle industry,<sup>4</sup> a change from what was formerly, practically a breeding and rearing proposition to one that is almost a purely finishing proposition. The post-war decline in number is due to an improvement in the livestock, quality replacing quantity. Science has improved the animal industry so that there is greater productivity per animal.<sup>5</sup> The recent upward trend in both the hog and beef-cattle industry is probably due to the fact that the use of the tractor and the automobile has caused a decline since the World War in the number of horses and mules, with the resultant release of a large number of acres of crops to feed to other farm animals.<sup>6</sup>

The sheep industry in Illinois has declined since 1900. Diversified farming, the growth of dairy interests around large urban centers, and the growth of grain farming have pushed sheep off to more remote grazing grounds.<sup>7</sup> The sheep industry is an extensive type of agriculture, and tends to disappear from regions of dense population and expensive land. Internal parasites, predatory dogs, and the method of farm tenantry in Illinois further discouraged the sheep industry.<sup>8</sup> The increase in the sheep industry since 1928 is due to the marked increase in wool prices. Prices advanced sharply in 1933 to a point well above the pre-war price. Sheep numbers in most of the important sheep-producing countries are now declining, following five years of expansion. Drought in 1933 in several countries of the southern hemisphere foreshadows a further decline. World prices as well as the prices in the United States advanced.<sup>9</sup> The increased prices of sheep products plus the low price of grain warranted the increased production in sheep, whereas production of both hog and beef-cattle decreased.

<sup>4</sup> Rusk, H. P., *Rept. Illinois Farmers' Inst.* Vol. 20, 1915, p. 112.

<sup>5</sup> Wallace, Henry A., *Yrbk. of Agr.* 1934, U. S. D. A., p. 26.

<sup>6</sup> Baker, O. E., *Graphic Summary of Am. Agr.* Misc. Pub. 105, U. S. D. A., p. 1.

<sup>7</sup> Finch, V. C., and Baker, O. E., *Geog. of World's Agr.* U. S. D. A., p. 135.

<sup>8</sup> Coffey, W. E., *Rept. Ill. Farmers' Inst.* Vol. 20, 1915, p. 117.

<sup>9</sup> Bean, Louis H., and Chew, Arthur P., *Yrbk. of Agr.*, 1934, U. S. D. A., p. 121.

#### BIBLIOGRAPHY

1. Abstract of the 15th Census of the U. S.
2. BAKER, O. E., *A Graphic Summary of American Agriculture.*
3. FINCH and BAKER, *Geography of the World's Agriculture.*
4. *Illinois Crop and Live Stock Statistics*, Circular No. 437.
5. *Report Illinois Farmers' Institute*, Vol. 20, 1915.
6. *Yearbooks of Agriculture*, U. S. D. A.

# An Atlas of the Geography of Illinois

W. H. Voskuil

*State Geological Survey, Urbana, Illinois*

## ABSTRACT

I have been asked to present to the Geography Section of the Academy a brief statement of a proposed Atlas of Illinois Geography, the purpose of the Atlas, the nature of its contents, the progress of the work, and the probable time of completion.

This Atlas is being prepared by Professor Haas of Northwestern University, Professor Blanchard of the University of Illinois, and myself in order to meet the needs of public school and high school teachers for a source of reference and supplementary material to the standard text books on the Geography of Illinois. The Atlas will consist mainly of maps and economic charts with a brief description of each chart. It will be composed of eight sections, as follows: Physical Geography, Climate, Agriculture and Forestry, Minerals, Industry, Transportation, Population, and a Special Chicago Section.

Collaborators on the Atlas, in addition to Professors Haas and Blanchard are Dr. Voskuil, Professor Cox, Professor Ward of Northwestern University and graduate students in their departments.

Up to the present time the sections on climate, agriculture, minerals, and portions of the Chicago Section are in progress or nearly completed. Publication of the Atlas should be sometime this coming year.

The nature of the illustration materials of the Atlas can best be grasped from an examination of some of the completed charts. (Several maps and charts that will appear in the Agriculture and Minerals sections were shown with a brief discussion of each.)

## The Relation of Dams and Reservoirs to the Water Supply of Southwestern California

Richard H. Jahns

*Northwestern University, Evanston, Illinois*

The utter dependence of a populated semi-arid region on an adequate water supply, though a self-evident concept, is nevertheless one which entails many unforeseen complications. The inhabitant of a humid region, accustomed to drawing his water in any desired quantity from nearby lakes and rivers, finds it difficult indeed to conceive of the problems faced by communities in southwestern California. The Los Angeles Basin alone, an area surrounded on three sides by high mountain ranges and on the fourth by the Pacific Ocean, contains over fifty per cent of the people in the state, while but seven tenths of one per cent of the state's water occurs there.

Since this South Coastal Plain, or Los Angeles Basin, is a center of population, industry, and agriculture, its water supply problem, as compared with that of neighboring districts, is unusually severe. Embracing an area of nearly 3,000 square miles, some 2,200 of which are suitable for agricultural or residential development, it is drained by the Los Angeles, San Gabriel, and Santa Ana rivers and their tributaries. There are approximately ninety cities and urban communities in the district, and nearly all the remaining land is used in the raising of citrus fruits, nuts, grapes, grains, and other agricultural products. In the region south of Los Angeles industrial development is pronounced, embracing steel mills, oil fields, and factories of various kinds. Increasing demand of these enterprises for water is naturally expected.

The improved area has the form of a gently sloping, undulatory plain, extending roughly twenty-five miles from sea-level to an elevation of nearly a thousand feet at the base of the mountains. Normal yearly rainfall on this plain is fifteen inches, though seasonal variations are common. The mountains, some of which have altitudes of ten thousand feet, receive more nearly twice that amount. Since the climate of the region is of the Mediterranean type, most of the precipitation occurs during the winter, when it is least needed for agricultural purposes. For this reason, irrigation of crops during the dry summer months is essential. Furthermore, though evenly spread through the winter and spring, the individual falls of rain are often torrential in character, their waters swelling streams to many times their normal size and quickly discharging across the plains into the ocean as waste.

The site of the Pueblo of Los Angeles was chosen largely because of the available water in the nearby Los Angeles River. This was in 1781. It is significant that but twenty years later a dam was built across the

river, diverting water for irrigation and to a lesser extent storing it for use during unusually dry seasons. For 133 years the Los Angeles River continued as the sole source of water, until a series of dry years and a rapidly increasing population forced engineers to look elsewhere for water. It was not until late in the nineteenth century that realization came to most people concerning the true nature of this river, however. It has since been stated that southern California streams "flow upside down," and recognition of this fact was one of the greatest single steps in the growing knowledge of water resources in the region. The water in these streams actually flows through and is filtered by the highly porous gravels beneath the surface. Thus, the water obtained from wells in Los Angeles was of adequate amount and superior purity.

Applications of this new concept soon came into use. It was soon obvious why the smaller streams, perennial in the mountains, disappeared beneath the surface upon reaching the floor of the Los Angeles Basin. The question immediately arose as to how this water could be saved. The answer was the construction of subsurface dams on the outwash plains of a few such streams, their effect being to bar the underground passage of the water and force it to the surface, where it could be used. The more important type of dam, however, was not man made at all, but a product of geologic activity. The mountains surrounding the plains area have been uplifted along a series of faults in comparatively recent geologic time, and have constantly contributed coarse gravels to the areas along their base. These gravels themselves have been offset by faulting or by the initial irregularities on the bedrock "basement" in such a way that individual subsurface basins were developed. In a sense, these are reservoirs formed by natural damming of the water-bearing gravels, and have been the major source of water for Los Angeles, Pasadena, and neighboring cities for many years. In addition, actual artesian areas nearer the coast were discovered.

But these new sources were foolishly and wastefully exploited. Artesian areas decreased in size from an original 375 square miles to a few dozens of square miles by 1914, while other gravel basins were so alarmingly overdrawn that ground water levels fell as much as seventy feet. Springs dried up and the waters of even the large streams sank into the gravels and disappeared. Los Angeles, realizing that stringency of water would seriously affect its growth, settled its metropolitan problem by building an aqueduct from the Owens River watershed, on the east slopes of the Sierra Nevada Mountains, 250 miles across the Mojave Desert southwestward into the Los Angeles Basin. Capable of supplying the needs of two million people, the Owens River aqueduct has five major dams and reservoirs along its length, constructed for purposes of storage, flow regulation, and power plant use. Without these structures, an aqueduct of such length would not be sufficiently flexible for practicability. At the present time, a forty-seven mile extension is being built to tap the waters of Mono Lake, thus making available enough

water to fill the aqueduct to its maximum mean capacity of approximately 300,000 acre feet per year. Two large reservoir dams and several smaller stream diversion dams are involved in this project.

Other communities met the problem in similar fashion. Though the canyons in the mountains are narrow and offer few good reservoir sites because of their steep profiles, dams were nevertheless built. The function of these structures, which are found in nearly all canyons of any importance, is twofold: first, to divert water for domestic use of the cities lying in the basin below; and second, to arrest the rapid progress of flood waters during and immediately following heavy rainstorms, allowing these waters to escape later, when they can be used. Check dams of this sort are becoming important, especially since many forest fires on the mountain slopes have increased the runoff speed.

The water supply problems of this region are by no means solved at the present time. Estimates for 1934 showed an actual overdraft on ground waters in the Los Angeles Basin amounting to nearly 166,000 acre feet per year. The larger cities of the district are meeting this situation by constructing an aqueduct from the Colorado River that will be capable of delivering over one million acre feet of water per year. Large dams are being built across the Colorado and San Gabriel rivers, the former to divert the water and the latter to form a storage reservoir. Six other dams and reservoirs are contemplated.

The agricultural districts, however, cannot afford to use such transported water for irrigation; hence they must look to more immediate sources. Studies of ground water conditions in the basin have revealed that overdraft is due to avoidable waste, rather than to lack of supply, since estimates show an excess of 400,000 acre feet over present demands. Conservation of waste waters is being carried out along several lines, the most important of which is the use of check dams in the control of floods. The flood waters are later released, as mentioned before, and spread over the gravels in the basin below, replenishing the ground water supply. Reclamation of sewage waters will eventually contribute some 100,000 acre feet of water annually, while the importance of rain falling in the basin proper is being recognized.

Similar conditions obtain in other areas of southwestern California, though a scattered population makes the situation less acute. Nevertheless, there is hardly a stream course that doesn't have at least one dam along its length, and all indications point to continued erection of more and more of these structures as the demand for water increases. Some 130 years have elapsed since the construction of that first dam across the Los Angeles River, a period during which but a single process (though with many variations) has been used to obtain water. This is simply the prevention of runoff from reaching the sea by diverting it for human uses, and as long as human uses continue to exist in southwestern California, dams and reservoirs must be an integral and essential factor.

## Some Problems of Egyptian Agriculture

W. O. Blanchard

*University of Illinois, Urbana, Illinois*

While Egypt is the "gift of the Nile," like many free offerings there have been certain "strings" attached. True, in its natural state the great silt burdened river with its regular rise and fall has been able to transform its narrow flood plain from a desert into a garden. But the oasis was *small* and it was productive *only* during the season of natural flooding so that the output of food became inadequate for a growing population.

Attempts to increase production have been repeatedly made, especially during the past century. They had two major aims (1) to extend the productive area, and (2) to increase the yield per acre. Dams and barrages, canals and dikes, were built to both increase the water supply, to raise the water onto higher land, and to equalize the seasonal flow.

In general, then, the problems today, as in the past, center about the balance of *land and water* on the one hand, and of *population*, on the other. Both these factors are susceptible of a considerable degree of control. However, thus far attention has been centered only upon increasing the food supply; little or no effort has been made to restrict the birth rate. The latter has, in fact, far outrun the means of subsistence. In the past 50 years it is estimated that the cultivable soil has been doubled, but the population has multiplied four-fold. As a result there are now crowded onto that narrow flood plain some 14,000,000 people, the vast majority of whom are illiterate, miserably poor, hopelessly in debt, almost naked and half starved. A cotton rag, a bowl of corn mush and a few dung cakes (for fuel)—constitute the sole reward for the daily toil of millions. One hesitates to say they are "making a living"; rather, they are "ekeing out a bare existence."

How closely the population presses upon the food supply may be appreciated by computing the size of the individual holdings. For many years, the average number of acres per landowner has decreased until it is now less than  $2\frac{1}{2}$ . But this average does not reveal the real situation. That is still worse. Forty per cent of all the cultivated land is in the hands of only one per cent of the proprietors. As a consequence over  $\frac{2}{3}$  of all of the land owners average less than one acre each! Some of the holdings are unbelievably small—less than 3 feet in width.

It is obvious, then, that of the various problems confronting Egyptian agriculture, none is more serious, none more pressing, than that of the education of the masses. While Egypt is the seat of one of the oldest civilizations, today, over 90 per cent of the peasants are illiterate. Their farming methods are essentially the same as in the days of the Pharaohs. Above all, this education should include an understanding of the necessity for birth control, of sanitation and of hygiene. Egypt has the highest death rate of any country for which we have statistics, but its birth rate is likewise one of the highest.

The second problem, or group of problems, has to do with increasing the quantity and the variety of agricultural crops. What may, reasonable be expected in this direction?

It is estimated that of the potentially productive area in 1935—some 7,100,000 acres—only 5,500,000 acres were actually cultivated. The difference includes:

- (1) 200,000 acres of waste in Upper Egypt now not used, to be irrigated.
- (2) 1,400,000 acres of brackish swampland on the Mediterranean border of the Delta, requiring both drainage (by pumping) and irrigation.

In addition, of the land already cultivated, some 1,200,000 acres produces but a single crop annually, because of a lack of water during the summer. This is to receive perennial or year-round irrigation.

All of the above proposals presuppose *more* water and in addition a *better regulation* of the supply. More dams and barrages, pumps for delta drainage, a second heightening of the Aswan Dam together with added canals are part of the program. Some of these projects will be in the Sudan (English) and others within the border of Ethiopia and will involve cooperative agreements with those governments.

One unusual problem is that of the Sudd—a vast swamp of floating vegetation. Each year this material lodges in the channel of the White Nile. Here the river current is checked, evaporation is extremely large and there is a vast amount of water transpired by the vegetation. As a consequence, of the water entering the Sudd, only about  $\frac{1}{2}$  passes on to be available for irrigation. The most feasible solution of the difficulty seems to be to cut a new channel around the swamp and direct the river through this artificial canal.

One of the disquieting features of the food supply situation is the trend, apparent for many years, toward decreased acre-yields. Year-round cropping which has accompanied the institution of perennial irrigation, the deposit of the fertile silt back of the dams instead of over the fields, the general use of the animal manures for fuel instead of for fertilizer—all of these have made the problem of maintenance of soil fertility a difficult one. Other possible reasons for declining yields are being studied and further experimenting will be necessary before making recommendations for correcting this trend.

One further difficulty of Egyptian agriculture must needs be mentioned here, the need for crop *diversification*. Few countries are so economically dependent upon the production and export of a single commodity as is Egypt upon cotton. It is the all important, almost the only, money crop. Four-fifths of the country's export by value is represented by this staple. Thus, with all of their "eggs in one basket", price fluctuations of cotton brings prosperity or ruin to millions. Legal restriction of the maximum area which may be devoted to cotton has been the corrective used thus far.

All in all, it seems that the most important factor in the Egyptian environment is the Egyptian *farmer*, himself. No amount of engineering to increase production will permanently improve the economic status of the native as long as the great mass of people persist in breeding up to the extreme margin of subsistence. Every such increase in food supply in the past has been promptly followed by an increase in the number of mouths to be fed. Neglecting to recognize the *human* factor in the equation has simply resulted in a vicious circle and no progress.

## Alaska-Yukon: Unique Adjustments, Yet Unsung

C. Clifton Aird

*Morton Junior College, Cicero, Illinois*

One likes to feel that he is a pioneer—that he is a discoverer. The Alaska-Yukon region today is one of the places where, in one summer one can see much that he has never heard of nor read about. One reads much of the midnight sun, the well developed airplane service, the intense cold, and the activities in this high-latitude land. But one does not read of the simple adjustments that have been made in this large sparsely populated region. One can read of the “largest number of airplanes per capita” but one does not read of such things as what happens to the five-gallon gasoline containers once they are emptied.

Since the airplanes serve all the region, gasoline must be cached at somewhat converging points along the elastic air lanes. It is in this manner that the containers get distributed throughout the land. They are rectangular—bright and shiny when new—always soft and easily smashed. They serve as water pails when the top is cut off, and a wire handle is added. If water must be carried far, a thin slab of wood floats as a cover to keep it from spilling. One sees these pails everywhere, in towns, villages and at lone cabins.

Other containers are cut apart and serve as shingles; some of the pieces are used as patches on boats; some serve to strengthen the skii that replace the summer's wheels on the airplanes that do not use pontoons; some strips are attached around the posts that support the cache. These stop small animals from getting into the winter's food. Basements of course, are practically unheard of in this land of frozen subsoil.

Other containers—with the top intact but with one side removed, become a dish-pan, a pan for cooking cereal for man or dog, or a pan that serves as a laundry tub. A home-made plunger with a stick and an empty condensed milk can complete the laundry equipment in this region of men—trappers, miners, wood-cutters.

Mention has been made of the frozen sub-soil. Only the upper 3-6 feet ever thaws. The frozen gold-bearing sands and gravels of old stream beds, must be thawed before they can be dredged. (The individual miner must be content to work the upper layers.) The thawing is done by forcing (through hose and pipe) cold water into the ground. It percolates and penetrates slowly—that which is beginning to thaw

this summer, will continue thawing the following winter, and will be the location of next summer's dredging. The cold of winter, then, cannot refreeze the thawing of one summer—or, the cold of one winter cannot re-freeze hard enough the freezing of many winters.

At Fairbanks, the bigger buildings (bank, federal building, the town or city hall, and school-house) are constructed of re-inforced concrete. The new buildings at the University of Alaska, some five miles out in the country from Fairbanks are also of concrete. There is no building stone near, and lumber is, of course, a fire hazard (especially in this town where the mains are kept empty until the alarm is sent in). The foundations for the Fairbanks buildings rest on or in the frozen depths. Small piles of brush are burned, the heat below thaws all the night, and the next day the partly frozen material is hacked out, until ever-frozen depths are reached. The four-story Federal Building is now four years old, and there are no cracks to indicate settling.

The smaller cabins which are typical of the region, seem about to disappear into the "mush". One has the feeling he is going into a hole or a den, for these rest on the surface or very shallow foundations. All buildings, whether cabin, school, hotel or trading post, have a hole or opening near the ceiling for ventilation. This vent may be round or square, may be closed with a rag or be slatted, may be purchased or be home made. The vent is necessitated by the need to allow the heated air which would normally gather near the ceiling to escape. If it did not escape, the roof would sweat, and the room would be damp, uncomfortable and unhealthy. With 67 degrees above inside, and that much (or more) below zero outside, much rime gathers outside the openings to festoon the building. Wood is the common fuel. Stoves are cast iron or made of the iron barrels that we associate with iron oil-barrels.

Another building adjustment (also related to the cold) is the well-like entry in all public buildings. The entry is a room a step or two lower than the main floor. On entering, one door is closed before the other is reached. Any cold admitted settles, or is caught in this "catch basin", and when the inner door is opened there is no (or little) draft.

Although the impression is gained that dog teams are unusual, there are many teams still used by Indian, Eskimo, trapper, freighter and, of course, the government has teams. The prospector rarely has a team, although he may have a dog or two for company and as pack animals. During the summer, the white man may find his team a nuisance. They must be kept tied, fed, and watered (a gasoline container cut in half supplies two water pans). If the owner wants to do some seasonal work with a dredge company, if he wants to go to the trading post on the river, if he wants to go "Outside", then he finds his winter's necessity a summer's nuisance. There are, however, individuals that make a business of boarding dogs for the summer. Their places are near some center such as at Fairbanks or at Dawson, or along the Yukon where

river transportation serves to connect a widely scattered population. Mention has been made that the government owns dogs. The Mounted Police of Yukon have no mounts, but use canoe, skii or snow-shoe, dog-team or airplane.

There are many other unique adjustments which the environment has influenced. There are the board-marked graves in a land lacking in stone. One cannot help but realize the scope that a gold rush reaches after reading from the markers the original home-land of the deceased. Paper flowers are plentiful, and they suggest the lack of flowers or the futility of placing them on the winter's grave. They do not suggest that the green-houses (now dilapidated) are filled with lettuce, radishes, cucumbers and tomatoes. There is the white beaded altar skin in the Episcopalian mission at Ft. Yukon. There is the soddy or *yertch* that is occupied by some young men attending the University of Alaska. There is the Experiment Farm there (University) which is crossing cattle with the musk-ox to develop a new high latitude dual purpose breed.

There are many adjustments not commented upon, many unobserved. At Sitka there is the new home for old men. One side faces the sea. It is for the sailor and fisherman. The other side faces the mountains. It is for the trapper and prospector. One looks in, the other looks out. There is, yet, much to be discovered.

## Some Aspects of Geography of the Foochow Basin

Lin Kwan-te

*Northwestern University, Evanston, Illinois*

**China, a densely populated country.**—China is large in area but small in usable land. This means uneven distribution of population. Fully 83 per cent of population lives on 17 per cent of the land.<sup>1</sup>

**The Foochow Basin, a unit in China.**—The Foochow Basin, one of these densely peopled units has an area of about 150 square miles with about 700,000 people. Foochow City, the Capital of the Fukien Province alone has 322,725 people while numerous surrounding villages make up the rest. Thus the basin has a density of about 4,000 persons per square mile.

All usable land is every where under cultivation including terraced slopes and land on the mountain tops, in order to furnish the necessary food supplies. The basin with a little more than one per cent of the area of Rhode Island, the most densely populated state, has an equal population. It has been estimated that about 60 per cent of the total population is directly dependent on the land. Each person in the basin then is entitled to own only .14 of an acre of land.

Because of the density of population horizontal expansion in the area is limited while vertical growth to the mountain tops and down along river banks has been going on for years.

**The character of the population and the life of the people in the Foochow Basin.**—There are at least four groups of people classified according to the topography and occupation. The first is the city group including those living in the walled city and in the suburb, south of the city. These people are connected mostly with business, commerce, government and the professions. In the walled city, "the bee hive," is found the greatest density of population.

The second group lives in villages scattered throughout the basin. These villages lie close together and are separated by very regular fields. Commonly all the people in each village are descendants of the same family. Among these rural communities both men and women work on farms and do other heavy work. These women are nicknamed "Field Women." They are recognized by three large and sword-like silver ornaments which they wear in the coil of the hair at the back of the neck.

<sup>1</sup>Independent Critic, No. 3, Peiping, page 9, 1932.

The third group is the "Boat Population" including thousands of people making their homes in tiny house boats moored along the banks of the Min River. Both men and women are skillful sailors. Modern means of communication have replaced to a large degree, their labor. The competition is keen. Their frantic efforts to get passengers to cross the river bring them to the attention of every new arrival in Foochow.

Besides handling local river traffic some of them make a living by fishing, and some engage in bringing cargoes back and forth between Foochow and interior towns. The Min River on account of rapids becomes less navigable toward its head. The native junks or sampans of various sizes carrying twenty to sixty tons of goods are dragged up the river by means of long bamboo poles and by hemp cables pulled by the members of the boat family.

The fourth group is a mountain population. Some people build their little scattered rural communities on surrounding mountain tops and valleys. Farmers have terraced all possible mountain slopes. The chief occupations are farming and the cutting of wood for fuel. Both men and women carry the products of their co-operative labor with poles on their shoulders to the densely populated community at the foot of their mountain.

Habits of thrift and industry have their roots in the geographic conditions and are of long tradition. Children, rich or poor, are taught to value even a grain of rice. "Do not waste nature's gift" is a family slogan. Meals are carefully planned to avoid possible waste. The average cost of living relative to American standards is low. The cost of food for each person is around two to four dollars per month.

The large family or clan system of living together is a reflection of geographic conditions. It has been practiced as a means of living more economically and with better mutual aid. In the family there may be only a few people who earn the living for the entire family of several generations under one roof. The spirit of sharing is considered a virtue.

**Geographic Setting.**—The geographic make-up of the Foochow Basin has profoundly affected the lives of its inhabitants as described above. The region is surrounded by very steep granitic mountains towering up to 3,000 feet forming a natural and most magnificent and unique basin. On account of ocean and mountain barriers the people formerly enjoyed perfect isolation. Geographic isolation and absence of conflict resulted in a spirit of conservatism.

A profound effect of Foochow's geographic setting is also found in its dialect. The basin has its own dialect, unintelligible to the people beyond the limits of the basin. But this linguistic handicap has been overcome in some degree by the enforced adoption of the national language (or Mandarin) in public meetings as well as in class rooms.

The Min River cuts through the basin approximately in an East-West direction. The periodic floods enrich the already fertile soil. For

many centuries the Min River served as the only means of communication between Foochow and the interior.

The climate is of the humid subtropical type. The mei-yu or moldy period together with fog occurs generally in March, April and May and has a very high humidity, so high that the moisture condenses on all cold objects. Human disposition is greatly affected by this unpleasant atmosphere.

**Economic make-up of the Foochow Basin.**—The tea trade forms the backbone of Foochow's economic make-up. In the most prosperous trade period tea represented 80 to 90 per cent of the total export. Tea and other trades together have suffered greatly on account of outside competition.

About 90 per cent of Foochow's exported commodities come from her hinterlands along the Min River valley. They include tea, timber, paper, bamboo and its products, and formerly camphor and tung oil and so forth. About 85 per cent of the imported goods are distributed in her hinterlands.<sup>2</sup>

Between the years 1871-1880 Foochow ranked third in the trade volume among seven leading trading centers in China. But between 1921-1929 Foochow was out of the list. The economic situation is becoming more critical. The trade situation has been very unstable.

**Future of the basin and some of its problems.**—Foochow is handicapped by mountainous topography which isolates her from favorable contact with the outside world. The Min River, the life line of communication, has a V-shaped valley with a narrow winding exit and is shallow in its upper river course. This limits the usefulness of the river.

Outlets of Foochow's commodities have rapidly been closed. Formosa, once Foochow's chief market, now exports into the Foochow Basin. England, once the chief tea customer, trades now with Ceylon and India. Smuggling of goods by Japanese into Foochow increases the seriousness of the situation.

The Chinese Government has laid a program for economic reconstruction. Many changes have been taking place which involve changes in the minds of many Chinese. There are forces pushing for modernization and there are forces retarding it. There is a constant conflict between the old and the new. Chinese are given a choice between modernization, and tradition and old heritage. They are given a choice between chopsticks and forks. All these changes will involve the changes of an entire philosophy of life.

Geography furnishes a skeleton, man must do the building. Better economic conditions mean greater buying power, world powers in turn share the benefits. This could only be attained by fair trade and better co-operation among nations.

---

<sup>2</sup> China Maritime Custom Report, Shanghai, 1861-1928.

## Santa Marta, the Banana Port of South American

Rose Zeller

*Eastern Illinois State Teachers College, Charleston, Illinois*

Santa Marta, located in the northwest part of South America, is about 700 miles north of the equator and 2100 miles due south from New York.

The small harbor, which looks like a large amphitheatre, has an opening one and one half miles wide. The slopes are covered with thorn tree and cacti instead of the palm trees, so typical of the tropics. It extends in a northeast southwest direction, and is sheltered on the north and northeast, from the prevailing Northeast Trades, by a long rocky spur of the San Lorenzo Range. These almost bare hills jut out abruptly from the land and end in two islands. A beacon is placed on the larger island, while a beacon and a lighted buoy on the inner spur guide the pilots when ships are in that part of the harbor. Two buoys direct their course farther south.

In the inner harbor under the northern headlands, where the minimum depth alongside is 27 feet, two docks are built parallel with the shore. Each dock accommodates one ship. The long wharves enable cargo to be taken from all holds at the same time. The only mechanical handling equipment which the port possesses are the electric conveyors used for loading bananas. Ships use their own tackle for other cargo which they discharge or receive here. Cargo is handled by ships' slings directly to or from the freight cars. The exports are, in order named, bananas, coffee, hides and skins and dividivi. There are not port facilities for storage or for bunkering.

Santa Marta is built on the alluvial plain of the Manzanares River. The city may be divided into four sections; the center being the oldest. The narrow streets faced with low buildings, all lead to the cathedral.

The important market occupies the center of the business district. The railroad which diagonally cuts across the little city puts one section north of it. In this treeless area, most of the laborers, who work on the docks, live. In El Prado, in the south, the United Fruit Company has built attractive bungalows for its employees. Here in direct contrast to the north, grow many flowering bushes and trees.

Seaward of El Prado are the tall masts of the Wire Tropical Radio Telegraph Company. This wireless station gives communication with important Colombian cities and the outside world.

South of Santa Marta is the banana region. This region blocked out by the Sierra Nevada de Santa Marta Mountains on the east and the delta lands of the Magdalena River on the west, furnishes an ideal situa-

tion for banana plantations. The mountains give protection, from the Northeast Trades, to a broad sloping alluvial plain, and the melting snows and frequent rains of the upper slopes supply the water needed for irrigation. High temperatures vary but little and the region ranks high in the hours of sunshine.

The Santa Marta Railway begins at the docks and ends about 58 miles to the south. A ride over this road takes one through the cacti and thornybush covered hills, across the wide savana pastures, past little clusters of adobe or sheet-iron huts set in clearings in the tropical-scrub forest and into the banana region.

About three-fifths of the banana area belong to private Colombian planters but the United Fruit Company, which owns the rest, buys the fruit from the private planters, transports it to the docks and ships it with their own.

The banana plantations seem cut from the same pattern. Each has its master drainage ditch and its many canals. The fertile friable soil is a sandy loam, containing 30 per cent clay and 70 per cent sand.

The root-stalks are set in rows, the plants cultivated and three allowed to grow from each stalk. At the end of twelve to fourteen months the plantation is producing and continues to pay for about six or seven years. Each plant bears a stem of fruit, which weighs on an average, fifty pounds.

Plantations are divided into sections and the fruit in each section is cut once and in some seasons twice each week. The cutting gang consists of the man who selects the stems, the cutter, and the backer. "Thin" bunches are selected for shipments to Europe; "fuller" bunches for New York and New Orleans.

After the bunch has been selected, the cutter, using a long sharp-pointed pole, breaks the trunk of the banana plant and it bends over. The backer then catches the stem on his shoulder, the cutter severs it from the plant with his machete and the backer carries it to a cart, waiting in the nearest grass-covered lane in the section.

These carts carry the stems to the loading platforms or directly to trains on the sidings. At various times during the day the cars are assembled and sent in long trains to Santa Marta.

After the incoming cargo has been discharged and the holds cooled the bananas are loaded. This requires about twelve hours. The cars are run in on the docks; the fruit is carried from the cars past inspectors and placed in the canvas pockets of the conveyors which move to the holds of the ship.

In the holds men remove the stems from the conveyors and arrange them in the different compartments; two layers of standing stems, one horizontal. Fresh air, kept at a temperature of 56 degrees, is circulated through the compartments. Temperatures are taken every six hours.

Each year the United Fruit Company brings thousands of stems from the banana plantations in Santa Marta to the United States.

## PAPERS IN GEOLOGY

---

### EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN

The program for the Geology Section included nineteen papers, all but three of which are here represented. Those three were as follows:

*Origin of Chert*, by Charles H. Behre, Northwestern University, Evanston.

*The Stratigraphy and Structure of the Mississippian System of the Quincy Region*, by George E. Ekblaw, Illinois State Geological Survey, Urbana.

*Subsurface Geology of the Quincy Region*, by L. E. Workman, Illinois State Geological Survey, Urbana.

The meeting was well attended.

Mr. L. E. Workman, Illinois State Geological Survey, Urbana, Illinois, was elected chairman of the section for the 1937 meeting.

(Signed) HAROLD R. WANLESS, *Chairman*



## The Classification of Illinois Coals Under the Operation of the Guffey Bill\*

G. H. Cady

*Illinois State Geological Survey, Urbana, Illinois*

The Bituminous Coal Conservation Act of 1935, better known as the Guffey Bill, designed to stabilize the industry, is symbolic of a change that is taking place in the minds of the citizenship toward our solid mineral fuels. This change is revealed in the recognition given in the body of the bill to the fact that differences existing among coals affect their absolute value. The effect of the bill is to establish a schedule of prices which will reflect the actual differences among coals, thereby eliminating from any market those coals which, if equitably priced, would necessitate a mine price below the cost of production. With the bill in operation there would theoretically be no choice among the coals offered for sale at any market. All would be fairly graded with respect to actual value. Thus the bill states: "minimum prices . . . shall reflect the relative market values at points of delivery in each common consuming market area of the various kinds, qualities, and sizes of coal produced in the various districts."

Following the terms of the law it became necessary for each district board to establish these equitable prices at points of delivery for each variety of coal produced within the several mining districts in the different states. Serious difficulties faced many of these boards because of the absence of reliable data in regard to the coals over which they had jurisdiction, to say nothing of the absence of any reliable classification.

The paragraph in the bill relating to coordination of prices and regulations states that all minimum prices "shall be just and equitable and not unduly prejudicial or preferential." This statement should probably be regarded as the usual legal redundancy in explanation of the phrase "shall reflect . . . relatively market value." However, undoubtedly those who would be adversely affected by price rulings in accordance with relative market values would appeal for special consideration on the ground that such rulings were "unjust and prejudicial" with respect to their product under the previously existing competitive price conditions.

Price conditions at the time when the Guffey bill went into operation had generally been determined by boards operating under the authority of the National Industrial Recovery Act popularly designated

---

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

NRA. These boards did little more than "freeze" existing prices previously built up through competitive practice and as determined by the judgment of the members of the board. It is said that factors such as the following actually determined prices but it is not known how their relative importance was evaluated:

- Commercial analysis
- Ash fusion temperature
- Appearance
- Physical structure and friability
- Marketability
- Degradation in transit
- Storage qualities
- Consumer preference
- Plant performance
- Effect on plant maintenance
- Market and price listing.

We see that each board found itself instructed, on the one hand, to fix prices so that they should reflect relative market values, and, on the other hand, to avoid action likely to be assailed as "prejudicial" to previously existing advantages. Obviously the law, if carried literally into full effect, would constitute a serious infringement on the competitive marketing of coal as the system has been built up.

The boards turned to their task with vigor. The establishing of an equitable price scale required some basis of classification. Many states have so little public information on the classification of coal that the only possible method of evaluation was that used by the NRA boards, a classification by "the best judgment and experience of persons who have spent years in producing and marketing coal," thereby tending to perpetuate the *status quo*.

In Illinois a somewhat unusual condition existed because shortly before the Guffey bill was put into effect and the Bituminous Coal Producer's Board for District 10 (Illinois) was established the State Geological Survey published a classification of Illinois coal by rank in accordance with the tentative standards of the American Society for Testing Materials issued in September 1934. The classification was based upon evidence that had been accumulating for more than twenty years and was so thoroughly authenticated by time and experience that the neglect of such data by the Board was a remote possibility.

In this State, therefore, as in no other, the price-fixing board found it possible to take very literally the admonition of the law to establish prices "to reflect relative market value" at least to the extent that such prices could be fixed by rank, ash, and sulfur values. The board used the data supplied by the Survey as a basis for evaluation of the coals in the various districts, employing county averages weighted with respect to production. The value used for comparison was the "as received" value based upon rank, and the average ash values with heat of sulfur

eliminated. So far as coals were mined and prepared in essentially the same way this would give values essentially equitable for all sizes.

No other factors were used in evaluation, such as agglutination, ash-softening temperature, weathering characteristics, etc., because of the impossibility of placing definite evaluation on such factors with respect to all types of combustion devices.

This basis of evaluation was undoubtedly rational in character and based upon well substantiated evidence for Illinois coals. However, it is realized that the heat value of a coal is not the only basis for selection if imperfect combustion devices are used. There were therefore cogent arguments advanced against the strict application of the evaluation based upon calorific properties. To meet this objection the Board devised a scheme of adjusting the values based upon the calorific index so that they would agree more nearly with the prices previously set by the NRA authorities. That is, in the case of most coals 60 to 80 per cent of the price was determined by differences in calorific value and 20 to 40 per cent by previously established prices plus 15 cents. Although such a scheme to a considerable extent vitiated the effect of classification in accordance with actual and measurable differences it is considerable satisfaction to know that the standard method of classification was recognized and given consideration in classifying Illinois coals.

How was this classification applied to determine the price of coal to the purchasers (dealer or consumer)? First it was necessary to establish a basic price for Illinois coal. This was done by a study of mine costs and resulted as fixing \$2.60 per ton for lump coal and \$1.50 for screening—an average of \$2.05.

These were the basic prices for southern Illinois coal since this coal was valued at 100 per cent. Therefore, \$2.60 (or \$1.50) plus average freight rate to a market area established the basic price for southern Illinois coals. From this value was then established the local price of coals from other producing districts on the basis of 60 per cent or 80 per cent scientific classification and 40 or 20 per cent NRA price + 15 cents. The freight rate to the particular mining district was then deducted, giving the mine price. By a system of averages standard differentials between districts were established such that in the large northwestern market area Belleville-Central Illinois coal would be priced at \$1.95 and northeastern Illinois coals at \$2.25 as compared with \$2.60 for southern Illinois screenings.

For local markets within the coal field, mine prices were made by applying scientific and NRA ratings + 15 cents directly to the basic price of \$2.60. Thus we have prices varying from \$2.60 to \$3.25. In some instances it is quite apparent "intangible factors" are more important than scientific classification in fixing mine prices.

For coal shipped to local consuming market compensation is made for difference in freight but definite minimum mine prices are established varying from \$2.30 to \$1.80.

After a satisfactory method of classifying Illinois coals had been accomplished, adjustment with other districts became necessary. Such adjustment has not been consummated. After numerous conferences, however, standards of classification for all coals were adopted, March 21, 1936 and the following rules were made:

In making classification of coals, all pertinent factors, including those set forth below, shall be given due consideration by the District Boards:

(1) Proximate analyses; namely, moisture, ash, volatile matter, fixed carbon and sulfur, B.t.u.'s and ash softening temperature, analysis of ash, and ultimate analysis of coal.

(2) Physical characteristics.

(3) Plant performance characteristics.

(4) Market history and sales experience.

Just what the members of District Board for District 10 will do in the way of conforming to this ruling is difficult to foretell. It can be safely stated that classification can be satisfactorily achieved using some of the items but is entirely impossible on the basis of others. It seems probable that the board will stand pat on the conclusions that have been obtained on the assumption that values are based on the only substantial data available.

Of considerable importance to coal geologists and other technicians interested in coal is the attention that the successful operation of the act will undoubtedly require in the field of scientific classification and empirical tests. Undoubtedly the technicians will devise more and more methods for measuring such characteristics of coal as have a definite application to use. Correlation of such empirical data in order to permit substantial generalizations will require more careful investigations of the immediate physical and chemical properties of coal whereby variations arising from differences in type and in rank may be more thoroughly understood. This act of Congress has given a tremendous impetus to coal geology that undoubtedly will be recognized in the schools and colleges as well as in technical laboratories.

## The Separation and Concentration of Vitrain, Clarain, and Fusain in Illinois Coal\*

C. C. Boley and L. C. McCabe

*Illinois State Geological Survey, Urbana, Illinois*

The ingredients composing the bands in Illinois coals are termed vitrain, clarain, fusain, and durain, each of which possesses distinctive physical and combustion characteristics. Variations in the relative proportions of these ingredients must therefore affect the usefulness of a coal for any given purpose. The Illinois State Geological Survey has undertaken a study of such variations. Summarized data relating to the screenings from one mine in Williamson county, operating in No. 6 coal, are presented herewith.

Before proceeding with an examination of the data, the nature and relative importance of the four ingredients might well be reviewed. The homogeneous, vitreous-appearing vitrain is characterized by low ash content and high as-received calorific value. When coked, it has great swelling power and yields a fragile, well-fused coke, evolving important amounts of by-products. Vitrain comprises about 46.0 per cent of the screenings investigated.

The non-homogeneous clarain is seen to be finely banded, with a bright silky lustre and blocky fracture. Due to its content of coalified remains from the more resistant parts of the coal-forming plants, its as-received ash content is higher than that of vitrain, and its calorific value is somewhat lower. Clarain is structurally stronger than vitrain, and hence tends to concentrate in the larger sizes. The data indicate 41.9 per cent present in the screening studied.

Coal commonly breaks along layers of the soft and friable fusain. Although this ingredient shows great variability in chemical composition, it has, in general, considerable ash and a high fuel ratio ( $\frac{FC}{VM}$ ).

The latter factor together with its naturally fine size recommends it for pulverized fuel firing. Thiessen<sup>1</sup> has found 200-mesh dust from an Illinois dedusting plant to be very rich in fusain, indicating a possible source of supply. The screenings examined in this work contain about 2.4 per cent fusain.

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

Durain has been definitely noted in only four Illinois mines, appearing as a narrow band. Although it closely resembles bone coal, it may have a low ash content (3.7 per cent in one instance), a high percentage of volatile matter, and a low specific gravity. It forms a weak sandy coke and its ash fusion temperature is relatively high<sup>2</sup>. However, its extreme hardness causes it to remain in the lump coal, so that it appears in insignificant proportions in the screenings.

Details of the method employed in making the microscopic counts have been described elsewhere by McCabe<sup>3</sup>.

Table I summarizes the results of the petrographic analyses in terms of standard coal sizes. A comparison of these data with a previous analysis<sup>4</sup> of a column cut from the coal face at this mine demonstrates that ordinary preparation processes appreciably affect the actual character of the coal. The relative toughness of the clarain causes it to be somewhat concentrated in the sizes larger than 1 $\frac{1}{4}$  inches, as is shown by the drop in percentage from the coal at the face to minus 1 $\frac{1}{4}$ -inch screenings; while the more brittle vitrain has been more than doubled in the finer coal. Fusain and refuse matter likewise increase in the screenings. A study of the three common screening sizes indicates the trends of the ingredients with reduction in size. It is seen that vitrain, fusain, and refuse tend to increase, while the clarain content drops markedly.

Since most of the refuse material appears in the heavier gravity fractions, cleaning of the various sizes of coal at, for example, 1.50 specific gravity may be expected to reduce the refuse considerably. Table II presents data on dedusted screenings from which all sink at 1.50 has been removed. The refuse contents are all greatly lowered; and the minimum figure is reached not in the largest size, as was true for uncleaned coal, but at  $\frac{3}{8}$  inch x 48-mesh. Here, then, is a coal having an identical refuse content as the original face sample, 2.0 per cent, but with over two and one-half times the percentage of vitrain, double that of the fusain, and only about one-half that of the clarain. It would seem that we have produced a coal of greatly changed composition, which might be expected to form less ash on the grates and more by-products in the coke ovens.

It is thus apparent that coal preparation processes not only produce different sizes, together with a reduction in ash content, but they give us truly different coals which are composed of different proportions of the ingredients and which undoubtedly possess different combustion, coking, and hydrogenation properties. It is the aim of the State Geological Survey to study these changes by accurately determining the variations in the concentration of the ingredients in a number of typical Illinois coals. Combustion tests to correlate with the data on composition will then be undertaken. It is highly probable that we may some day produce concentrates of the ingredients, blending them as need be to produce coal of optimum composition for any specific use.

TABLE I—SIZED SCREENINGS FROM COAL No. 6

	Vitrain	Clarain	Fusain	Refuse
	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>
Face sample <sup>4</sup> .....	20.1	76.5	1.4	2.0
1 $\frac{1}{4}$ inch x 0—Screenings.....	46.0	41.9	2.4	9.7
1 $\frac{1}{4}$ inch x $\frac{3}{4}$ inch—Chestnut.....	42.4	49.5	1.7	6.4
$\frac{3}{4}$ inch x $\frac{3}{8}$ inch—Pea.....	47.5	43.2	1.5	7.8
$\frac{3}{8}$ inch x 0—Carbon.....	47.4	36.5	3.3	12.8

TABLE II.—COAL No. 6 SCREENINGS DEDUSTED AND CLEANED AT 1.50 SPECIFIC GRAVITY

	Vitrain	Clarain	Fusain	Refuse
	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>
1 $\frac{1}{4}$ inch x 48 mesh—Screenings.....	48.7	46.5	2.3	2.5
1 $\frac{1}{4}$ inch x $\frac{3}{4}$ inch—Chestnut.....	44.0	51.0	1.7	3.3
$\frac{3}{4}$ inch x $\frac{3}{8}$ inch—Pea.....	50.7	45.6	1.5	2.2
$\frac{3}{8}$ inch x 48 mesh—Carbon.....	51.2	43.6	3.2	2.0

## REFERENCES

1. THIESSEN, G. (1936). "Fusain Content of Coal Dust from an Illinois Dedusting Plant," A.I.M.E. TP 664, 1936.
2. SIMPKIN (1926). "Note on the Composition of Durain," Jour. Soc. Chem. Ind. 45, 76T, 1926.
3. MCCABE, L. C. (1936). "Concentration of the Banded Ingredients of Illinois Coals by Screen Sizing and Washing," A.I.M.E. TP 684, 1936.
4. MCCABE, L. C., MITCHELL, D. R., and CADY, G. H. (1934). "Banded Ingredients of No. 6 Coal and Their Heating Values as Related to Washability Characteristics," Ill. State Geol. Surv. R. I. 34, p. 14, 1934.

## A Collecting Trip into the Jurassic of Southern Mexico in 1935

A. C. Noé

*University of Chicago  
Illinois State Geological Survey*

I had hoped for some time to collect in the Lower and Middle Jurassic beds of the Mixteca Alta in the state of Oaxaca, Mexico. G. R. Wieland had been there in 1909, and later published his *Flora liasica mexicana* (Instituto de Geologia de Mexico, Bull. 31, 1916). During a visit to the Institute in 1934 I had an opportunity to examine Wieland's types, and was impressed by the fact that these fossils could shed a new light upon the history of gymnosperms. I arranged for an exploration trip during September, 1935, after having attended the sessions of the Seventh American Scientific Congress held in Mexico City that year.

I had the good fortune of having Dr. F. K. G. Müllerried assigned as my travelling companion by the Director of the Instituto de Geologia, Ingenieur Manuel Santillán. Dr. Müllerried speaks Spanish like a native of Mexico, where he has been working in geology for seventeen years. We went by bus to Puebla and Tehuacan in the state of Puebla. From Tehuacan we went by Ford car to Huajuapam in the state of Oaxaca. The trip was continued on horseback, with one pack mule to carry specimens, and Indian guides, to the former property of the Oaxaca Coal and Iron Company on the Rio Consuelo. We slept with our guides in an abandoned mine house, collected coal specimens and plant fossils, and returned the same way we came. The trip was made more difficult by the rainy season, still much in evidence in September.

In the mountainous region of northwestern Oaxaca we find at the bottom Archeozoic sediments with much volcanic intrusion. Above the Archeozoic, or igneous rocks, is a rather well developed system of Jurassic layers in the following arrangement: Malm (Upper Jurassic); Dogger (Middle Jurassic); and Lias (Lower Jurassic).

The Lias and Dogger are mostly fresh water deposits with coal seams and plant fossils, while the Malm and the uppermost Dogger are of marine origin and contain invertebrates. Above the Jurassic are marine Cretaceous deposits and above the Cretaceous are Pleistocene and alluvial deposits. It goes without saying that southern Mexico had no glaciation in the Pleistocene.

The fossil plants and the coal seams were found throughout the Lias and Dogger. They consisted mostly of Cycadophytes, but also of Cordaites and Cycadofilicales. Formerly the two latter groups were considered to have been extinct at the end of the Permian or not later than in the Triassic. The fact that they were found in the Lower and Middle Jurassic invites further exploration in this interesting region.

## The Occurrence of Coal Balls in No. 6 Coal Bed at Nashville, Illinois<sup>1</sup>

G. H. Cady

*State Geological Survey, Urbana, Illinois*

Coal balls were found in the mine at Nashville about one year ago, April 9, 1935, by L. C. McCabe, C. G. Ball, and the writer, who were being taken through the mine by Mr. Samuel Day, mine manager and part owner of the mine. At a recent visit, April 17, 1936, by J. M. Schopf, Eugene Baysinger, and the writer two other pockets of coal balls were observed, both, however, much smaller than the one found in 1935, from which nearly 200 coal balls were recovered, after a considerable part of the accumulation had been cut down and discarded.

The Nashville mine is located at a central position in Washington County, Illinois, and is working Herrin (No. 6) coal at a depth of 407 feet. Including a basal "bone" coal layer the bed has the unusual thickness of about 9 feet. The thickness of the part mined above the bone coal is 5 1/6 to 6 feet.

The surface of the coal bed is even except for local depressions of relatively small area and an extensive channel-like depression along the east side of the mine which probably cuts entirely through the coal. There are a few places where the bed is broken for short distances by faults, none with a throw greater than about one-half the thickness of the bed. Except for the irregularity in the beds along the east side of the mine no definite alignment or arrangement of the depressions in the coal bed have been noted. These, of course, can only be observed in the face or ribs of rooms and entries but none seems to be traceable more than fifteen or twenty feet, and usually they do not extend this distance.

Three varieties of shale overlie the coal, each being in some places in direct contact with the coal bed. In addition there is to be seen over large areas of the mine the blanketing layer of the caprock, a limestone bed which at the shaft is reported as 10 feet in thickness. This limestone bed seems to be an unbroken, unjointed layer of limestone unaffected by the irregularities observed in the beds between it and the coal. The three varieties of shale are first, a gray shale, always when present immediately overlying the coal bed; second, a very argillaceous limestone or calcareous shale usually black to very dark gray in color but locally much purer limestone and of light gray color, which overlies either the coal or the gray shale into which it grades; and third, black

<sup>1</sup> Presented by permission of the Chief, State Geological Survey, Urbana.

sheety shale which always underlies the caprock, and may overlie the coal, the dark calcareous shale or limestone, or the gray shale. In general when the gray shale is present there is a transition upwards into the impure argillaceous limestone. The black slate is in abrupt contact with whatever strata underlie it but there is not uncommonly a thin streak of coal one-eighth to one-fourth inch in thickness at the bottom of this bed. This bed has a very uniform thickness of about 30 inches, the upper part being somewhat less carbonaceous and less indurated than the lower half. A few inches of rather soft shale lie immediately below the limestone. The base of the limestone, which is all that can be seen except in the shaft, is for the most part very even in its general appearance, but in detail this lower surface is a series of knobs and depressions several inches across and one or two inches deep. Here and there, however, the limestone extends downward in a knob-like protrusion several feet across at the top reaching almost to the top of the coal bed, thus they not uncommonly have a height of 20 to 30 inches.

From this description it is doubtless understood that there is involved in the stratigraphic succession a widespread coal bed, except where absent along a channel-like cut-out on the east side of the mine, a lenticular layer of gray shale which in general grades upward into a lenticular layer of argillaceous limestone or calcareous shale, a widespread bed of black sheety shale, and a massive limestone at the top.

The irregularities in the upper part of the bed are apparently all phenomena resulting from the lenticular character of the gray and calcareous shales. The lenses of such material in some instances thicken very gradually and widen the interval between the coal and the black slate. In other places they thicken very abruptly and very apparently represent deposition made in narrow depressions in the top of accumulated material. At such places there have been necessary adjustments in the coal and "slate" and in the arching and possibly faulting of the limestone because of the greater thickness of strata between the base of the coal bed and the base of the limestone where the shale lens is present. Such adjustments account for most of the structural irregularities in the mine.

The coal balls are found in the northern part of the mine where the immediate roof of the bed is the argillaceous lower limestone. At the locality where the largest accumulation was found the limestone was purer than usual and relatively massive, indicating an abundance of calcareous material present. They lie in the upper two or three feet of the bed and the adjacent coal is heavily impregnated with calcite facings.

## Preservation of Plant Material in Coal Balls From Nashville, Illinois\*

James M. Schopf

*Illinois State Geological Survey, Urbana, Illinois*

### ABSTRACT

Calcification of plant materials in No. 6 coal, Clarkson mine, at Nashville, Illinois, has assumed three rather characteristic modes of occurrence:

(1) Elongated wood "stringers" which must represent portions of sizable logs. The preservation is in general poor.

(2) Nodules, i. e. "coal balls" in the more technical and restricted sense. These contain heterogeneous plant materials frequently in an excellent state of preservation.

(3) Encrusted nodules, i. e. a nodular center surrounded by a coaly shell and a more or less completely calcified outer layer. This

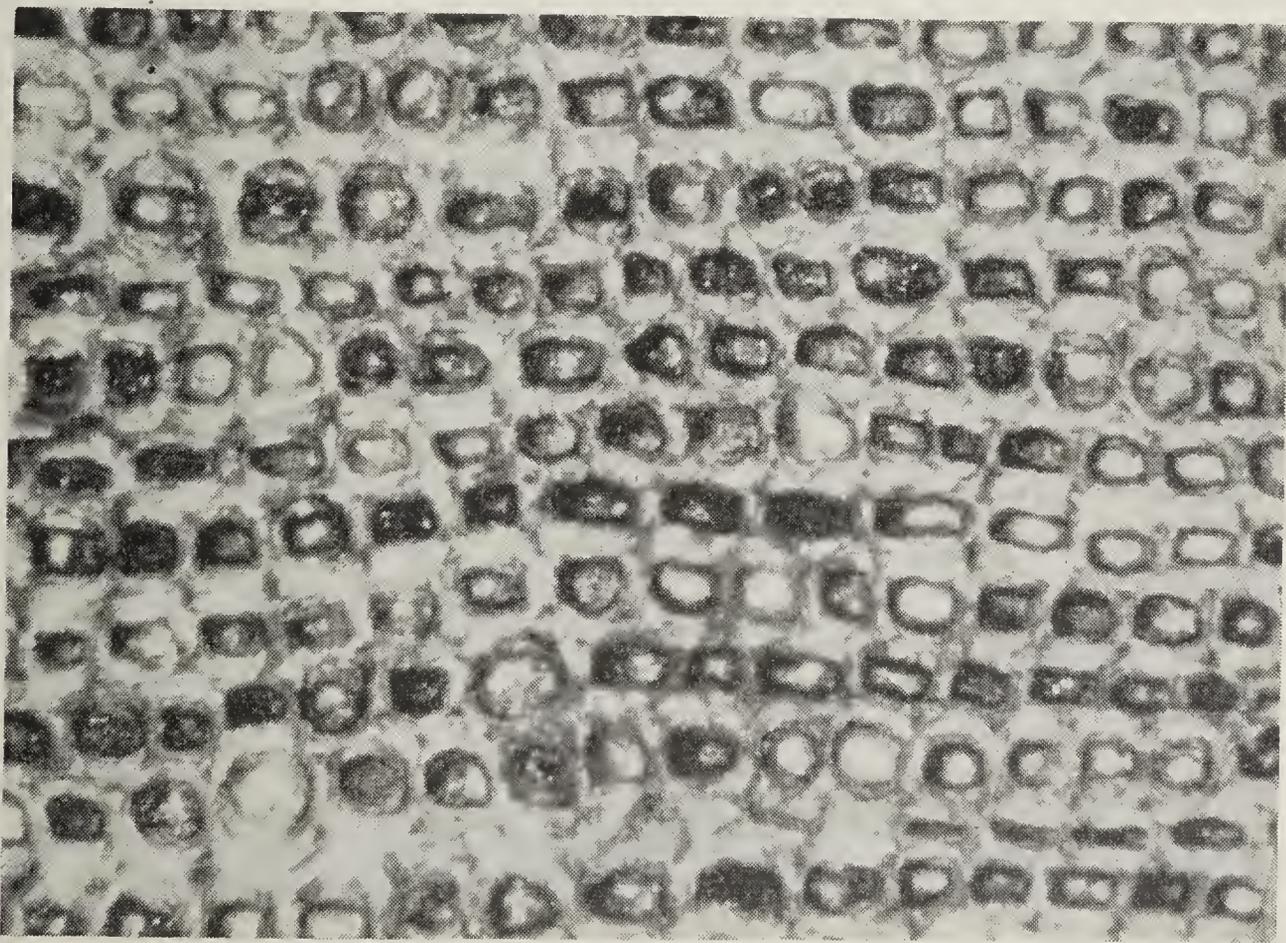


Fig. 1.—WOODY TISSUE FROM COAL BALL, CROSS-SECTION. Secondary cell walls prominent, lamellar portions nearly entirely replaced by calcite. Cells with dark lumens contain a filling of pyrite. Photographed by reflected light from an etched surface. Magnification 90 times.

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

arrangement suggests that the calcite was deposited at two successive times separated by an interval of coal compaction.

The introduction of calcite seems indirectly associated with a sporadic "middle" limestone occurring directly over the coal wherever it is present.

The less well preserved woody tissues are interesting since it often appears that a considerable proportion of the original substance is missing. In nearly all cases the lamellar region of the cell wall seems to be the portion most extremely attacked. The secondary walls of these wood cells are present, represented by a somewhat laminated brownish (humified?) residue, each cell being definitely isolated from its neighbors as shown in the accompanying photograph.

It has been definitely established that lignin is concentrated in the middle lamella region in wood cells of present day plants, the secondary cell walls being predominately cellulosic. If this relation holds for these paleozoic woods, then the lignin has been depleted with proportional increase of cellulose. The process of calcification may have some direct bearing on this condition. It seems possible that the plant tissues which adjoined the areas of petrification and were converted into coal may likewise have been depleted of their lignin content.

Some support may be found in these observations for the contention of various authors that coals are derived from materials rich in cellulose and poor in lignin. It seems to the writer however, that such a condition as observed in these calcified woods, would hardly apply to the entire bed of coal.

# Petrology of the Marine Sediments off the Mid-Atlantic Coast<sup>1</sup>

G. V. Cohee

*University of Illinois, Urbana, Illinois*

## AREA AND SAMPLES

The area included the continental shelf off the coast from Delaware Bay north to Marthas Vineyard. Seven hundred samples from all parts of this area were studied. Mechanical analysis, including pipetting when necessary, was carried through for 200 samples and heavy mineral studies included 60 of the analyzed samples.

## TYPES OF SEDIMENTS

The sediments of the continental shelf in this area are largely sand, but many zones of pebbles and silt are found scattered over all parts of the shelf. There are two principal zones which outline the distribution of the sediments in a general way. A southern zone from Delaware Bay to Block Island contains sediments composed almost entirely of sand with subordinate amounts of gravel but with almost as coarse sediment outside as near shore. The northern zone extending to Georges Bank has finer sediment on the outer portion of the shelf, but the inner portion shows the same patchy arrangement of coarse and fine sediment found farther south.

Histograms and medians show irregularities in grain size along and across the shelf and there is no general decrease in median size from the shore to the edge of the shelf.

## PETROGRAPHY OF THE SANDS

**Abundance of the minerals on the shelf.**—The most abundant mineral on the shelf is quartz. Off Long Island feldspar, which is next in abundance, comprises from 20 to 30 per cent of the light fraction, with quartz making up almost all of the remainder. The sediments off New Jersey contain only 10 to 20 per cent feldspar.

The heavy minerals vary from .01 to 8.0 per cent in the sands. The amount of heavy minerals is usually lower in the samples near shore than in samples farther out on the shelf. Heavy minerals are even found with the silt and clay on the continental slope and on the deep ocean bottom at the base of the slope.

<sup>1</sup>From a doctor's thesis completed under the direction and supervision of Dr. F. P. Shepard of the Department of Geology and Geography of the University of Illinois.

**Localized zones of heavy minerals.**—The distribution of the heavy minerals over the sea bottom is very general, but some minerals are found to be diagnostic of certain zones. Hornblende is most abundant on the east side of the Hudson submarine valley off New York, especially in the silt-sand zone. Biotite is also common in this same zone. Angular salmon colored garnets are numerous on the New Jersey shelf near the submarine valley of the Hudson. These angular grains, in contrast to the well rounded grains of most of the shelf in this area, suggest that they were possibly derived from the glacial debris carried out by the streams during lowered sea-level. The cover of the shelf contains well rounded, frosted, and pitted pink garnets, staurolite, titanite, and tourmaline. These mineral grains may have been derived from re-worked Coastal Plain sediments.

**Authigenic minerals.**—Glauconite was found in almost every sample examined, even off Long Island within three miles of the shore and in a depth of from 10 to 15 fathoms and at a little greater distance from shore but in the same depth of water off New Jersey. Since the glauconitic Cretaceous and lower Tertiary formations crop out along the shore north of Asbury Park, New Jersey, it is possible that much of the glauconite very near shore and for a short distance south may be derived from these formations.

Colony<sup>2</sup> states that no glauconite is present in the beach sands off Long Island. Its presence in the samples near shore and in shallow depths suggests conditions of non-deposition of sediment. Glauconite formation, according to Hadding<sup>3</sup>, is favored in agitated waters with limited deposition of detritus, particularly fine detritus, and under reducing or neutral conditions.

Galliher<sup>4</sup> concluded that glauconite is formed by the alteration of biotite and that very little, if any, biotite would be found where there is much glauconite and conversely where the biotite abounds there would be little or no glauconite. In accord with Galliher's conclusions little biotite was found in samples containing much glauconite.

Limonite is widely distributed over all parts of the sandy zone of the shelf off New Jersey and Long Island but occurs in no great abundance. Where the limonite pellets are found very little biotite is present. Alexander<sup>5</sup>, in a recent study of some continental shelf sediments, explains this condition by the oxidation of the biotite flakes to form the limonite pellets. A hardening of a gel-like hydrosol around the pellets gave the grains a varnish-like surface which probably resisted further chemical action.

<sup>2</sup> R. J. Colony, Source of Long Island and New Jersey Sands. *Jour. Sed. Petrol.* Vol. 2 (1932), p. 156.

<sup>3</sup> A. Hadding, Glauconite and Glauconitic Rocks Review by W. H. Twenhofel in *Jour. Sed. Petrol.* Vol. 2 (1932).

<sup>4</sup> E. W. Galliher, Geology of glauconite. *A.A.P.G.* Vol. 19 (1935), pp. 1569-1601.

<sup>5</sup> A. E. Alexander, A Petrographic and Petrologic Study of some Continental Sediments. *Jour. Sed. Petrol.* Vol. 4 (1934), pp. 12-22.

Pyrite is very abundant in the silt-sand zone east of the Hudson submarine canyon but is scarce off New Jersey and Long Island. However, small amounts have been found in samples within a short distance of both shores.

Calcium carbonate found in the sediments was in the form of shells and shell fragments. The shells exhibited weathered powdery surfaces suggesting solution rather than precipitation of the calcium carbonate.

Dr. Shepard and the writer believe that the wide distribution of authigenic minerals over all parts of the shelf indicates conditions without pronounced sedimentation whether these conditions be neutral or reducing. A period of oxidation during which limonite was formed may have preceded the present neutral or reducing condition. The most favorable conditions must have existed at a time when the shore line was nearer the limonite areas and the water was shallower.

#### ORIGIN OF THE SEDIMENTS ON THE SHELF

The characteristic flat, elongated pebbles and well rounded heavy and light mineral grains suggest reworked materials from the old Cretaceous and Tertiary formations of the Coastal Plain. This material was left upon the shelf during the period of sub-aerial erosion in Pleistocene time<sup>6</sup>.

South and east of Long Island for a short distance the sediment appears to be largely glacial debris of the outwash plain from the moraines of Long Island<sup>7</sup>.

The silt which forms a secondary maximum in the samples of the silt-sand zone southeast of Long Island was possibly eroded from the morainic material of Georges Bank<sup>8</sup> by strong currents sweeping southwestwardly, and deposited on this part of the shelf where the water was deeper and the currents slackened.

Occasionally angular pebbles are found on various parts of the shelf which may have been carried out and dropped by ice-rafting.

<sup>6</sup>F. P. Shepard, Submarine Valleys. Geog. Review, Vol. 23 (1933), p. 83.

<sup>7</sup>A. C. Veatch et. al: Underground water resources of Long Island, N. Y. U. S. G. S. Prof. Paper 44, p. 50.

<sup>8</sup>F. P. Shepard, J. M. Trefethen, G. V. Cohee, Origin of Georges Bank. Geol. Soc. Amer. Bull. Vol. 45 (1934) p. 291.

# The Contact Between the Glenwood and Platteville Formations\*

Stanley G. Elder

State Geological Survey and Northwestern University

**Introduction.**—Several phenomena at the contact of the Glenwood and Platteville formations have considerable significance. This contact is exposed along a line between Minneapolis, Minnesota, and Guttenberg, Iowa, along an arc through southwestern Wisconsin, and in the Oregon-Dixon area of Illinois. The Glenwood formation overlies the St. Peter sandstone and underlies the Platteville dolomite.

**Difference in lithology between the upper Glenwood and the lower Platteville formations.**—The Glenwood formation,<sup>1</sup> varying in thickness in exposures between 0 and 29 feet, is separated from the St. Peter sandstone by an erosional disconformity with a maximum relief of at least 45 feet. The St. Peter sandstone, therefore, was locally emergent throughout the deposition of the Glenwood formation and continuous into Platteville time.

The Glenwood formation is characterized by: (1) Diversity of rock types, grading from sandstone through shale to sandy dolomite, and (2) a peculiar texture of the sandstone.<sup>2</sup> A typical section of the formation in the vicinity of Oregon is as follows:

	<i>Thickness</i>
	<i>Feet</i>
(1) Soft green shale.....	5½
(2) Argillaceous sandstone.....	5½
(3) Very sandy dolomite and dolomitic sandstone...	12
(4) Argillaceous sandstone.....	6

The green shale formation of the upper Glenwood contains more or less sand, principally in the lower half but locally in the upper half.

The lower Platteville formation consists of buff to brownish-gray dolomite which locally contains argillaceous and sandy layers, some local beds having a sand content of 77 per cent. Sandstone pebbles and phosphatic nodules occur in the basal Platteville beds which are more or less fossiliferous with brachiopods, gastropods, and trilobites, whereas the green shale beds of the upper Glenwood formation are sparingly fossiliferous with *Lingula*.

The contrast in lithology indicates a contrast in environments during the deposition of the Glenwood shale and the Platteville dolomite. Shallow muddy waters prevailed during Glenwood deposition and more

---

\* Presented with permission of Dr. M. M. Leighton, Chief, State Geological Survey.

or less clear waters existed during the deposition of the Platteville dolomite.

**Rounded pebbles of sandstone in the basal Platteville dolomite.**—Locally in the vicinity of Oregon, more or less rounded pebbles of sandstone varying from 3 to 12 mm. in the longest dimensions occur near the base of the Platteville dolomite. The interstices of the aggregates are filled with dolomite similar to the enclosing rock. All the grains of sand are of the St. Peter type, well-rounded and frosted. These show that the St. Peter sandstone was emergent during the deposition of the lower Platteville.

**Phosphatic nodules in the basal Platteville dolomite.**—The phosphatic nodules occur in a zone 10 to 30 inches thick in the basal dolomite, sandy dolomite, and dolomitic sandstone of the Platteville formation. This zone has been traced over a wide area in the Upper Mississippi Valley. The matrix beds are more or less pyritic and fossiliferous. The nodules, varying in shape and size, are of three types: (1) Gastropod molds, (2) varicolored and more or less glossy nodules, and (3) phosphatized and pyritized aggregates of sand.

Pettijohn<sup>3</sup> observed phosphatic nodules associated with large limestone pebbles and "corrosion surfaces" in dolomite or limestone in the basal Platteville formation near Minneapolis. The phosphatic pebbles, which are partly fragments of gastropods and brachiopods, are largely black and contain many fine crystals of pyrite. He postulated that during a period of non-deposition, following a period of normal limestone deposition, phosphoric acid was formed by the solution of shells and other carbonates in the limestone, and that this reacted under anaerobic or reducing conditions with ammonia generated by decaying organic matter to form phosphates, the sulphides accounting for the black color. He concluded that since phosphatic pebbles are associated with a period of non-deposition, they indicate disconformities.

In contrast to these observations on the basal Platteville beds, the writer has observed no limestone pebbles or corrosion surfaces or any evidence to indicate that the deposition of limestone preceded the period of non-deposition. It is believed, therefore, that it is not necessary for the deposition of limestone or dolomite to have preceded the period of non-deposition in order to produce conditions favorable to the formation of phosphatic nodules. The very first deposits of Platteville age are without fossils and contain only a few phosphatic nodules. The most abundant nodules are often in a very fossiliferous bed. It is postulated (1) that phosphorus, ammonia, and hydrogen sulphide were derived from the solution and decay of organic matter rich in phosphorus in amounts proportional to the rate of destruction of life, and (2) that the phosphates were precipitated under reducing conditions<sup>4</sup> about nuclei of undissolved phosphatic material within or outside of shells.

According to Aberdeen,<sup>5</sup> who studied the phosphatic pebbles at the base of the Decorah, the formation of the phosphates followed a period

of non-deposition brought about by the development of a profile of equilibrium. She postulated that the phosphates resulted from certain chemical reactions caused by the decay of life destroyed by a change of environment. These conditions would be equally applicable to explain the phosphatic nodules in the basal Platteville dolomite. The diastem or unconformity thus indicated by the presence of phosphatic nodules in the basal Platteville dolomite is further confirmed by the lack of gradation from Glenwood to Platteville beds.

Phosphatic nodules and disconformities are found at the base of the Platteville, Decorah, Galena,<sup>6</sup> Maquoketa,<sup>7</sup> and Edgewood<sup>8</sup> formations. This occurrence is significant and indicates that stratigraphic breaks may be located by the occurrence of phosphatic nodules.

**Conclusions.**—(1) The Glenwood and Platteville formations are separated by a disconformity, shown by: (a) The difference in lithology; (b) rounded pebbles of sandstone in the basal Platteville dolomite; (c) phosphate nodules in the basal Platteville dolomite.

(2) An historical resume is as follows: (a) Final deposition of the upper shale of the Glenwood formation; (b) a period of non-deposition; (c) change of relations of land and sea; (d) deposition of dolomite, sands, clays, and pebbles accompanied by a partial destruction of life, the decay of animal matter, and the precipitation of phosphatic nodules and pyrite; (e) normal deposition of Platteville dolomite.

#### REFERENCES

1. CALVIN, SAMUEL, *Geology of Winneshiek County*: Iowa Geol. Survey, vol. 16, pp. 60-61; 74-76, 1906.
2. BEVAN, ARTHUR, *The Glenwood beds as a horizon marker at the base of the Platteville formation*: Rept. of Investigations No. 9, State Geol. Survey of Ill., 1926.
3. PETTIJOHN, F. J., *Intraformational phosphate pebbles of the Twin City Ordovician*: Jour. of Geol., vol. 34, pp. 361-373, 1926.
4. BLACKWELDER, ELIOT, *The geologic role of phosphorus*: Amer. Jour. Sci., 4th series, vol. 42, pp. 292-293, 1916.
5. ABERDEEN, ESTHER, *Location of the break between the Galena and the Platteville limestones*: Unpublished thesis, Northwestern Univ., pp. 40-47, 1931.
6. KAY, G. M., and ATWATER, G. I., *Basal relations of the Galena dolomite in the Upper Mississippi Valley lead and zinc district*: Amer. Jour. Sci., 5th series, vol. 29, pp. 98-111, 1935.
7. LADD, H. S., *Stratigraphy and paleontology of the Maquoketa shale of Iowa*: Iowa Geol. Survey, pt. 1, vol. 34, p. 348, 1929.
8. WELLER, STUART, *Geology of southern Calhoun County*: Year-book for 1906, State Geol. Survey of Ill., pp. 224-225, 1907.

## A Study of a Remarkable Meteor

A. J. James, M. D.

*Houston, Texas*

Twenty miles north of Peoria, the Illinois river is skirted on the east by a belt of timber about ten miles wide. In the midst of this forest, in the winter of 1875-76, there stood a large school house. A night session of a revival meeting was in progress with a crowded house. Although eight inches of snow covered the ground, a large, red hot stove made the house uncomfortably warm, the windows were open; time about 8:15 P. M.

The service is interrupted by cries "The house is on fire!" Looking through the windows it appears as light as day out of doors. The jam at the door delays the hurried exit. "Don't crowd, there is plenty time" the minister calls. Finally we are outside.

It seems really daylight, but everything is robed in a mantle of deep saffron. The crowd is gazing at an object in the heavens which appears to be nearly the size of the full moon. It is moving rather leisurely toward the east and is now very near the meridian. Its elevation from the southern horizon is between 50 and 60 degrees. The body shows a reddish-yellow disc with a distinct, circular limbus. No trail of light follows it.

We glue our eyes to the remarkable spectacle for a long while, maybe a full minute. It has now reached a point about half way between the meridian and the eastern horizon. There is an explosion, the body has divided into three large sections and a shower of sparks. The sparks quickly cease to emit light, and the large sections move forward at a considerable angle to each other. In a few seconds these sections explode again and the showers of sparks resulting cease to emit light quite a distance above the horizon.

The crowd has now gathered into groups listening to arguments, pro and con, as to the probability of this being the sign in the heavens which shall presage the end of the world. While many were talking excitedly, this absurd yet interesting comment was heard.

"I was sitting in a window and I saw the thing when it rose in the west, but I paid it no mind. I just thought it was the moon cutting up capers."

Finally the crowd reassembles in the house and the minister resumes his discourse. It is probably fifteen minutes since the meteoric display terminated. It begins to thunder, a soft deep toned rumble, but loud enough to make it difficult to hear the speaker. This continues for more

than a minute, and thus passes into history a meteoric visitation remarkable and awe inspiring in the extreme.

The newspapers reported observations of the meteor, but no account of its falling to the earth is remembered.

The above description is crude and, no doubt, inexact, but it is not imaginary, and it may serve, if considered with good judgment, as a basis for answering many intriguing questions in regard to the nature of this visitor to our planet.

Was the thunder caused by the flight through the atmosphere or by the explosions? If we grant that the thunder began fifteen minutes after the disappearance of the meteor, it must have been caused by the explosions. Sound travels about 180 miles in fifteen minutes and that is probably about the distance from us at the time of the explosions.

How high in the heavens was it when crossing the meridian?

It seemed to be moving leisurely—an indication of great distance. It had been in a state of incandescence and was therefore moving through the atmosphere for some minutes before reaching the meridian. The thickness of the atmosphere is variously estimated by different authorities. An encyclopedia published in 1925 estimates it from 300 to 500 miles. Other authorities estimate it 150 to 200 miles. It may be that the meteor was 200 miles from the earth when first seen in the west. It was constantly losing speed ahead and gaining acceleration of descent. After it crossed the meridian it traveled forward for something like 150 miles and exploded still quite high in the atmosphere. Probably an elevation of thirty miles and a distance of forty miles from the place of observation would be a fair estimate.

What dimensions may the meteor have had?

It was compared in size to the full moon. Even when hundreds of miles away in the western sky, it was mistaken for the moon by one spectator. The moon has an angular diameter of thirty minutes. A body at forty miles with an angular diameter of thirty minutes, must have a diameter of 1800 feet. Far beyond all reason. No doubt the glowing surface produced an exaggerated impression upon the retina. Still the body must have had considerable size. It produced a flood of light much greater than that of the full moon. It was incandescent for some time before the heat penetrated the core. A body forty feet in diameter at forty miles distance will have an angular diameter of four-tenths of a minute or about  $1/75$  of the angular diameter of the moon. A body of less diameter could hardly show a disc with a distinct limb to the naked eye.

What was the probable constitution of the meteor?

The brightness of the light which shone on the earth suggests incandescent calcium or magnesium or both. The deep saffron coloration was quite certainly caused by glowing sodium vapor. A meteor composed of the heavy metals, as most meteors are, would hardly have occasion to explode. This meteor evidently had an inexplusive shell sur-

rounding an explosive core. The fact that the fragments ceased to emit light quickly after the explosions, indicates that they were of very low density, probably of a marked vesicular character. What could have caused the explosions anyway? Most likely the meteor was of homogeneous composition, a distinctly vesicular mass whose vesicles originally contained an explosive gas. Through long existence in empty space, the vesicles of the outer portion had evaporated their explosive contents, but, on account of the magnitude of the body, the core had not completely dried out.

Pumice stone is a mineral which fits the demands of the case quite perfectly. What gas fills the vesicles of pumice during its formation? LeConte's geology, page 85, says "Pumice is a peculiar, vesicular, variety of feldspathic lava". On page 86 he says "The gases expelled by volcanoes are steam,  $H_2S$ ,  $SO_2$ ,  $HCl$ , and  $CO_2$ . By far the most abundant of these is steam". Another author states "99 per cent of the gases escaping from volcanoes is steam". The explosive character of steam needs no comment.

If we grant that the meteor was of volcanic origin, we may still wonder if it was of earthly or lunar origin. There is evidence of the inconceivable violence of volcanic forces on the moon as well as on the earth. A mass of low density like pumice would be seriously hampered in its escape from the earth by the atmosphere. A given force acting on a projectile would drive it six times as high on the moon as on the earth. At the apex of its ascension, on the moon, the feeble lunar gravity would be opposed by a perceptible earth pull, which might be the deciding factor favoring a separate existence.

Why did the meteor move so leisurely in the heavens in apparent defiance of gravity?

To enter into this most interesting problem fully would prolong this discussion beyond reasonable bounds. Let it suffice to briefly mention a few of the factors operating, and anyone so inclined may elaborate them to his own enjoyment.

(1) If we grant that it was a satellite, it had very recently passed its perigee, and at this time it and the earth were relatively moving in opposite directions. For a while, gravity was entirely expended in overcoming this divergence.

(2) As gravity pulled it into a curved path, it had considerable head-on velocity; therefore much of gravity was consumed in overcoming its tangential stress.

(3) The meteor was observed by the people at the school house for 5 minutes or longer. In that 5 minutes, the earth rotated eastward 83 miles, thus prolonging the view.

(4) The meteor was evidently a large mass of very low density. Its glowing surface produced a strong current of ascending air. The buoyant force of which retarded to some extent gravitational acceleration.

## The Economic Utilization of the Burlington Limestone in the Quincy Region\*

J. E. Lamar<sup>1</sup>

*Illinois State Geological Survey, Urbana, Illinois*

The Burlington limestone formation crops out at a great many places in western and southwestern Illinois. It is characteristically cherty so that chert-free beds more than a few feet thick are generally rare. Although the formation is also cherty in the Quincy region, it is distinguished by the presence of a chert-free stratum 20 to 30 feet thick. It is this stratum which is now of chief commercial importance.

The chert-free bed is usually a coarse grained, crystalline crinoidal stone or medium crystalline limestone and is characterically white or very light gray. Chemically it is of high purity. A calcium carbonate content of over 98 per cent is usual and analyses showing 99 per cent are recorded. Magnesium carbonate is usually less than 1½ per cent and iron oxide, alumina, and silica together less than 1½ per cent.

Due to its white color and high calcium carbonate content the non-cherty Burlington limestone is used for a wide variety of purposes. Worthen in his "Geological Survey of Illinois," dated 1870, reports at Quincy a flourishing lime business which used the chert-free stone as a raw material. At the present time as well, large amounts of limestone are burned annually for lime which is sold for building purposes, for agriculture, for use in various chemical processes, and for making paper. In the form of small chips or when finely ground, the limestone is used for poultry grit, paints, kalsomine, rubber filler, wall board, stock feeds and medicines, polishes, putty, pottery making, floor filler, etc. Important uses for the broken stone include concrete aggregate, road metal, rubble, rip-rap, blast furnace flux and agricultural limestone. The value of the total output of the limestone and lime industry at Quincy in 1934 amounted to \$200,000.

There are three open pit quarries producing crushed and broken stone in or near Quincy, three principal mines in the Mississippi bluff south of Quincy, and one mine along Mill Creek at Marblehead. At the four mines quarrying was conducted by open pit methods for some time but the overburden of loess and cherty limestone eventually became too heavy to be economically stripped. Subsurface mining was resorted to and is now employed by all three of the operators, although some

---

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

<sup>1</sup> Geologist and Head, Non-fuels Division, Illinois State Geological Survey.

stone is also produced from open pits. Room and pillar mining methods are employed and trucks are used to haul the stone from the mine to the lime kilns or crushing plants.

Aside from the major production of high calcium limestone from the chert-free bed of Burlington limestone, other parts of the formation provide the raw materials for a number of comparatively small quarries which have been operated in the county, many of them periodically, for the production of agricultural limestone, road metal and rubble.

A new development in the Quincy area is the manufacture at Marblehead of rock wool, an insulating material. The raw material used is a blend of dolomitic Burlington limestone obtained from strata lying above the non-cherty Burlington stratum previously mentioned, and a siltstone of Kinderhook age which lies below the non-cherty stratum.

The crystalline, chert-free Burlington limestone takes a high polish and yields an attractive commercial marble, of light gray or white color. Much of it is stylolitic. In places parts of this stratum and other strata as well are colored buff by iron oxide and give rise to an attractive light brown stone for exterior construction which also appears to have promise for interior use. As colored marbles, rather than white marble are in demand at present, the Illinois Geological Survey some years ago undertook a preliminary study of means of coloring Illinois building stones, particularly those for use as interior decorative marble. It was found that the white Burlington took dyes and stains very satisfactorily and it appears that possibilities for increased utilization of the stone may lie along these lines.

## The Glacial History of the Quincy, Illinois, Region

M. M. Leighton

*Illinois State Geological Survey, Urbana, Illinois*

Before the first ice-sheet invaded the Quincy region, the topography, drainage, and soils were quite different from those of today. The present valley of the Mississippi River was smaller and shallower and was not occupied by a master stream of the size of the present Mississippi. Most of the present tributaries of the Mississippi River in the Quincy region proper were not in evidence. The old valleys have been largely eradicated by the mantle of glacial drift and the present tributaries have chosen their courses with respect to the new surface, following the retreat of the ice-sheets. Limestone sinks probably dotted the upland surfaces where limestone was the surface bedrock. The soils of the region were those resulting from the weathering of the underlying bedrock formations. They consisted of two great groups: those which mantled the belt of limestone that extends from Quincy east nearly to Liberty, and those which mantled the "Coal Measures" formations from there on eastward.

The oncoming refrigeration of climate was world-wide in its effects. Great snowfields and ice-caps formed over the northern part of North America and northern Europe, and more and longer glaciers formed in the mountainous regions than exist now. Doubtless the same climatic factors operated in the southern hemisphere as in the northern hemisphere, but due to smaller land masses the glaciation of the southern hemisphere was much less pronounced. Four successive ice invasions occurred during the Glacial Period, separated by prolonged intervals of warm climate.

Three great centers of ice accumulation formed in Canada—one east of Hudson Bay, known as the Labradorian center, one west of Hudson Bay, known as the Keewatin center, and one in the Cordilleras of western Canada, known as the Cordilleran center. Only ice from the Keewatin center affected the present site of the city of Quincy, although a few miles to the eastward ice from the Labradorian center came to a halt in a later glacial age. The former is known as the Kansan ice invasion and the latter the Illinoian. Still older, or Nebraskan drift, is not definitely known to exist in the Quincy region but its presence is suspected. The Kansan ice radiated eastward well towards Peoria. The terminal moraine of the Illinoian drift trends in a northeast-southwest direction and approaches the eastern limits of the city.

At the time of the Kansan glaciation, there was probably a maximum amount of ice existing on the continents. It is estimated that in North America this amounted to 6,500,000 cubic miles, in Europe 1,700,-

000 cubic miles, Siberia 240,000 cubic miles, and other regions 1,700,000 cubic miles, or a total of 10,140,000 cubic miles. This water had been taken from the oceans and when the ice-sheets melted it was returned. The difference in ocean level between the maximum glaciation of the Kansan ice age and the warmer portion of the Yarmouth interglacial age was probably something like 300 feet. Streams were extended out onto the continental shelves during the ice age and the valleys which they cut were drowned during the following interglacial age. The drainage lines close to the ice-sheets were probably depositing streams, whereas farther downstream with the lowering of the ocean level they were erosive and cut their valleys deeper.

Due to the filling of the old valleys by the glacial drift, the subsequent streams became superimposed upon hidden bedrock divides and rock spurs in many places. As a result, the present valleys are narrow where they have become incised in the bedrock and are wide where they have been cut in glacial fill. Mill Creek, including South Fork, shows many narrows bordered by cliffs of bedrock and wider portions with gentle pastoral slopes.

The Yarmouth interglacial age of warmer climate which succeeded the Kansan glacial age is very definitely recorded by the old soil and weathered zones developed on the Kansan drift which passes eastward for many scores of miles beneath the Illinoian drift. The changes which took place were oxidation from a blue color to yellowish and brownish, the leaching of limestone pebbles and other calcareous constituents to a depth of several feet, decomposition of the silicates in the upper few feet to produce a gumbo substance or hardpan, known as gumbotil, and a soil at the top from which the finer clay constituents were eluviated downward into the gumbotil. The amount of such change is such as to imply the lapse of some two to three hundred thousand years.

Then came the effects of another climatic change, an ice-sheet, the Illinoian, which had its source in the Labradorian glacial center of eastern Canada. This ice-sheet radiated to a more southern limit than any other, reaching a point a few miles south of Carbondale, Illinois, its western limit in the Quincy area reaching almost to the eastern outskirts of Quincy. Limits of the glacial outwash made by the melt water from the ice field are found in protected recesses in the valleys that drained away from the ice. The ice-sheet remained for sufficient length of time for the forward moving ice to bring forward material in such quantities as to build a belt of terminal moraine, of high country, at and beneath the ice front which was held more or less stationary by the rate of melting equalling the forward advance of the ice.

Again, after several scores of thousands of years of glacial conditions, the climate ameliorated and ushered in the Sangamon interglacial epoch. This epoch was warm, like that of the Yarmouth, and a soil and weathered zone was produced on the Illinoian drift similar to that on the Kansan drift, but the alteration did not take place to such

a degree or to such a depth as on the Kansan drift. In other words, the Sangamon interglacial epoch was something like 150,000 years in duration as compared to two or three hundred thousand years for the Yarmouth.

At the close of the Sangamon interglacial age, dust storms resulted in a thin mantling of the uplands and slopes with a brownish silt of a few inches to a few feet in depth. Upon this silt, a soil was formed before the Wisconsin glacial age began.

With another change to glacial climate, the Wisconsin glacial age arrived. This region, however, did not suffer actual glaciation during this time for the Iowan glacial lobe in Iowa fell short of this area by some 80 or 90 miles and the Tazewell glacial lobe in Illinois reached only as far west as Peoria, some 120 miles to the northeast. However, there were, no doubt, changes affecting this region as a result of the refrigeration. Enormous floods came down the Mississippi, and thick loess deposits were blown from the Mississippi River flats onto the adjacent uplands, burying the old soil of the late Sangamon loess and giving rise to new soil-making materials. It should be borne in mind that the constituents of loess are the constituents of glacial flour which were deposited by the glacial waters of the Mississippi in river bars, and the barrenness of these bars and the great width of the Mississippi valley gave the westerly winds just the conditions needed for dust storms of great magnitude over a considerable period of time, far greater than the dust storms of the present. This mantle of loess was a fortunate gift of nature to this area for the deposits are open-textured and are highly fertile. The deposits are thickest along the east side of the Mississippi River valley, reaching thicknesses of 30 feet or more, and thin eastward. Because they were blown by the westerly winds, the west side of the Mississippi River valley in Missouri contains thinner deposits and their agricultural productivity is considerably less.

When the Wisconsin ice-sheet was melting away from the Great Lakes area, the west end of Lake Superior discharged southward through the St. Croix River down the Mississippi River in large volume. This was a time of high floods, which ceased only when the Wisconsin ice had melted back sufficiently far for Lake Superior to become connected with Lake Michigan and Lake Huron. The water level then fell to the level of the Chicago outlet and later to the level of the St. Clair River near Detroit and Niagara Falls.

Another flood stage came when the retreating Wisconsin ice blocked the drainage of the Lake Winnepeg region in Canada and gave rise to an enormous glacial lake, Lake Agassiz, which drained south through the Minnesota and Mississippi River valleys. These floods had strong erosive powers and they swept away much of the glacial valley trains that had previously been deposited in the Mississippi River valley during the earlier portion of the Wisconsin ice age. However, when the floods subsided and the Mississippi River assumed smaller proportions

like those of the present stream, there was some refill. Today the Mississippi valley at Quincy has a fill of nearly 135 feet of silt, sand, and gravel resting on its bedrock bottom.

With the climatic change from cold to warm, the Recent age was ushered in.

**The life of the glacial period.**—Our records of the life of the glacial period are very fragmentary. They consist mainly of those fossil remains which are found here and there in the glacial deposits. Like all of the fossil record, it can be but a minute representation of the entire flora and fauna that lived during the glacial period. A student of life history, working in the Quincy area, notes the profound changes which had taken place in the life of the earth from the time that the Mississippian limestones underlying the glacial drift were laid down to the time that the glacial deposits were formed. The highest types of life found in the Mississippian strata are fishes and amphibians. Between that time and the beginning of the glacial period nearly two hundred million years elapsed and there was a great evolution of life forms, including the reptiles and birds of the Mesozoic and the generalized and more specialized mammalian forms of the Cenozoic. The plant kingdom likewise was greatly changed. The tree-ferns and gymnosperms of the Mississippian and "Coal Measures" strata were augmented during the Mesozoic by the great angiosperm group of plants. The coming of these sweet-flowered and fruited forms, including the grasses, was probably responsible in large measure for the evolution of the great mammalian group.

When we come to the glacial deposits, we find that there are mastodons, mammoths, hairy rhinoceroses, bison, horses, sloths, glyptodents, saber-toothed tigers, deer, and many other forms roaming the continent in their respective prairie and forest habitats.

The late Dr. O. P. Hay of Carnegie Institute in Washington, has published a large volume listing and mapping the localities of the central region of North America where finds of these fossil forms have been made.

In Europe, the remains and crude artifacts of primitive man are found in strata of early glacial age. There we derive the most complete history of man. At the present time archeological researches in the great plains region and in the southwest are revealing evidences of probably late glacial man. Along the Mississippi River valley are mounds of prehistoric age in North America, but which are contemporary with historic man in Europe, Asia, and Africa. Finally, the Caucasian race arrived as a late comer to this continent and as we all know, his record is but a few hundreds of years in length. His arrival took place after all other forms of animal and plant life reached their present distribution and adjustment to the changes of the glacial period, and as a result of his coming all plant and animal life is being initiated into another period of rapid change.

In closing, it may be well to pause and orient ourselves with respect to geologic time. The paleontologist's time scale is given in the upper part of the illustration (Fig. 1) for the last two hundred million years of earth history. This dates back only to the Paleozoic era or the beginning of the Mesozoic era. You will note that the last one million years, during which man has lived upon the earth and which embraces the length of the glacial period, is but a minute fraction of this time.

PART OF  
THE PALEONTOLOGIST'S TIME-SCALE

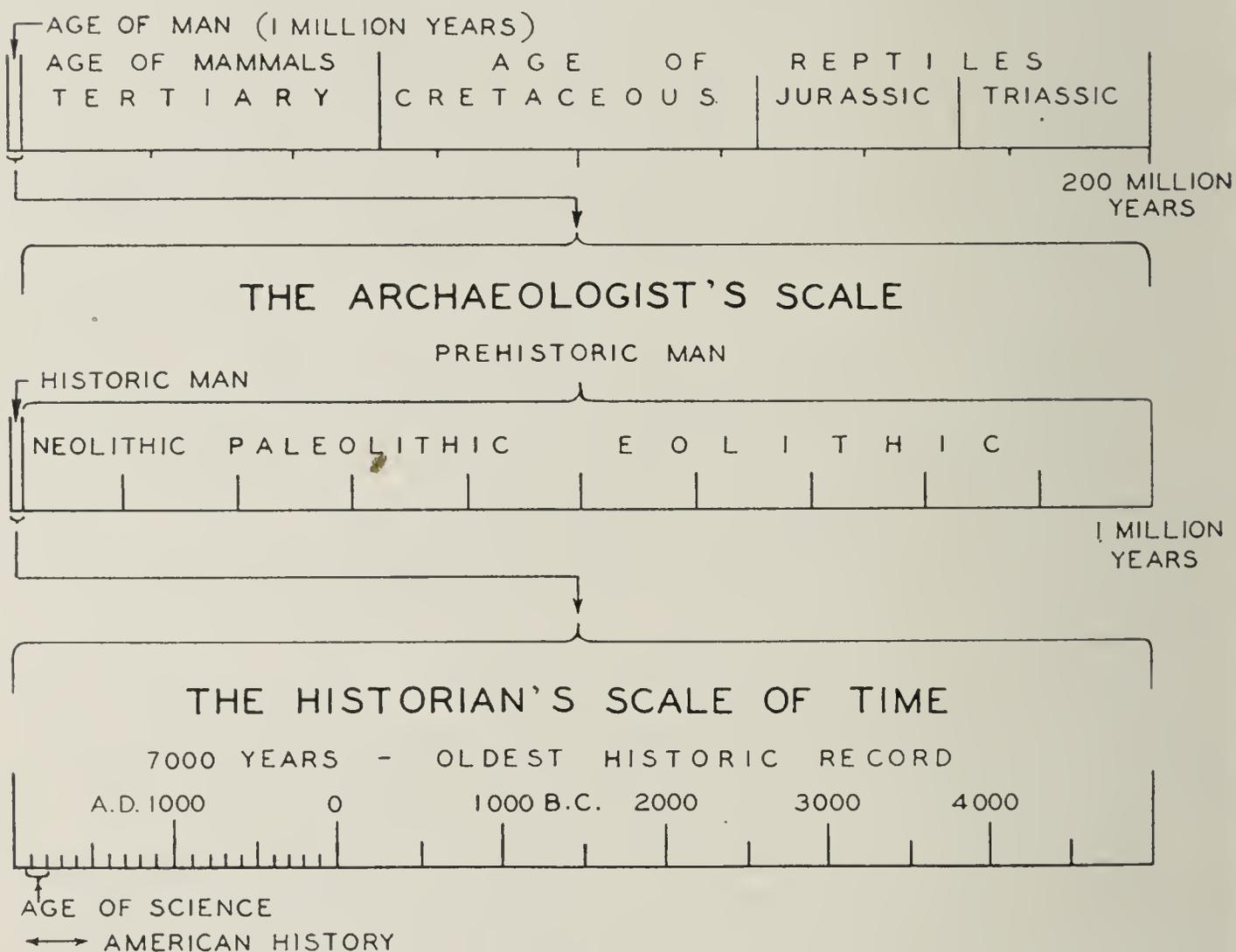


Fig. 1.—CHART SHOWING TIME SCALES. (By Dr. Carey Croneis, University of Chicago.)

The archeologist's scale is a magnification of this period of earth history to cover both prehistoric man and historic man. Prehistoric man extends over the entire period of the glacial age to about 5000 B.C. The close of the glacial period was about 25,000 years ago.

The time unit for historic man is enlarged to the historian's scale of time, where it is shown that American history comprises but a minute portion of historic time and the age of science an even smaller portion. Another approach to the question of time ratios may be made by considering all geologic time to be compressed into the Christian Era. Then the Great Ice Age would have begun one year ago, the Recent Period nine days ago, the Historical Period day before yesterday, and the settlement of the Quincy region about one hour ago.

## A New Means of Demonstrating Optic Figures

T. T. Quirke

*University of Illinois, Urbana, Illinois*

The recent introduction of a new polarizing substance of paper thickness known as *polaroid* has made possible certain demonstrations and experiments with the microscope not possible with the ordinary nicol prism.

If one places a basal section of a uni-axial crystal upon the stage of a microscope and places immediately above it a sheet of polaroid, he can project an optic figure, without the use of the microscope, onto a paper sheet or a ground glass held above the figure. By moving the ground glass, or even piece of paper, up and down above the thin section, one can easily demonstrate that the rays of light coming through the polarizer with the condensing lens in place are moving in a radiating direction so as to form a solid cone of light with rings of color, one within the other, and spaces of darkness which make the cross. If one places a cylinder of translucent material over the section one can obtain horizontal rings of color, again demonstrating the fact that the rays of light in the optic figure have a conical shape. An even more graphic illustration of this can be arranged by the use of a block of uranium glass which becomes luminous wherever a beam of light passes through it. These luminous beams unfortunately are very faint and good demonstrations are not possible except in a very dark room. With the use of uranium glass it is even possible to see that the light is divided into four separate beams by the black crosses. With bi-axial figures demonstration becomes even more striking. When a section cut normal to the acute bisectrix of the bi-axial mineral is placed on the stage with a plate of polaroid above it, transmitted light will throw a brilliant optic figure on a piece of ground glass held above the stage. A paper cylinder shows the emergence of the optic axes along the side of the cylinder, and a block of uranium glass shows the passage of light as a luminous cone without any suggestion of bands of darkness such as those which make the crosses in the uni-axial figures.

It occurred to the writer that with blocks of glass of known thickness it would be possible to make a calibration upon the ground glass surface in such a way as to enable one to read the optical angle of bi-axial minerals in a manner very similar to the method devised by Mallard. A little experimentation, however, shows that these axes can easily be projected onto a curved surface, and the writer devised a goniometer by which the optic angles in air could be read direct.

This device is made of two semicircles, preferably of celluloid, 5 cm. in radius which are attached to a base 10 cm. long and 2 cm. wide and with a hole 1 cm. in diameter in the middle. The semicircles are joined by a semi-translucent strip 2 cm. in width, which is a protractor numbered from zero at the zenith to  $90^\circ$  at each horizon. This is placed over a bi-axial section which gives a good optic figure, preferably in a position such that the acute bisectrix passes through the zenith. When the section is turned to the  $45^\circ$  position with the isogyres passing through the eyes, then the angle E can be read in both directions from zero in case the acute bisectrix is really vertical. Of course these two angles will be the same. In case the acute bisectrix is not vertical but not too eccentric, the sum of the two angles read from zero may be taken as being closely equivalent to  $2E$ .

The angle  $2E$  as measured on the goniometer scale may not be equal exactly to  $2E$ . It is assumed that the rays of light which pass through the center of the optic eyes are exactly parallel to the radii of the goniometer, but in certain cases they may not be quite parallel because the point of convergence of the condensing lens may be either slightly above or slightly below the base line of the semicircular goniometer. That error is minimized in the author's device by having it made with a radius of 5 cm., which is so large in proportion to the probable lack of coincidence between the point of condensation of the lens and the center of the protractor's circle that any difference is practically negligible. In any case it seems impossible that this difference could amount to more than  $1/10$  cm. in a vertical direction, which, with a radius of 5 cm. and small angles, would be entirely insignificant and only in the case of readings where  $2E$  is more than  $40^\circ$  could the error amount to more than  $1^\circ$ .

Another model of this same device is made with a radius of  $2\frac{1}{2}$  cm. This has the advantage of use on the stage of a microscope without withdrawing the barrel, but it has the disadvantage that the error discussed above becomes relatively much more serious, especially for minerals with high values for  $2E$ .

The use of the goniometer here described is made possible only by the invention of polaroid, because with the ordinary nicol prism it would be impossible to bring the base of the goniometer any where near the point of convergence of the condensing lens. Aside from the use of this simple goniometer, polaroid seems to the writer to be of great help in demonstrating the nature of optic figures as seen under a polarizing microscope.

# New Nepheline Syenites From Bigwood Township, Ontario\*

T. T. Quirke

*University of Illinois, Urbana, Illinois*

## INTRODUCTION

The author has collected from Bigwood Township, near French River, Sudbury District, Province of Ontario, specimens of syenite of types hitherto not named. In the Bigwood locality a suite of intrusive rocks ranges from quartz-bearing adamellite into nepheline-rich litchfieldite. The rocks of this suite are characterized by a general scarcity of dark constituents, by their content of soda-rich plagioclases and micropertthite, and by an approximate balance in the amounts of potash and plagioclase feldspars. Among this suite are certain fine grained, pink rocks low in ferro-magnesian constituents and low also in their content of nepheline. Some fall, according to Johannsen's classification, between families 14, 15 and 10 and 11. If they had a little quartz they could be called sodaclase syenites and monzonites, but the occasional small content of nepheline allies even those free of nepheline (and free of quartz) with the families 14 and 15 rather than with 10 and 11.

For rocks falling in family 1114, those richer in potash than in soda feldspars and characteristically low in ferro-magnesian constituents, the name *Bigwoodite* is proposed. For rocks falling in family 2115, those with more plagioclase than potash feldspars, the name *Rutterite* is proposed. These names might have been supplanted by *nepheline-sodaclase syenite*, and *nepheline sodaclase monzonite*, but confusion might easily arise with *sodaclase nepheline syenite*, which is *litchfieldite*, 2119, and the term *nepheline sodaclase monzonite* might refer equally well to rocks numbered 2114 and 2115.

## SYENITIC ROCK FACIES

The rocks described in this paper are found in the township of Bigwood, Sudbury District, Ontario, and in small parts of Delamere township and Parry Sound District adjoining. The major part of the bedrocks of this locality are well bedded, highly metamorphosed sediments of Huronian age. They enclose two large masses of apparently intrusive rocks. These masses are concordant with the foliation of the paragneisses and appear to be sill-like in shape. One of these masses is

\* Published with permission of the Director, Geological Survey of Canada.

sodaclase adamellite; the other is a composite mass of gray nepheline syenite and pink syenites, which are characterized by compositions corresponding to rocks in Johannsen's classification of Families 2115P., 2114P., 1115P., and 1114P.

A considerable quantity of the pink syenite must have enough dark constituents to fall in family 2114, for which Brögger has already provided the name *fenite*<sup>1</sup>. But a distinctive feature of *Bigwoodite* is its low ferromagnesian content which first called the writer's attention to it as a possible source of glass rock. Consequently a distinctive name for that variety seems desirable. By increase in nepheline content it grades into family 2118, *lakarpite*<sup>2</sup>, but the nepheline rich phases, although more striking, are probably not so widespread in outcrop as those with little or no nepheline. Similarly, the syenites in which the plagioclase content is greater than that of microperthite and potash feldspars grade from 2115, *rutterite*, with little or no nepheline into 2119, which is *litchfieldite*. There are leuco phases of *rutterite* and *litchfieldite* but they seem to be more rare than the leuco-rock called *bigwoodite*.

#### BIGWOODITE

Bigwoodite (1114) in the type locality lies in an elongated mass which appears to have replaced the country rock for a distance of about eight miles along, and about one mile across the strike. The rock is medium grained, composed essentially of microcline, albite, microperthite, and hornblende. The plagioclase varies in composition from approximately Ab<sub>90</sub> to Ab<sub>100</sub>. The microcline is irregularly intergrown with albite in microperthitic and less conventional textures. Hornblende is highly pleochroic and bright green, presumably high in soda. In many specimens aegirine-augite or biotite takes the place of the dark mineral. The dark minerals are arranged in places in bands or streaks which are discontinuous and even patchy in distribution. Potash feldspar in places is considerably in excess over albite and thereby causes the rock to go over into the family 2114. Calcite is a common accessory mineral, and in some facies of the rock constitutes an important proportion of the rock. Other phases, graphite-, corundum-, and nepheline-bearing might have been described but do not seem to the writer to require separate rock names. The association of this rock with nepheline bearing facies, its gradation into typical litchfieldite, allies it clearly with the nepheline rather than with the quartz bearing rocks. Otherwise, since it contains in typical facies neither quartz nor nepheline, its place would be on a line between 1115 and 1110.

#### RUTTERITE

*Rutterite* (2115) can be distinguished only with difficulty from *fenite* (2114) in the field, and is distinguished from *bigwoodite* and other members of the first class by its higher content of dark consti-

<sup>1</sup> and <sup>2</sup> These names provided by Prof. Johannsen's personal communication.

tments. It is characteristically an equigranular, medium grained, dark pink rock which grades into the blue gray nepheline syenite by loss of dark constituents and decrease in amount of the pink feldspar, microcline, and increase of gray albite. It grades also into the ruddy adamelite by increase in ferromagnesian minerals and addition of quartz. Different facies grade both into the quartz bearing rocks and into those with nepheline. It occupies a truly transitional position between the two groups.

It is composed essentially of feldspar with minor quantities of nepheline, quartz (epigenetic), biotite, graphite, magnetite, and amphibole. In places calcite is important. The feldspars are usually microperthite, microcline, and albite. In several specimens examined by Dr. R. H. Pegrum<sup>3</sup>, Dr. Chas. Milton<sup>4</sup>, and by the writer almost pure albite was noted.

The plagioclase varies in composition ordinarily between  $Ab_{90}$  and  $Ab_{100}$ .

### NEPHELINE SYENITES

Within the exposure of bigwoodite there are two areas of nepheline syenite. The northern one extends from the northwest corner of Con. 6, Lot 12, Bigwood township nearly three and one-half miles to the northeast corner of Con. 3, Lot 10. The maximum width of the mass at the surface is one-half mile in Con. 5, Lot 11. The total area is about one square mile. The southern mass extends from the northeast end of Con. 2, Lot 11, Bigwood township to the north shore of Pickerel River, a distance of nearly three miles. Its greatest width is nearly three-quarters of a mile, and the total area of the body at the surface is about one and one-half square miles. This rock is well exposed on both banks of French river for about one-half mile in Lot 10.

In general the nepheline syenite may be described as a gray, medium to coarse grained, gneissoid rock composed essentially of white feldspar, pink nepheline, and black biotite or amphibole with magnetite, zircon, calcite, cancrinite, and sodalite frequently present as accessories<sup>5</sup>. The gneissic structure, which is a marked feature of this rock, is shown by the parallel arrangement of the biotite and amphibole and the tendency of the minerals to segregate into bands. The latter is especially true of the northern mass. Jointing in the rock is not particularly noticeable but it was observed in both bodies, and its direction is parallel to the jointing in the surrounding country gneiss, that is, east and west. On the French River, joint faces in the syenite occasionally form scarp faces on the river shore.

<sup>3</sup> R. H. Pegrum, field associate of the writer during the seasons 1925-27 who wrote a doctor's dissertation (hitherto unpublished) upon this and similar syenites.

<sup>4</sup> Charles Milton, formerly a student at the University of Illinois, where he prepared an unpublished study of certain specimens collected by the writer in Bigwood township.

<sup>5</sup> Minerals from the new nepheline syenite area, French River, Ontario, T. L. Walker and A. L. Parsons. University of Toronto Studies. Geol. Ser. No. 22, 1926. p. 6-14.

The nepheline syenites everywhere show conformable relations with the bigwoodite, and the gradation between these rocks is perfect in regard to both minerals and texture. Within the nepheline syenites there frequently occur coarse grained, pegmatitic masses and veins which are usually parallel to the foliation but occasionally cut across it at a low angle. A few veins in the nepheline syenite on the French River definitely cut across the foliation and in some cases they are parallel to the joints.

Both these nepheline syenite bodies in Johannsen's rock classification are litchfieldites (2119) with local variations to leuco-litchfieldite (1119) and mela-litchfieldite (3119).

### ADAMELLITE

On the western side, the bigwoodite is in intimate intrusive contact with well bedded country gneisses, and on the east side with a slightly gneissose rock, a sodaclase adamellite (216"). The adamellite is altered with curious blotches of discoloration near the contact with the bigwoodite, and the bigwoodite, losing its characteristic composition by the addition of quartz, grades into syenite.

Perhaps the bigwoodite and nepheline syenites are connected genetically with the sodaclase adamellite, which in turn appears to be an offshoot of much larger masses known as the Dead Island sodaclase adamellites which lie chiefly to the south and west of the bigwoodite.

**Pink and white massive rocks.**—Near the bigwoodite there are also minor outcrops of feldspathic rock somewhat different from the bigwoodite. These rocks are nearly white where exposed. Near the northern line of lot 7, concession II, Bigwood township, about three-quarters of a mile west of the Canadian Pacific railway, white streaks lie within a dark, hornblendic gneiss which is the adamellite. The adamellite is coloured chiefly by the hornblende and its weathered products. Both the dark and white rocks are garnetiferous to about an equal degree, and seem to be distinguished from one another by the presence of hornblende in the dark rock, and by the gneissic texture characteristic of the dark rock and absent in the white streaks. These rocks are associated intimately with a fine, pink, alaskite-like gneiss in narrow layers and bands, which appears to be part of the bigwoodite. There appears in this place to be a gradation between the dark adamellite and the bigwoodite, both being garnetiferous, whereas the white streaks appear to be quite massive, containing unshered feldspar crystals, apparent to the unaided eye. Another white rock outcrops near the railroad about one mile south of Rutter station. It is somewhat coarse grained and massive in texture, apparently composed solely of white feldspar and garnet. Under the microscope (Thin section 108—1925), however, quartz is apparent as interstitial filling between the feldspars. The groundmass is flecked with scarce, very small, dark green flakes of biotite. The garnets are distinctly skeletal, and of two kinds, the more

abundant being brown and the rarer being pale pink. Cloudy areas of plagioclase are replaced partly by bright, fresh, clear areas of younger microcline.

Examination of the pink rock under the microscope, shows (Thin section 109—1925) great similarity to the white rock. It is composed of albite partly replaced by both microcline and quartz. Grains of zircon and apatite are scattered throughout the specimen examined, and magnetite appears in both small and large grains. Mineralogic analyses of these rocks follow:

#### ROSIWAL ANALYSES (by volumes)

	(1)	(2)
Quartz .....	26.5	27.4
Microcline .....	39.6	41.2
Albite .....	30.7	21.7
Garnet .....	2.1	4.2
Biotite .....	0.6	0.4
Magnetite .....	—	0.1
Zircon .....	trace	trace
Apatite .....	0.3	trace

(1) White layers of massive rock, near Rutter. Leucosodaclase-adamellite, Rock number 116".

(2) Pink layers of massive rock, near Rutter. Contact phase of bigwoodite (?). It might be called a sodaclase-alaskite, with Rock number 116'.

The foregoing analyses illustrate the close relation existing between the pink and the white rocks. The rather high content of quartz allies these rocks with the outer, or contact, phases of bigwoodite. The nearly massive texture of these alaskite-like rocks, their very high content of alkaline feldspars, and their sill- or dike-like shapes lead one to regard them as late arrivals in the episode of intrusion which produced the suite of rocks to which they belong.

#### MINERAL AND CHEMICAL CLASSIFICATION

This suite of rocks is marked first of all by its sodaclase characteristics. Some of the plagioclase feldspars examined under the microscope appeared to be almost pure albite. The rocks are usually low in ferromagnesian minerals. Such dark rocks as occur are in streaks or bands, local in development. Streakiness is quite characteristic. This streaky nature of the rocks makes accurate analysis or description of the rock types difficult, and makes areal mapping almost impossible. It is now uncertain whether 14 or 15 is the more prevalent of the two rock families. The sample listed as No. 4 in the chemical analyses was thought to be representative of family 2114, but upon analysis it was discovered to be 2115. It is certain that rocks of the family 14, in which potash feldspar is distinctly predominant over soda feldspar, are very prevalent in the rocks of Bigwood township. They vary from distinctly pale to dark colored types. The leucorock, bigwoodite (1114), is illustrated by the Rosiwal analyses as Nos. 1 and 2. These analyses are fairly representative of the very pale pink phase of the rock. Darker

phases, fenite (2114), are common, but very dark phases, shonkinite (3114), are rare and small in area.

These rocks show general excess of salic molecules over the femic; nevertheless, most of the adamellites and some of the nepheline bearing rocks fall in class II of the C. I. P. W. classification and in Class 2 of Johannsen's classification. Feldspars are extreme or dominant over both quartz and feldspathoids, consequently the rocks fall in orders 4, 5, and 6 of the C. I. P. W. classification and exclusively in order 1 of Johannsen's. In Johannsen's classification further separation depends first upon the presence of quartz or of feldspathoids, then upon the nature of the plagioclase, which is albitic ( $Ab_{90}$ — $Ab_{100}$ ) in all of these rocks, and upon the relative quantity of the potash and plagioclase feldspars. Many of these rocks fall in the sodalase adamellite family 6" — 7", but grade through sodalase monzonite into the definitely feldspathoid rocks, lakarpite and litchfieldite, with an unusual development of the transition rocks low in nepheline—bigwoodite, fenite, and rutterite. The chemical analyses show a definite gradation from sodalase adamellite to leuco-litchfieldite. The gradation goes from class 4 to class 6, rutterite and bigwoodite syenites both being in class 5. The peralkalic nature of the series is shown by the fact that all the analyses fall within or nearly within rank 1. The relative importance of soda and potash is reflected in the range of subrangs from the dopotassic in bigwoodite and fenite to the dosodic in the litchfieldites.

## ROSIWAL MINERALOGIC ANALYSES

	Johannsen's Rock Classification										
	1	2	3	4	5	6	7	8	9	10	11
Orthoclase.....	36.7	81.56	47.6	52.7	.....	.....	.....	.....	75.86	12.	3.24
Microcline.....	22.3	.....	.....	.....	47.1	44.6	42.	41.20	.....	45.	29.17
Microperthite.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.58
Albite.....	37.6	11.09	35.7	44.3	25.7	47.9	45.94	44.40	7.15	21.	40.34
Hornblende.....	3.1	.....	1.62	8.9	19.6	7.1	12.	14.22	.....	1.	.....
Biotite.....	.....	.....	6.23	1.9	.....	.....	.....	.....	.....	9.	2.28
Magnetite.....	.3	.....	1.88	trace	.....	trace	.....	.....	.....	1.	.....
Calcite.....	.....	.....	2.01	.....	.....	.....	.....	.....	.....	4.	.....
Apatite.....	.....	.....	.....	.....	.....	0.3	.02	.08	.....	.....	.73
Titanite.....	.....	.....	.....	.....	.....	.....	.04	.10	.....	.....	.....
Zircon.....	.....	.....	.....	.....	.....	0.1	.....	.....	.....	.....	.....
Nepheline.....	.....	7.35	4.32	.9	0.6	.....	.....	.....	12.95	7.	21.08
Cancrinite.....	.....	.....	.....	.....	.....	.....	.....	.....	2.47	.....	1.58
Epidote.....	.....	.....	.....	.....	.....	.....	.....	.....	1.57	.....	.....
Rock family.....	1114	1114	2114	2114	2114	2114	2115	2115	1118	2118	1119

1114, Bigwoodite.  
2114, Fenite.

2115, Rutterite.  
1118, Leuco-lakarpite.

2118, Lakarpite.  
1119, Leuco-litchfieldite.

## CHEMICAL ANALYSES

	1	2	3	4	5	6a	6b	6c
SiO <sub>2</sub> .....	64.79	59.51	59.58	62.01	55.90	69.35	71.36	66.75
Al <sub>2</sub> O <sub>3</sub> .....	19.	18.09	18.11	13.59	22.12	14.38	13.93	17.96
Fe <sub>2</sub> O <sub>3</sub> .....	.39	2.50	.84	6.68	.96	1.80	.97	.25
FeO.....	.46	1.79	2.50	1.96	4.33	3.13	2.30	1.04
CaO.....	.76	1.48	2.98	2.98	.44	1.32	.50	2.50
MgO.....	.54	1.67	3.51	1.18	.37	.13	.25	1.88
Na <sub>2</sub> O.....	4.76	4.97	3.76	5.17	8.35	4.05	3.84	4.16
K <sub>2</sub> O.....	9.30	8.28	8.76	5.17	6.42	5.60	5.43	5.60
H <sub>2</sub> O+.....		.50		.04	.57	.28	.48	
H <sub>2</sub> O-.....				.08		trace	none	.12
TiO <sub>2</sub> .....				.71	.05	.29	.37	.08
P <sub>2</sub> O <sub>5</sub> .....				.41		.04	.08	
MnO.....					.14	.02		
CO <sub>2</sub> .....		.89			.67	.05	trace	
S.....				.08		.25	.01	
BaO.....						.05	.02	
.....				less O/S .06		less O/S .19	.07	
Total.....	100.00	99.68	100.04	100.00	100.32	100.55	99.64	100.34
C. I. P. W. classifications	I, 5, 1, 2	II, 5, 1, 2	II, 5, 1-2, 2	II, 5, 1, 3	I, 6, 1, 4	I, 4, 1, 3	I, 4, 1, 3	I, 4, 1, 3

1. Bigwoodite (1114) computed from Rosiwal analysis No. 1. Bigwood township.
2. Fenite (2114) computed from Rosiwal analysis No. 3. Bigwood township.
3. Fenite (2114) computed from Rosiwal analysis No. 5. Bigwood township.
4. Rutterite (2115) analyzed by R. J. C. Fabry. Bigwood township.
5. Leuco-litchfieldite (1119) analyzed by H. C. Rickaby<sup>1</sup>. Bigwood township.
6. Sodaclase-adamellite (216"). Dead Island Mass.
  - 6a. Lump sample collected by T. T. Quirke, analyzed by R. J. C. Fabry.
  - 6b. Chip samples collected by F. F. Grout, analyzed by Grout.
  - 6c. Rosiwal analysis from part of lump sample 6a, analyzed and computed by Quirke. All these samples numbered 6a, b, and c come from the same location on the east side of Dead Island.

<sup>1</sup>H. C. Rickaby. University of Toronto Studies. Geol. Ser. No. 22, 1926.

## A Pleistocene Bog Deposit and Its Fossil Fauna

Elmer S. Riggs

*Field Museum of Natural History, Chicago, Illinois*

A fossil deposit near Minooka, Illinois, affords an example of animal-trap and bog preservation of remains combined in a way that presents features of unusual interest. The number and variety of mammals preserved in a small area is greater than has been observed elsewhere by this writer in bog deposits.

**History.**—In February, 1902, reports came to the Field Museum that bones of Mastodon had been found on a farm then owned by John Bamford, some three and one-half miles north of Minooka, in Kendall County, Illinois. The writer visited the place and found men working in a muddy pit eight by ten feet in size and at a depth of seven feet below the surface. Bones of bison, deer, and Mastodon had been encountered and much interest had been awakened in the neighborhood. The work was being done by the farmer with volunteer help from his neighbors. The pit was located in a slight natural depression of the ground including a small area of boggy land. Snow from the surface was melting and water flowing into the pit. A huge bucket, made from a half-barrel and attached to a rope and windlass, was being used to bail out the water. A young farmer, George Bedford, in hip boots appeared to be the natural leader of operations in the pit. This man, later known as Judge Bedford, of Morris, Illinois, became closely associated with development of this bone deposit.

The locality had, since the earliest settlement of the region, been the site of a spring which issued from the middle of this small area of boggy land. A wooden curbing had served to keep back the peat and formed a reservoir to hold and supply water as a stock-well. Planking laid over the boggy land offered a safe approach for men; fencing kept animals from entering upon the treacherous ground.

The farmer had, at a period of leisure in winter time, set about digging his stock well wider and deeper in order to have a reliable supply of water during the dry months of late summer and fall. At a depth of five feet the diggers had encountered a mass of smaller bones such as those of deer and bison. After passing through such a layer of some twenty inches in thickness, the workmen had encountered bones of Mastodon. This discovery had awakened interest which spread to the neighboring towns and attracted the press. A wide pit had been opened and many bones had been taken out. At this stage the Field Museum was notified and this writer visited the place.

Little attention had been paid to remains of the smaller animals. The bones, mostly of bison but some of deer, were scattered throughout the dump-heaps. The larger bones were being saved as carefully as unskilled men were able to do. A tusk had been uncovered to a length of some feet, a rope attached and men on the bank above eagerly hauling upon it had broken it at the middle. Not deterred by this needless destruction they had uncovered the remaining stump, again attached the rope and pulling sidewise had torn it from its socket in the skull. A fine specimen of adult Mastodon was thus broken up.

A careful count made by this writer, upon his arrival at the pit, disclosed teeth and jaws of six individuals of Mastodon. These animals ranged in size from young individuals with first dentition to adult males and females. Mr. Bamford was so impressed with the value of his discovery that no deal could be made with him to secure the specimens. He was willing to receive instructions as to how best to preserve the remains salvaged. The writer remained over night at the farm and left instructions that the tusks and jaws should be stowed in the farm cellar where they would dry out slowly.

For a period of years the larger bones, jaws and tusks were exhibited about the country and at County Fairs. When interest in them died out they were left in a barn—some of them fell to pieces in the farmyard. At this stage Mr. George Langford of Joliet, Illinois, a gentleman who had a taste for collecting natural history objects and a decided interest in fossils, salvaged the remains of the Bamford collection and conveyed it to his home. There he assembled some parts and repaired others so as to make sure of their further preservation. In the spring of 1918, Mr. Langford made known to the Field Museum that he was ready to part with the collection. Accordingly the writer went to the Langford home and packed up the entire lot. So after sixteen years the Bamford collection came to Field Museum and the best of it was placed on exhibition. Meanwhile the Bamford farm had passed to a new owner who looked with disfavor upon further excavation. The bog had been drained, the stock well done away with and the little basin converted into meadowland.

Through all the intervening years Judge George Bedford had retained his interest in the Bamford bone deposit and awaited opportunity to explore it further. He had become a staunch friend of Field Museum and had been a member of two field expeditions directed toward collecting fossil vertebrates. Accordingly, in the summer of 1929, Judge Bedford undertook to further explore the old bog-deposit and find out what remained of the specimens so hastily exploited twenty-seven years before. When this was accomplished, the residue was brought to Field Museum.

The bog proved to be of more limited extent than had been anticipated. In fact it was merely a product of the spring which, fed by ground-water from a gravel bed had broken through an overlying bed of boulder clay and had formed in it a basin of limited extent. Decayed

vegetation and wash from the surface, saturated with water from below had formed the mire. Masked by rank vegetation in summer and lightly frozen over in winter, this bog, with its tempting spring at center, had formed a trap which tempted animals to come into it to drink, and from time to time had ensnared numbers of them. Common humus acids developed by decaying vegetation had preserved the bones while the flesh was carried away in the usual processes of decay.

A cross-section of the spring had been constructed from data furnished by Judge Bedford.

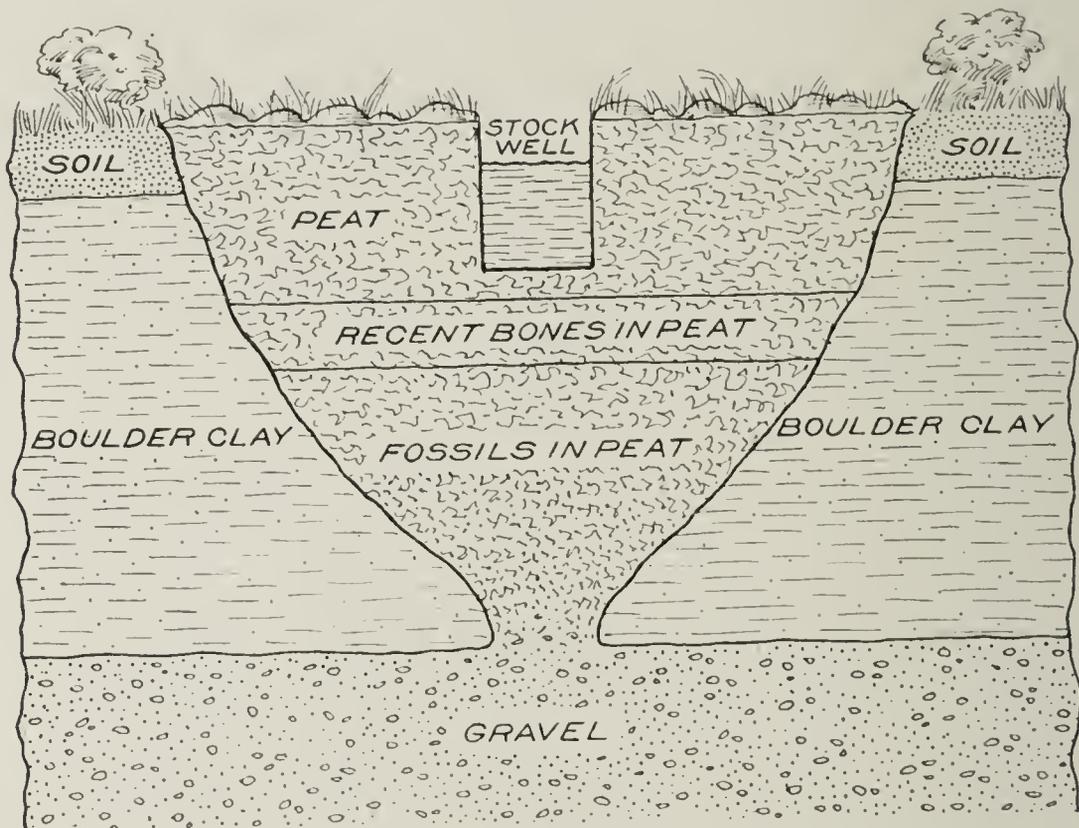


Fig. 1.—SECTION THROUGH PEAT BOG ON THE BAMFORD FARM NEAR MINOOKA, ILLINOIS, as explored in 1902 and in 1929, showing basin eroded by spring in boulder clay, and filled with peaty matter; stratum of water-bearing gravel and layers of recent and fossil bones. Width of basin at surface 20 feet; depth from surface to gravel stratum, 14 feet; width of opening into basin below, 3 feet; layer of recent bones, 20 inches; of fossil bones, 7 feet.

This section shows a depth of black soil some twenty inches, about twelve feet of firm impervious clay, apparently boulder clay, and below this water-bearing gravel of unknown thickness. The spring occupied a basin twenty feet in diameter and fourteen feet in depth, penetrating the soil and clay stratum as far as the gravel bed below. The lower opening was about three feet in diameter.

The source of the spring is at once evident. The stratum of glacial gravel carried water, confined by the impervious stratum of clay, and under pressure from some higher source it had broken through the clay stratum and found outlet at the surface. Gradually the outlet had been enlarged forming the basin above described. Surface wash, combined with plant and animal humus and saturated with water of the spring formed a peat-bog upon which wet-land plants grew abundantly. Ani-

mals venturing upon this treacherous surface to reach the tempting spring-water had broken through and, unable to extricate themselves, had perished in the bog. Hence the accumulation of bones preserved by the usual bog action—exclusion from air and antiseptic action of humus acids. The entire history of the spring and its accumulation of trapped animals is post-glacial, animals such as bison and deer are of species now living.

#### LIST OF ANIMALS DETERMINED

##### MASTODON AMERICANUM

Parts of nine individuals. One skull, two pairs lower jaws and various bones of two mature adults.

Two pairs humeri and femora of young adults, mandibles and maxillaries of five young individuals.

##### ELEPHAS COLUMBI

One mandible, tusk and other bones, apparently a female.

##### CELVALCES SPECIES

One craneum with half beams of antlers.

One entire beam of antler with part of palm.

One metacarpal bone.

##### ALCES SP.

One broken antler.

##### CERVUS SP.

One broken antler.

##### BISON BISON

Miscellaneous bones of many individuals.

From lack of care in preserving the smaller bones taken from the bog it is not known what number of bison and deer may have been found but not preserved.

The predominance of *Mastodon* in the lower levels of the bog, indicates that it was by far the more common large animal to visit this spring—at least the one most frequently trapped. The lone specimen of *Elephas columbi*, in relation to the number of Mastodons, indicate a rarity consistent with the known occurrence of this species in post-glacial time. The presence of *Cervalces* represented by three adult individuals, as compared with the single specimen of a young *Alces*, would seem to indicate that the former species was the more common moose in this locality in post-glacial time. The great mass of bones of *Bison bison*, reported by Bedford and seen by the writer scattered about the dump heap in 1902, indicates that this species was most commonly trapped at the Bamford spring. The fact that bones of this animal lay higher than those enumerated and within a few feet of the surface, would indicate that this species frequented the spring at a later period. The number of *Cervus sp.* which may have been intermingled with the bison bones, and with them destroyed, cannot be estimated. From the nature of the trap, animals smaller than the deer would not often be caught, no matter how numerous they may have been in this region.

## Volcanic Phenomena in the Craters of the Moon, Idaho

G. Frederick Shepherd

*Museum of Science and Industry, Chicago, Illinois*

This paper reports field observations made in the summer of 1935 in the Craters of the Moon area in Central Idaho, part of which is included in the National Monument of the same name. It is located at the north edge of the Snake River plain midway between the towns of Arco and Carey. A complete traverse across the desert to Minidoka and an airplane trip over a large portion of the lava fields furnished additional information reported here.

The surface features of this area are the results of the most recent volcanic activity of the Snake River lava plateau. As far as has been determined in other regions, where lava flows overlie till deposits, this activity took place in Pleistocene and Recent time and at three distinct periods of eruption, the last of which dates from 500 to 1000 years ago.

Many phases of volcanic activity are represented here. Most of the eruptions were of Hawaiian type, producing basic aa and pahoehoe flows in abundance. Numerous lava tubes are found in the latter flows. Cinder and spatter cones of Vesuvian type have been formed and there are indications that some of the eruptions may have been accompanied by *nuées ardentes* such as characterize eruptions of Mont Pelée altho its lavas are generally acidic.

The surface flows are extremely fresh and exposed in much the same condition as left on first cooling. A view from any elevation at once reveals the source and direction of flow of many of these lavas. Having this positive information as a check, I was interested in other criteria for determining the direction of flow, but found only one reliable criterion. No bent amygdule pipes were found such as have been described from the Keweenawan flows of northern Michigan. The bending of pahoehoe curls which form rough semi-circles with the convex side pointing in the direction of movement was the one type of index that could be used with at least local certainty.

One large irregular dike-like mass was observed at the edge of a flow where the lava had been forced from beneath the flow at a late stage in its eruption, oozing out between the edge of the flow and the older retaining wall beyond. It was traced for more than a half a mile and was from twenty to sixty feet high. The width could not be determined, but was at least thirty feet in places. Dikes of this character have been found along the crater rim of Mont Pelée and elsewhere.

The striking features of this region and the one furnishing the chief unsolved problem is the Great Rift and associated phenomena. As already mentioned, there have been three distinct periods of eruption

and the forces responsible for the Rift Zone were active thru all of them. The most obvious manifestation of this force is the alignment of the vents in a northwest-southeast direction forming a belt nearly three miles wide clearly shown on the topographic map of the Craters of the Moon, N. M.

If this line is projected north of the plain into the White Knob mountains a group of volcanoes known as the Lava Creek Vents is found at a distance of less than five miles. Not only is the group in line with the Rift Zone, but the vents themselves are similarly oriented. Their age is comparable to those on the plain and the Lava Creek Vents are several thousand feet higher in elevation.

This complete alignment of the cones in the Craters of the Moon led early investigators to call this an illustrious example of a fissure eruption and the National Monument was set aside as such. Of the true Icelandic type of fissure eruption, however, there was almost no evidence found in this entire region. Two questionable areas may be referred to other processes. The lavas have not been extruded along a great fissure, spreading out in large lake-like sheets, but have come from individual, widely separated vents.

The second feature of the Rift Zone is the parallelism of the numerous open fissures, predominantly oriented in the direction of the cones. These fissures are open fractures in the flows and cinder cones and are not sources of lava flows. The cracks range from a few feet to over a quarter of a mile in length, a few inches to over fifty feet in width, and some have a depth of nearly a hundred feet. No vertical or horizontal displacements could be found or other indications of faulting.

Exceptions to the linear arrangement of the rifts are found, usually at a considerable distance from the Rift Zone where there is a definite lack of orientation. In the Rift Zone itself there are a few areas where the fissures have been formed at an angle of  $60^\circ$  from the average trend.

The problem raised by these phenomena is to explain the force or forces which could determine the orientation of the vents and produce these fractures of similar alignment. The fissures are all tensional in character and have narrow U cross-sections. It is not impossible that the cinder cones were formed along similar rifts beneath the present surface flows, but this does not explain the open fractures in the latest of the lava flows. Also, if this were the case, one would expect to find feeder dikes along the Snake River canyon, but none have been reported. It does not seem probable, therefore, that the fissures determined the position of the vents, but that the rifts were produced by forces accompanying or associated with the eruptions.

Whatever may be the explanation, the force was tectonic and was undoubtedly connected with the major diastrophic disturbances of central Idaho. A regional investigation of the problem may throw some light on it considering the tectonic history of this region and the extrusion of the Snake and Columbia river lavas from every standpoint.

## Progress in Geologic Mapping of Illinois, 1839-1936\*

J. Marvin Weller

*Illinois State Geological Survey, Urbana, Illinois*

It is interesting historically that the first discovery of coal in North America was made in Illinois by Father Hennepin in the latter part of the seventeenth century. This can hardly be considered the beginning of geology in our State, however, because geological science did not make its appearance until another two hundred years had passed.

In the early part of the nineteenth century several exploring expeditions, mostly organized by various agencies of the Federal Government, passed through Illinois. Some of these parties included naturalists and more or less unrelated geological observations were included in the published reports of their findings. The first systematic study of the geology of any part of Illinois, however, was undertaken by David Dale Owen in 1839 for the Federal Land Office. His first report on the lead region centering around Galena, Illinois, and including adjacent parts of Wisconsin and Iowa was published in 1844. Included in this report was a map showing the extent of the Illinois Coal Field which was the first map showing with any accuracy any of the major geological features of the State.

In 1851 the first Geological Survey of Illinois was organized with Dr. J. G. Norwood as State Geologist. His studies covered the entire State and in 1858 he published a colored geological map on a scale of 50 miles to one inch. This map shows with a fair degree of accuracy the distribution of Silurian (including Ordovician = Lower Silurian), Devonian, Mountain Limestone (Middle Mississippian), Millstone Grit (Upper Mississippian or Chester), "Coal Measures" (Pennsylvanian), and Tertiary (including Cretaceous) rocks and was a very creditable piece of work for that time.

Norwood was succeeded by A. H. Worthen in 1858 and field work was continued until 1872. In 1875 Worthen published a geological map of the State on a scale of about 6 miles to one inch. The geological divisions recognized differed from Norwood's in that the St. Peter sandstone and Lower Magnesian limestone, Trenton Group (Galena-Platteville), Cincinnati Group (Maquoketa shale) and Upper Silurian-Niagara Group (Silurian) are differentiated, the Lower Carboniferous (Mississippian) is not subdivided and the "Coal Measures" (Pennsylvanian) is shown in two divisions.

---

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

The present Illinois State Geological Survey was organized in 1905 and in 1906 a new geological map prepared by Professor Stuart Weller on a scale of 12 miles to one inch was published. This was quite similar to Worthen's map of 1875. A few errors in Worthen's map were in some measure corrected but in some respects this map was less accurate than the preceding one. This map was revised and republished in 1907. It differed from the map of 1906 principally by the addition of important alluvial areas and the abandonment of a two-fold division of the Pennsylvanian. Corrections resulting from field studies were made in parts of Calhoun and Jersey counties and to a lesser extent in the vicinity of Rock Island.

A new geological map on a scale of 8 miles to one inch was prepared and published by the Survey in 1912. Changes were of minor importance except for the revisions of the Silurian and various Ordovician boundaries in the northwest corner of the State, the differentiation and separate mapping of the Upper Mississippian (Chester), the more accurate delineation of the Mississippian and Pennsylvanian boundary in southwestern Illinois, and the inclusion of additional alluvial areas along the principal streams in the southern part of the State.

The most recent geological map appeared in 1917. It is principally distinguished from the last by revision of the Silurian and Ordovician boundaries in northeastern Illinois and the much more accurate representation of the distribution of Chester beds in southern Illinois which resulted from the extended field investigations of Professor Weller.

After nearly twenty years a new geological map of Illinois is now in preparation. Since 1917 an extensive program of field investigations has covered nearly the whole State which has involved the detailed mapping of many quadrangles and reconnaissance work elsewhere. According to present plans alluvial deposits of Recent and Pleistocene age will be indicated consistently throughout the State, Tertiary and Cretaceous beds in southern Illinois will be separated, the Pennsylvanian system will be subdivided into six or more parts, five divisions of the Mississippian will be distinguished and Lower, Middle and Upper Devonian will be shown. As on the last map the Silurian will be undivided and three units of the Ordovician will be recognized. Finally the small area of Cambrian outcrop now known to occur near Oregon will be distinguished.



## PAPERS IN MEDICINE AND PUBLIC HEALTH

---

### EXTRACT FROM THE REPORT OF THE SECRETARY

No program was planned for this section for the 1936 meeting. For this reason the following paper was presented before the Zoology Section.

The chairman for the 1937 meeting is to be appointed by the Council.

(Signed) W. M. LUCE, *Secretary*



## Recent Research in Vibro-Tactile Sensitivity

Louis D. Goodfellow

*Lecturer in Psychology, Northwestern University, and Associate Director of Research, American Institute for the Deaf-Blind*

By the word, vibro-tactile, I refer to the organs involved in sensations that accompany the application of mechanical vibrations to the skin. The exact nature of this form of sensitivity is still in question, but we have evidence that both superficial and deep sensitivity are involved. Hence our term, vibro-tactile.

Professor Gault and his associates at Northwestern University have been interested in this form of sensitivity during more than a decade. By way of introduction, let me mention the reason for this great interest in the vibro-tactile field. It is a very practical one, namely, the enlargement of the uses of the vibro-tactile senses in relation to the education of the deaf. For those deafened individuals (and there are many of them) who do not have sufficient residual hearing to be helped by an earphone, some other approach must be substituted. The vibro-tactile senses, since they are the phylogenetic ancestor of hearing, appear to be the logical ones. Repeated experiments appear to demonstrate the practicability of this approach.

Probably all of you have touched the cone of your radio loudspeaker and have felt the vibration of the incoming speech or music. Although these vibrations are quite meaningless as felt by the finger-tip, when they are conducted to the ear they are readily distinguished and understood. In other words, the ear is sufficiently keen to respond to the subtle differences among them. The finger-tip is not so. Here then is the real problem: to develop techniques for accentuating these subtle differences so as to make them detectable by the finger-tip. This is a difficult task and already much time has been devoted to this end. The result of this effort has been the development of the Gault-Teletactor or "Phonotactor" as Dr. Gault now prefers to call it, an instrument by which one can feel speech or music. It consists of a microphone, special amplifier and vibrator upon which one places the fingers to feel the vibrations that correspond to the speaker's voice.

Five years ago, the Illinois State School of Deaf installed the Gault-Phonotactor for the use of a first grade class. Two years later, on their own initiative, they extended its use to fourteen classes. Each pupil has a vibrator on his desk which is connected to the teacher's microphone. As she speaks the pupils both read her lips and feel her words. Experiments show that the pupil's comprehension of speech is increased on the average 20 per cent because of these vibro-tactile cues.

I well remember a few years ago observing a teacher at work with the phonotactor. It was the first day of school, and a five year old lad was being introduced to the instrument. He appeared normal in every respect, but he had never heard a sound, and, therefore, did not know that such a thing as sound existed. The child's hand was placed upon the vibrator while the teacher spoke into the microphone. As he felt these vibrations in his fingers he appeared greatly interested in the new experience. Soon he noticed that he felt these vibrations only when the teacher held the microphone to her lips and made certain movements with her vocal apparatus. To us, hearing folk, the teacher was speaking, but to this deaf youngster, she was merely making queer movements with her lips and jaw which, in some mysterious way, caused this tingling in his fingers. Later the child placed the microphone to his own lips and tried to imitate his teacher, and in so doing he made probably the greatest discovery of his life. He discovered his voice. He found that when he exercised the vocal organs something happened—something which he and others could become aware of. Here then started the long process of teaching the child to make the delicate and accurate movements of the vocal musculature necessary to produce speech. In all this process the Gault-Phonotactor played a very useful part.

Although we are interested at the present time in developing the instrument for use as an adjunct to lip-reading and as a means of developing speech, we hope to extend the applications very greatly after we have mastered some of the difficult technical problems.

I think you will readily see that many educational and psychological problems arise from this work. They are being worked out in the State School for the Deaf, in our own private school, and in the psychological laboratory; but since they are not pertinent to this report we shall pass on. Probably our greatest emphasis at present is on the engineering and physical problems involved. We are confronted with the task of developing apparatus to compensate for what the finger lacks in sensitivity and in discriminating capacity. Here are many fascinating problems but they will not interest you. The fourth main division of our research projects centers around physiological and neurological problems. In the following pages I shall review our research on these items.

#### THE NATURE OF THE VIBRO-TACTILE SENSES

At least a dozen different experimenters have contributed evidence toward the isolation of specific end-organs involved in this form of sensitivity, but it is all quite incomplete and contradictory. Even the question of the relative role of deep and superficial sensitivity is still uncertain. Most of these studies<sup>1-11</sup> have been clinical observations of the independent loss or impairment of the two forms of sensitivity, and are interpreted as evidence of the existence of independent receptors responsible for vibratory sensitivity.

From the experimental approach, evidence pointing to the same conclusion is available. Bing, for example, by anaesthetizing various areas of the skin with cocaine, demonstrated that vibratory sensitivity is not markedly decreased, although other forms of sensitivity are destroyed. Katz found that the same thing holds after violent rubbing of the skin; namely, tactual sensitivity is impaired much more than vibratory sensitivity. We have found the same thing in our own laboratory, namely, the anaesthetizing the area being stimulated does not markedly decrease sensitivity although tactile sensitivity is entirely absent<sup>12</sup>. However, we doubt the significance of this experiment as an indication of the supreme importance of the deep sensitivity, since it is quite probable that in this case vibrations applied to the anaesthetized area of the skin were conducted through the anaesthetized skin to a normal area. The probability of this explanation has been demonstrated by showing that vibrations applied to the skin can be detected two feet away from the point of application.

Katz<sup>13</sup> argues that since the amplitude of vibration necessary to produce a sensation is far less than the movement required to give rise to tactual sensation, something other than touch must be involved. We discredit this form of reasoning since it would seem quite possible to account for the observed fact by the summation of rapid subliminal tactile impressions into a vibratory sensation. As further evidence of a differentiation he reports different reaction time and latent periods for tactile and vibratory senses.

A difference in the effect of fatigue has been reported. Katz found very little fatigue due to vibratory stimuli whereas touch fatigues quite rapidly. Kampie<sup>14</sup>, however, reports different findings. In our laboratory we have carefully investigated the effect of vibratory stimuli versus pressure stimuli on vibratory sensitivity. The results show quite marked differences. Two minutes exposure to a vibratory stimulus decreases considerably one's vibratory sensitivity but two minutes exposure to a purely pressure stimulus shows no fatiguing effect on vibratory sensitivity.

Attempts have been made to correlate vibro-tactile sensitivity with cutaneous spots as mapped out by the traditional psychological experiments. One experimenter found some correlation with point spots from which he concluded that naked nerve endings picked up these vibratory stimuli. This finding, we have been repeatedly unable to verify, and we doubt very much whether correlation with any specific form of sensory experience will ever be established.

The following findings from our laboratory indicate the importance of deep sensitivity in vibro-tactile stimulation, although they by no

means indicate that vibro-tactile sensitivity is to be identified solely with deep sensitivity.

(a) The tongue, which is presumedly quite sensitive to touch is not very sensitive to vibratory stimuli. This is verified by Katz but refuted by Pollock, who says the tongue is quite sensitive to vibratory stimuli. This discrepancy in findings can be accounted for, we believe, by the different conditions under which the two results were obtained. Pollock used a much lighter vibrator than ours. Since our vibrator was large and massive, the damping effect of normal variations in pressure was negligible. It is quite possible that different end-organs are involved in the two situations. Furthermore, a different criterion of "more or less sensitive" was used. Our criterion of sensitivity is the threshold intensity, whereas Pollock's criterion is the observer's estimate on the intensity—psychologically a very different thing. We believe that those two facts, difference in apparatus and criterion, will adequately account for the different findings.

(b) The finger nail, which we would expect to find relatively more sensitive to vibratory stimuli than to tactual, is quite sensitive to the Phonotactor. The inference is that the vibratory sense and not touch is responsible for the greater sensitivity of the nail.

(c) Sensitivity is not markedly decreased by the wearing of a kid glove. The opposite is obviously true for the sense of touch.

(d) The back of the finger which contains many times fewer touch spots than the palmar surface is no less sensitive to vibrations. This lack of correlation between sensitivity and the distribution of touch spots suggests the predominant role of the vibratory sense.

(e) The sensitivity is not greatly changed by the use of a point instead of the diaphragm stimulating several square centimeters.

(f) The sole of the foot is less sensitive than the palm of the hand. Since previous experimenters have found the lower extremities less sensitive than the upper extremities to vibratory stimuli, we would expect this result if vibratory stimuli played a dominant role.

### VIBRO-TACTILE SENSITIVITY

Although we do not know at present the specific end-organs responsible for the vibratory sensation, or the manner in which they function, we do have very definite data on the sensitivity and discriminatory capacity of these receptors. In our research on extending the uses of this type of sensitivity for the deaf, these data have a great practical value.

One of the first questions to be asked is the frequency range in the vibro-tactile sphere. Several attempts to measure this have been made in various laboratories, and each experimenter has reported a different upper limit. One of the first experimenters<sup>15</sup> reports 528 c.p.s. as the upper limit. Later experimenters<sup>16, 17, 18</sup> placed the upper limit at successively higher values ranging to 2700 c.p.s. We have evidence that all of these upper limits are artifacts, i. e., they are due to the functioning of the specific apparatus employed instead of true upper limits. By using a vibrator especially designed for the higher frequencies, and a high-gain amplifier, we<sup>19</sup> have had observers respond to vibrations as

high as 8000 c.p.s. We do not consider this figure as necessarily the upper threshold, but merely the limit to which our apparatus could function with the required amplitude.

Since the frequency range has in the past been determined by the intensity of the stimulation, we turn now to the study of intensity thresholds. Our measure of intensity is so many decibels above an arbitrary level, which in this case is the approximate threshold of the normal ear. Intensity thresholds have been determined for eight different frequency levels, and are given in Table I.

TABLE I.—THE SENSITIVITY OF THE FINGER-TIPS TO VIBRATORY STIMULI

Frequency	Sensitivity of finger-tip in decibels below our arbitrary level
64.....	41
128.....	53
256.....	69
512.....	89
1024.....	102
2048.....	115
4096.....	105
8192.....	91

The above thresholds were all determined for the finger-tip. Vibrotactile thresholds for other areas of the body are given in Table II.

TABLE II.—THE SENSITIVITY OF VARIOUS AREAS OF THE BODY TO VIBRATORY STIMULI IN DECIBELS BELOW THE SENSITIVITY OF THE NORMAL EAR

Area of body	Frequency		
	64	256	1024
1. Left index finger.....	40	67	95
2. Right index finger.....	44	75	104
3. Right index finger (wearing kid glove).....	48	78	108
4. Right index finger (using sharp point instead of large conical diaphragm).....	44	75	105
5. Back of the right index finger.....	45	74	105
6. Nail of the right index finger.....	43	70	92
7. Tip of tongue.....	59	90	118
8. Sole of foot.....	56	77	114
9. Palm of right hand.....	54	66	101
10. Inside surface of right fore arm.....	53	80	121
11. Inside surface of right fore arm shaved.....	53	79	124
12. Outside surface of right fore arm.....	49	76	114
13. Outside surface of right fore arm shaved.....	52	83	119

We are careful to distinguish between sensitivity and discriminatory capacities, since we find there is little correlation between the two—popular opinion to the contrary. Our interest in this was aroused a number of years ago when we discovered that one of our very best observers—best because he was able to make accurate discriminations of subtle differences in vibratory pattern—was quite insensitive in comparison with our other observers. We followed this up with a careful study and found very little relation between ability to sense and ability to discriminate.

As to the differential sensitivity we have found that trained observers can distinguish a difference in frequency of two vibratory stimuli provided the difference is at least  $2\frac{1}{2}$  per cent when the standard frequency is 400 d.v.sec. As to the ability to discriminate difference in intensity, a difference of 4 to 12 per cent, depending on the absolute intensity, is sufficient to enable trained observers to detect a difference.

Today accurate and specific data are available on the sensitivity of the vibro-tactile organs—their capacities and limitations. The following statements from laboratory findings indicate that all the important physical characteristics of speech can be detected by the finger-tip.

- (a) The finger-tip can detect vibrations as high as 8,000 per second.
- (b) It can differentiate intensity differences comparable to the ability of the normal ear.
- (c) It can differentiate two pitches when the frequencies concerned differ by as little as  $2\frac{1}{2}$  per cent of the standard—400 d. v.
- (d) It can detect differences in tones and beats.
- (e) It can detect the individual tones in a chord and can discriminate between consonance and dissonance.
- (f) It can detect differences in short intervals of time with 90 per cent of the accuracy of the ear.
- (g) It is only one one-hundredth to one one-hundred-thousandth (depending on pitch) as sensitive as the normal ear. This is the only score on which the senses of touch and vibration do not compare favorably with the ear, but it is a deficiency which can be compensated for to a considerable degree by apparatus such as the Gault Phonotactor.

The ultimate success of the Phonotactor as a sole means of communication depends on the ability of the individual to interpret complex vibratory patterns. The deaf person will have to learn the meaning of each vibratory disturbance that he feels in his finger just as the normally hearing person has to learn the meaning of sound—the vibratory disturbances at his ear-drum. The task is not simple and a great deal more research is needed. However, three experiments done in this laboratory suggest that individuals can interpret complex vibratory patterns.

The first is an experiment in which a long series of four different musical intervals was presented to observers both auditorially and tactually. The result showed correlation of  $.53 \pm 0.11$  between a person's ability to identify intervals by hearing and his ability to identify them by touch. Furthermore, training in recognition of intervals by ear caused considerable improvement in the ability to recognize the same

intervals by touch. In short, our observers soon learned to recognize a musical interval by touch.

The second experiment is one in which two deaf and two normally hearing persons who had had no previous experience with the Phonotactor were given three half-hour periods of training in identifying five vowel and diphthongal sounds by touch. Then they were tested on the sounds and the results are shown in Table III.

TABLE III.—THE RECOGNITION OF SPEECH SOUNDS BY TOUCH (BASED ON 500 OBSERVATIONS BY 2 DEAF AND 2 HEARING PERSONS AFTER THREE HALF-HOUR PERIODS OF TRAINING).

Sound pronounced	Observer's response in per cent					Energy in milliwatts
	A	E	I	O	U	
A.....	70	12	6	6	6	0.27
E.....	12	60	14	9	5	0.08
I.....	6	13	72	4	5	0.17
O.....	11	8	6	66	8	0.46
U.....	7	5	5	7	76	0.12

The data in the table show, for example, that when "A" was spoken the observers interpreted it as "A" 70 per cent of the time. Twelve per cent of the time it was interpreted as "E" and 6 per cent of the time as "I", and "O", and "U".

The sounds were produced from a victrola made from the speech of an instructor in the School of Speech. The average value of the electrical energy going into the Phonotactor was measured for each sound and is given in Table III. It is clear from the data in the table that our observers did not differentiate these vibratory patterns on the basis of differences in intensity alone as is sometimes suggested by our critics. "A" and "E", it will be observed, were the most frequently confused, yet they differed widely in intensity in this particular experiment. On the other hand, "U" and "I" are frequently confused yet their respective intensities are of a similar magnitude. It must be pointed out that these simple experiments by no means prove that our observers detect quality differences but until further research is done we consider it quite likely that such is the case. The experiment is being repeated more carefully, using all the vowel sounds between the letters "b" and "t" (e.g., boot, boat, but, bit, bite, etc.) Tentative results indicate the same conclusions.

The third experiment on the interpretation of vibratory patterns is one in which observers were trained to recognize sentences as they were felt over the Phonotactor. The experimenter had before him a list of sentences of twelve syllables each. The observer had before him the same list except that the even numbered sentences had been omitted,

and were represented by their number only. The experimenter gave the signal "one" and read sentence number one several times. The observer, in this case, knew exactly what was being read. At the signal "two" the experimenter read sentence number two. This time, however, the observer did not know the actual sentence read but knew only its position in the list. After an extended period of training, the observers were tested on their ability to identify each vibratory pattern. In all cases, our observers learned to identify vibratory patterns when they were represented merely by a certain position in the list just as readily as when they were represented by the actual sentence being read. In brief, learning was necessary and then interpretation became possible.

We have presented data showing the great sensitivity and the discriminatory capacities of the vibro-tactile organs. Although we do not as yet know the exact anatomy or physiology involved, we have had considerable success in making this more or less neglected form of sensitivity serve human ends to a hitherto undreamed of degree.

- 
- <sup>1</sup> Barker, L. F., Vibration Sense (Pallesthesia). *Mono. Medicine*, 1920, 4, 136.  
<sup>2</sup> Goldschneider. *Über das Vibrations-gefuhrs*. *Berl. klin. Wchnschr.*, 1904, 41, 353-356.  
<sup>3</sup> von Frey, M. *Die Vergleichung von Gewichten mit Hilfe des Kraftsinns*. *Ztsch. f. Biol.*, 1915, 65, 203-238.  
<sup>4</sup> Anderson, F. N. *Comparison of the Sense of Vibration and Passive Movement in Organic Neurological Cases*. *Med. Herald*, 1929, 48, 265-266.  
<sup>5</sup> Drought and Hill. *Observations on the Vibratory Sense with Special Reference to Postencephalitic Parkinsonism*. *J. Neurol. & Psychopath.*, 1931, 11, 318-323.  
<sup>6</sup> Egger, M. *De la sensibility ossiuse*. *J. de Physiol. et de path, gen.*, 1899, 1, 511-520.  
<sup>7</sup> Piercy, H. *Quantitative Measurement of Vibratory Sensation*. *Ohio State M. J.*, 1923, 19, 572-577.  
<sup>8</sup> Rydel, A. & Seiffer, W. *Untersuchungen über das Vibrationsgefühl*. *Arch. f. Psychiat. u. Nercenk.*, 1907, 37, 486-536.  
<sup>9</sup> Trietel, *Ueber das Vibrationsgefühl*. *Arch. f. Psychiat.* 1897, 29, 633-640.  
<sup>10</sup> Williamson, R. *Vibrating Sensations*. *Amer. J. M. Sc.*, 1922, 164, 715-727.  
<sup>11</sup> Head, H. *Studies in Neurology*. Oxford Press, 1920, Vol. 1, pp. 143. *Sensation and Cortex*. *Brain*, 1918, 41, 57-253.  
<sup>12</sup> Goodfellow, L. D. *Experiments on the Senses of Touch and Vibration*. *Jour. Acoustical Society of America*, 1934, 6, 45-50.  
<sup>13</sup> Katz, D. *The Vibratory Sense and Other Lectures*. *The Maine Bull.*, 1930, 32, 10. *Der Aufbau der Tastwelt*, Leipzig: Barth, 1935.  
<sup>14</sup> Kampie, A. *Experimentelle Untersuchungen über die praktische Leistungsfähigkeit der Vibrationsempfinden*. *Arch. f. d. ges. Psychol.*, 1930, 76, 3-70.  
<sup>15</sup> Thiel, F. C. *Experimental Studies in the Vibratory Sense in Deaf Mutes*. *Ztschr. f. Psychol. u. Physiol. d. Sinnes Org.*, 1931, 119, 109-178.  
<sup>16</sup> Kampie, A. *Experimentelle Untersuchungen über die praktische Leistungsfähigkeit der Vibrationsempfinden*. *Arch. f. d. ges. Psychol.*, 1930, 76, 3-70.  
<sup>17</sup> Knudson, V. O. *Hearing with the Sense of Touch*. *J. Gen. Psychol.*, 1928, 1, 320-352.  
<sup>18</sup> Gault, R. H. *The Upper Limit of Vibration That Can Be Recognized by Touch*. *Science*, 1927, 65, 403-404.  
<sup>19</sup> Goodfellow, L. D. *The Sensitivity of the Finger-tip to Vibrations of Various Frequency Levels*. *J. Franklin Inst.*, 1933, 216, 387-392.

## PAPERS IN PHYSICS

---

### EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN

Of the eleven papers presented before the meeting of the Physics Section, ten are here represented. The other one was:

*The Thomson Effect in Crystals*, by Lester I. Bockstahler, Northwestern University, Evanston.

Harold Q. Fuller, Illinois College, Jacksonville, Illinois, was elected chairman of the Physics Section for the 1937 meeting.

(Signed) F. W. TANNER, *Chairman*



# Electrical Discharge Phenomena in Insulation Under High Continuous Potentials

H. A. Brown and E. B. Paine

*University of Illinois, Urbana, Illinois*

Two years ago the authors reported before this group on their method of detecting the presence of electrical discharge phenomena in the insulation of electric wires and in the space between the outer surface of the wire insulation and a flat metal test plate upon which the test specimen rested. About a year ago the authors found that when high continuous potentials were applied to the conductor of an insulated wire and a metal plate touching the insulation, electrical discharge phenomena could be detected by means of suitably arranged filters and amplifiers. As this is believed to be a hitherto unobserved phenomenon in a dielectric it should be brought to the attention of those working in the fields of theoretical and applied electricity.

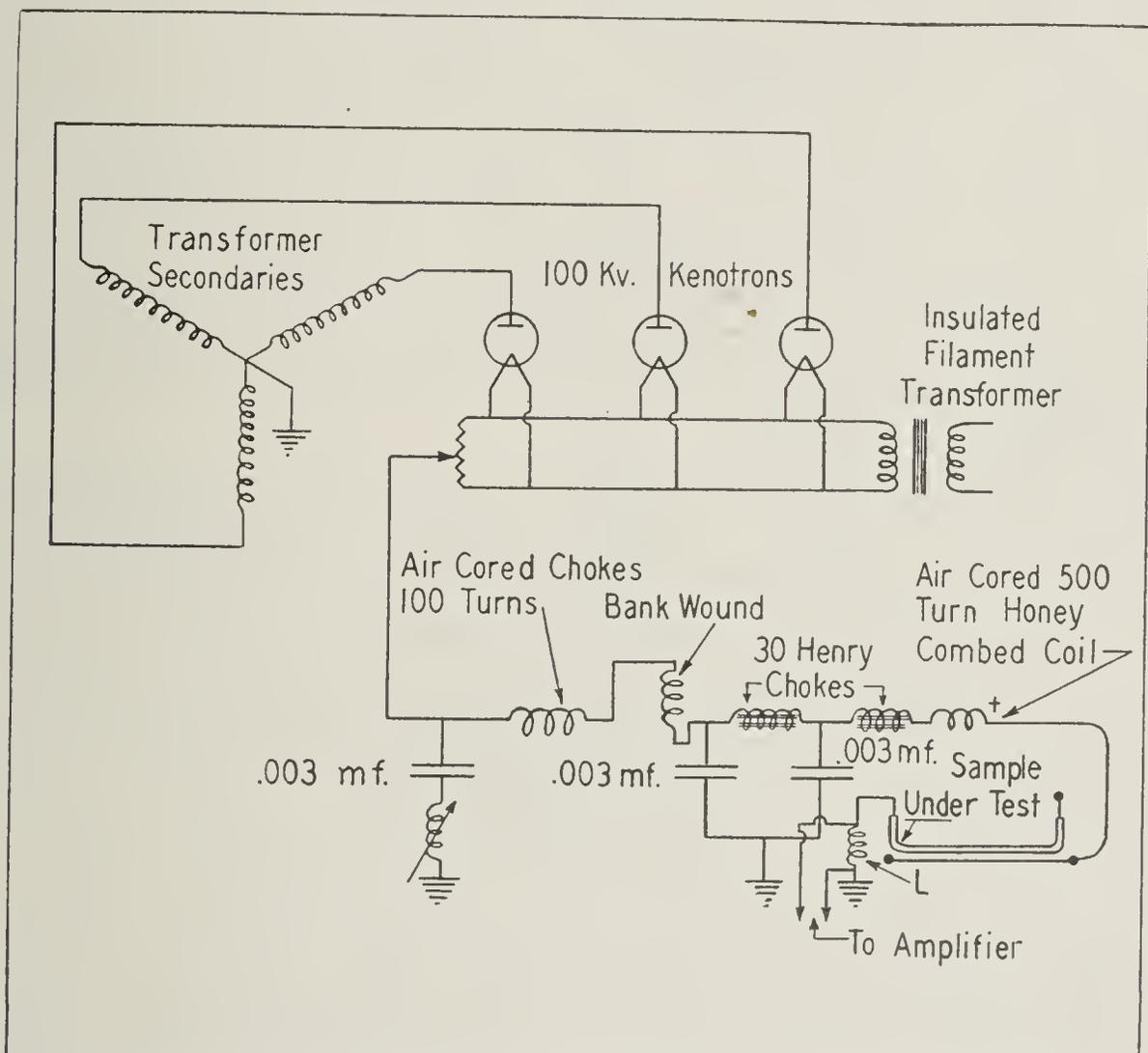


Fig. 1.—RECTIFIER FILTER FOR HIGH VOLTAGE D. C. SUPPLY.

The high voltage d. c. supply is obtained from a three-phase kenotron tube rectifier and filter shown in Fig. 1. Three phase rectified output pulsates 13 per cent, and this must be smoothed out with an adequate filter. In addition to this, steep wave front discharges occur inside the glass envelopes of kenotron tubes at high potentials, and the

filter must be so designed as to suppress these also. A filter design that has proved effective for the authors is indicated in the figure. It is essential that the rectified d. c. potential at the output end where the test piece is connected be entirely free from any steep wave front disturbance and from any harmonic pulsation. The input connections to a high gain resistance coupled amplifier are placed across the inductance  $L$  in the figure. Hence any fluctuating current flowing through  $L$  will excite the amplifier. The amplifier must have a response that is constant for frequencies up to at least 20 kilocycles, and it must have a voltage gain of at least 75 decibels. A high grade telephone receiver and a good output rectifier type voltmeter should be provided to listen to and to obtain quantitative readings of the discharge intensity.

The test piece of dielectric such as a sample of insulated wire is placed upon the metal test plate and the latter connected to the positive terminal of the d. c. voltage supply, and the conductor of the test piece is negative when connected to ground through the inductance  $L$ . When the voltage is raised to a certain value there is noted occasional popping sounds in the telephone receiver. As the voltage is further raised the popping sounds occur more rapidly, and finally merge into a steady rattle which is quickly changed to a hissing sound, much like that of escaping steam. If the polarity of the voltage applied to the test piece is reversed the hissing sound is often never attained, but the sound remains a rattling type. If a test piece other than wire insulation is used, say a flat sheet of dielectric, electrodes must be placed in contact with each face; the positive electrode may be a flat plate with rounded edges, and the negative electrode a thin walled cylinder whose edge is rounded. This provides a ring shaped electrode giving a high potential gradient near this negative electrode.

Discharge phenomena occur at lower potentials when the conductor in the case of an insulated wire test sample is negative, and when the ring or cylinder edge electrode in the case of a flat test piece is negative. After the hissing discharge sets in it varies in intensity in a random fashion. It usually increases with further increase in d. c. voltage, but not always. Deterioration of the insulation sometimes alters the discharge characteristics such as causing the hissing discharge to occur at lower potentials. For new rubber insulation the potential may be increased some 20-30 per cent after the hissing discharge sets before failure occurs. When the hissing discharge begins direct current of a measurable amount flows through the test piece, whereas at potentials below the hissing discharge point a D'Arsonval galvanometer having a sensitivity of  $10^{-9}$  amps. per m. m. at 1 meter showed no deflection. These observations indicate that when insulation is stressed beyond a critical value frequent pulses of unidirectional current pass through the solid body of the insulation, and that the direct current is not a steady stream of drifting electrons. Ionization of the solid dielectric has probably played an important part. The foregoing may be an aid in the study of the mechanism of break down of solid insulation.

# A Cold Cathode Rectifier (demonstration)

Charles T. Knipp

Department of Physics, University of Illinois, Urbana, Illinois

This rectifier makes use of Hittorf's principle of limiting the expansion of Crookes dark space. Alternating voltages up to 12,000 have been rectified by it. The phenomenon was made visible: (a) by observing the trace of the discharge through the vacuum tube MM (styled the load), (b) by simultaneously observing the trace of the wave-form with a cathode ray oscillograph, and (c) by watching the changing Crookes dark space within the rectifier itself as the vacuum in it became higher and higher due to the charcoal-liquid air control.

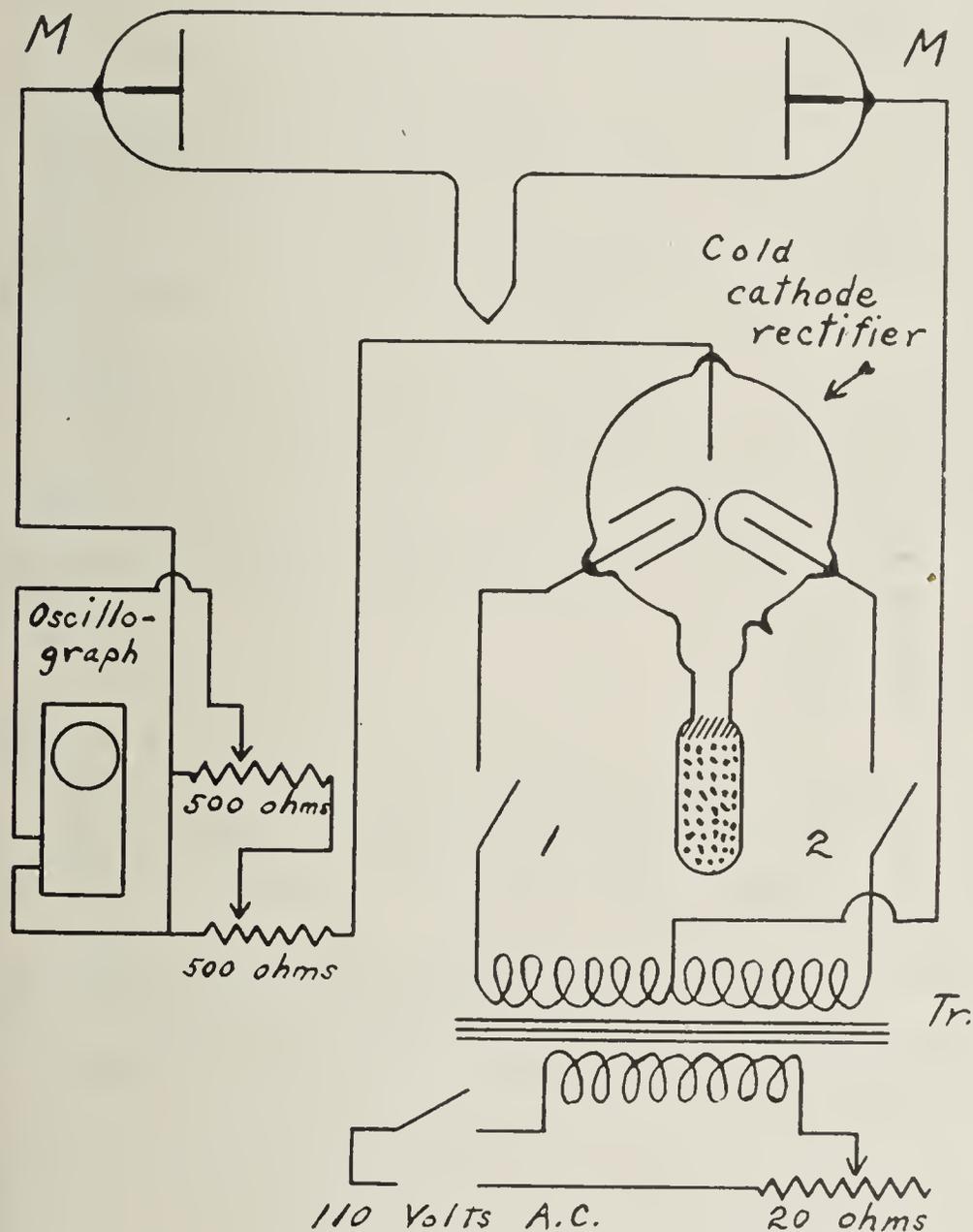


Fig. 1. — COMPLETE SET-UP FOR BOTH HALF AND FULL WAVE RECTIFICATION.

The set-up in complete form is shown in Fig. 1. There are four essential parts,—

- (1) A 12,000 volt transformer (Thordarson) with a grounded secondary.
- (2) The cold cathode rectifier with its three electrodes.
- (3) A long large diametered discharge tube MM, the load.
- (4) A 5-inch DuMont oscillograph (complete).

In addition to these, rheostats and switches are needed as shown in the figure.

Fig. 2a shows form of trace on oscillograph when the vacuum in the rectifier is *low*, and switch 1 alone is closed. There is no evidence of rectification, the alternating current passing with equal ease in either direction. The same type of curve results when switch 2 alone is closed.

If now the vacuum in the rectifier is made high by means of the charcoal-liquid air control and the switch 1 alone is closed, we get Fig. 2b, which shows half wave rectification. When switch 2 alone is closed we get Fig. 2c, which also shows half wave rectification, only that the half waves are shifted along the axis by a half period.

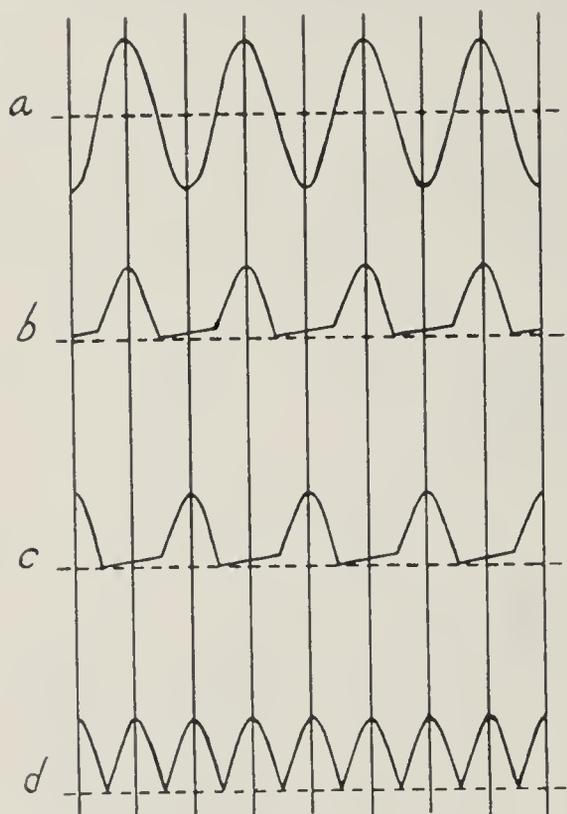


Fig. 2.—WAVE FORMS.

- a*—Wave form of alternating current. Vacuum in rectifier low, no rectification. Either switches 1 or 2 closed.
- b*—Wave form showing half wave rectification. Vacuum in rectifier high. Switch 1 only closed.
- c*—Wave form showing half wave rectification. Vacuum in rectifier high. Switch 2 only closed.
- d*—Wave form showing full wave rectification. Vacuum in rectifier high. Switches 1 and 2 closed simultaneously.

On closing both switches 1 and 2 simultaneously, we get Fig. 2d, which is full wave rectification, i. e., the half wave that is suppressed in Fig. 2b (or 2c) is now utilized. This wave form also results, as may be seen, by superposing 2c upon 2b.

The visible discharge through the tube MM (the load) is most interesting. When the rectifier is soft, and the discharge through MM is unrectified, the striae extend from electrode to electrode. When the rectifier is hard, and rectification has set in, one electrode is distinctly anode, and the other cathode, the latter with its dark spaces extending out in front. This corresponds to 2b or 2c with switches 1 or 2 closed respectively.

Visually one can not distinguish between the discharges through MM on closing either switches 1 or 2, but when 1 and 2 are closed simultaneously (as for full wave rectification, Fig. 2d) the discharge through MM appears distinctly brighter, since more electrical energy is now forced through it.

The above phenomena were shown during the presentation of this paper.

# Origin of Positive Rays in Cathode Ray Discharge Tubes Having Hollow Cathodes (demonstration)

Chas. T. Knipp and James E. Holcomb

Department of Physics, University of Illinois, Urbana, Illinois

The exact origin of the positive rays in a hollow cathode has become a moot question. Formerly the view was held, in the case of a hollow cylindrical cathode with an opening along the axis, that they had their origin in the negative glow just beyond the Crookes dark space, and fell, under the action of the strong electric field, towards the cathode, passed through it, and emerged as a compact beam of positive rays. A more recent view is that the positive rays have their origin *within* the hollow cathode itself. By mounting a mica vane on a track in front of the cathode face, the true origin of the rays can readily be demonstrated.

Two forms of positive ray tubes were used.

**A. Positive ray tube with a hollow cylindrical cathode.**—This form is shown in Fig. 1 when the vacuum (which is regulated by a charcoal-liquid air control) is right, cathode rays (—) leave the cathode surface normally and pass along the tube to the left. The position of the Crookes dark space is shown by the plane *mn*. The positive rays (+) emerge from the opening in the other end of the cylindrical cathode and pass along the tube to the right.

For the purpose of our demonstration a vane *V* was mounted on a carriage, carried on a track (shown in elevation in Fig. 1). By tilting the tube as a whole, the vane could be moved along the track and made to occupy any position out in front of the cathode, and thus intercept the cathode ray beam at any point along its path. This procedure should give us information as to the origin of the positive rays. If the origin is within the negative glow, then the vane when placed between that and the cathode face should cut off the positive ray beam. This was found *not* to be the case. The beam seemed to be as bright as before. The conclusion from this experiment follows that the positive rays have their origin *within* the hollow cathode.

This experiment, however, was not very conclusive, since the presence of the vane so near the cathode (for technical reasons) interferes with the total electrical energy passing between the electrodes *A* and *C*. Further experimentation with another form of positive ray tube seemed desirable.

**B. Kunz<sup>1</sup> positive ray tube with hollow triangular cathodes.**—The form of cathode consists of two triangular sheets of aluminium spaced about 2 mm. apart and riveted together. The term “hollow” relates to the space between. This structure constitutes the hollow cathode and is mounted as shown in side elevation in Fig. 2a, and in front elevation in Fig. 2b. The front and back faces of this hollow

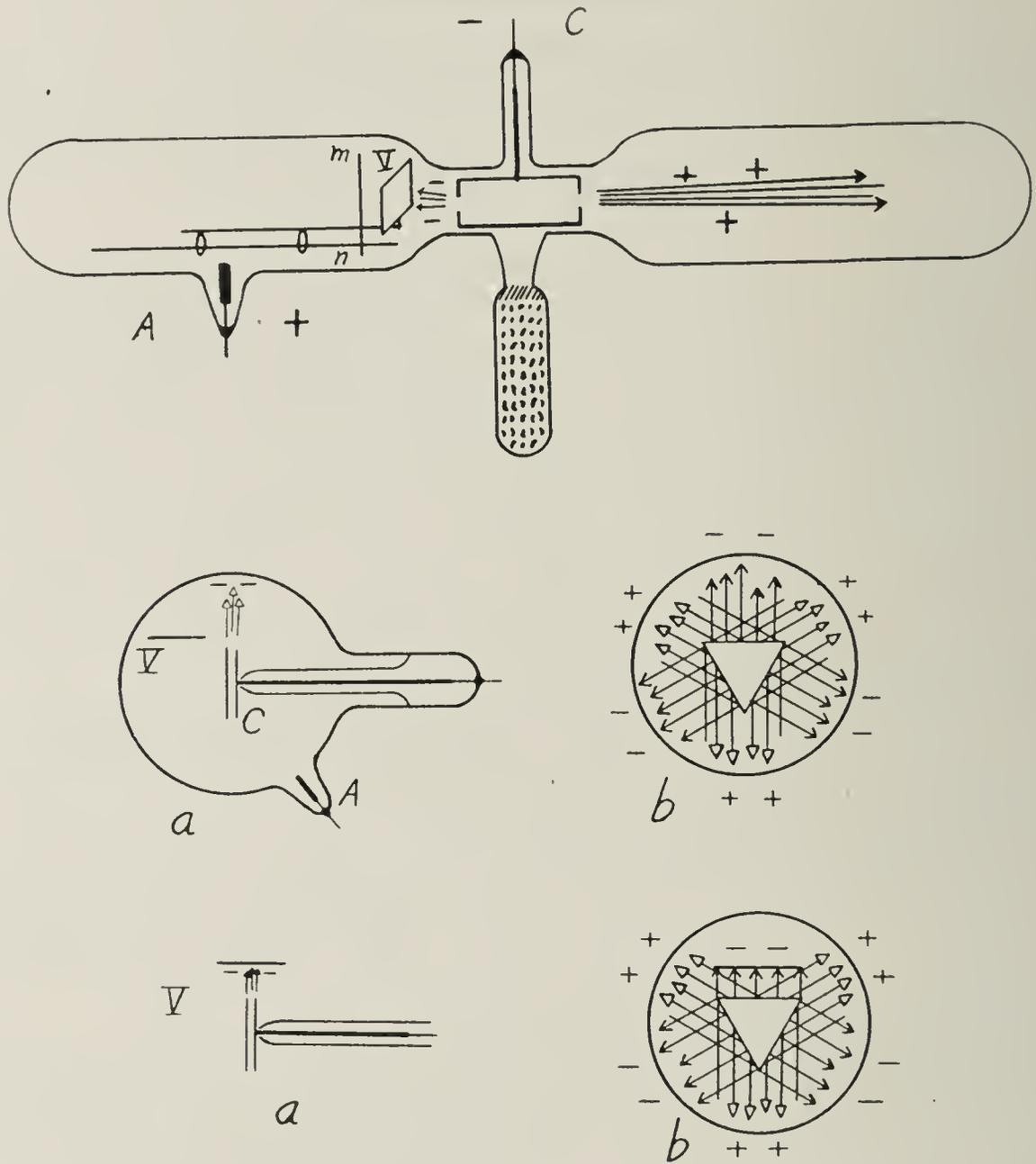


Fig. 1 (Top).—CYLINDRICAL HOLLOW CATHODE.

Fig. 2 (Center).—KUNZ HOLLOW TRIANGULAR CATHODE.

Fig. 3 (Bottom).—KUNZ HOLLOW TRIANGULAR CATHODE WITH VANE V IN PLACE.

cathode are usually covered with sheet mica to prevent electrical discharges from them. When the discharge tube is exhausted to the proper degree and a high direct potential is applied to the anode and cathode, as shown in Fig. 2a, there result cathode rays and positive rays as shown in Fig. 2b. When the residual gas in the tube is helium, the cathode rays appear apple green in color, while the positive rays are a bright

<sup>1</sup>Phil. Mag., VI, XVI, p. 161, 1908.

red. The cathode rays issue perpendicularly from the edges of the hollow triangle, and are shown in the figure by closed arrows. The positive rays are shown with open heads and are, as in the experiment with the hollow cylindrical cathode, in the opposite direction of the corresponding cathode rays, thus emerging seemingly from the apexes of the hollow triangular cathode. The relation of the positive rays to the cathode rays is thus the same as for the hollow cylindrical cathode (A) above, with the important difference that there are three sets of rays radiating out from the hollow triangular cathode at the same time, so that screening one set has but little effect on the electrical energy flowing through the tube. It should therefore be comparatively easy and reliable to study the origin of the positive rays by interposing a mica vane in the cathode rays of one set.

The position of the vane, V, drawn to one side so as not to interfere with the cathode rays coming from that edge of the hollow cathode, is also shown in Fig. 2a. The vane was then moved into position shown in Fig. 3a while the discharge was passing. The resultant arrangement of the beams is shown in Fig. 3b. The interception of the cathode ray beam did not in any way alter the positive ray beam in arrangement or in intensity. Nor was the brightness of the remaining two sets of beams around the triangle affected in any way.

This experiment demonstrates conclusively that the positive rays in these forms of positive ray tubes have their origin *within* the hollow space of the cathode.

The phenomenon, using the Kunz tube was demonstrated during the presentation of this paper.

## A Convenient Method for Measuring the Speed of a Gyroscope

K. G. Larson

*Augustana College, Rock Island, Illinois*

If a gyroscope whose moment of inertia is  $I$  is spinning with a velocity of  $\Omega$  radians per second around its horizontal axis, and if a torque of  $L$  dyne centimeters is acting perpendicular to the spin axis, the latter will rotate about a vertical axis through its point of support, this rotation being known as precession. If the velocity of precession is  $\omega$  radians per second, then

$$L = I \omega \Omega$$

To test this relation we have used the following method.

The moment of inertia of the wheel is found by a weight and string wound around the shaft in the customary way. The wheel is then started by means of a motor and friction disc. By adjustment of the counterpoise and lever the precession is made slow, on the order of one revolution in 5 seconds, while the spin velocity is 30 or 40 revolutions per second. The thing which was new to us was the determination of the spin velocity. A disc of bakelite, 3 cm. in diameter, with six holes arranged in a circle, has been fixed on the shaft, and serves as a miniature siren. Compressed air is used with it, after the wheel has been started, and a sonometer wire quickly tuned to its pitch by sliding a bridge. The gyroscope is then allowed to precess while one revolution is accurately timed; immediately the siren is again used, and a second sonometer wire tuned to it. The vibration rate of the wires is then found by measuring lengths, and tuning to standard tuning forks. From these values is calculated the average spin velocity of the wheel, in radians per second, during the precession. The torque about the horizontal axis, due to the counterpoise, is found by using a spring balance to find the force in dynes necessary to produce equilibrium. The torque is

$$L = Fl$$

where  $l$  is the lever arm of this force.

The value thus obtained agrees reasonably well with the product of the moment of inertia, the spin velocity, and the precession velocity. Using it as a regular experiment in the general physics course, errors are usually within 5 per cent.

## Heat Insulation

F. M. McClenahan

*Monmouth College, Monmouth, Illinois*

While engaged in developing a method for extracting the chemical values of pottery clays, attention was called to the necessity of providing some economic outlet or outlets for the ever present silica component derived from the clays.

The silica is in the form of nearly pure colloidal silicic acid. As produced by our method in the routine break-down of the clays it emerges as a material of extreme granular fineness. By actual measurement its particles have been found to be less than one-twenty-five thousandth of an inch in diameter. Several valuable outlets have been developed which depend for their effectiveness upon the fineness and chemical stability of the silica under the assumed operative conditions.

The particular value here emphasized is its adaptability to heat insulation. Early it was recognized that our silica physically is related closely to "silica gel" which may be obtained on the open market. However, it differs from this material in the fineness of its particles. On the other hand we have noted certain similarities to diatomaceous earth. We will give our method of preparation of this form of silica which we have named "Presil".

In the above mentioned process for the economic break-down of pottery clays to the end that metallurgical alumina and silica, each of the highest purity, be obtained, the latter material emerges as precipitated silicic acid, and separates as a soft wet pulp. This is dried, pulverized, and furnaced to low redness. The resulting powdery product is what we have named "Presil" (prepared silica). The apparent specific gravity of Presil powder is approximately 0.200. When moistened the particles adhere only when wet, but upon re-drying they fall apart readily from one another, and the same light powder results.

In order that this Presil be molded into brick or tile, or be used as a plaster, it must be made plastic. This may be brought about by adding some other material to the Presil, such as caustic or lime. Or, it may be possible to bring about a slight alteration of the particles themselves so that they will adhere to one another with reasonable tenacity after the moistened mixture shall have dried. We tried various expedients and finally devised the slight alteration of the particles them-

selves to such an extent that they hold to one another with marked tenacity after drying. The altered Presil we have named Plastosil (plastic silica).

When Plastosil is mixed thoroughly with water of the proper amount it takes on the general physical characteristics of glazer's putty. The plasticized batch may be molded, extruded, or otherwise shaped. It air-dries easily. The dried form does not warp, buckle, spall, or shrink markedly when furnaced to 1800° F. Its tensile strength is about 130 lbs. per sq. in. It does not have notable crushing strength. The apparent specific gravity of the dried product is 0.550. Microscopic inspection of the broken faces indicates the body to be shot through and through with air cells. Furthermore when those air cells are examined under the microscope they are seen to be smooth-lined, as though they are plastered by a fine textured cement. The walls of the cells appear as though the separate particles of Plastosil have been compacted densely each with its neighbor. The true density of this material, referring to tridymite, may be assumed quite reasonably to approximate 2.200. Thus we have a body, air-dried, consisting of twenty per cent hard tridymite silica and eighty per cent air. The air-dried body takes up water to a large degree before showing signs of wetness and much more before it shows signs of softening. The furnaced body takes up water and air-dries readily but does not soften with excess of water. Its physical strength, however, is not as great as that of the air-dried body. The atmospheric hygroscopicity of the air-dried Plastosil is almost nil and that of the furnaced Plastosil is not detectable. The heat insulation value of a material depends directly upon the mass and stability of dissociated "dead air" pockets per unit area per unit thickness and also upon the heat conductivity of the material substance itself, which encloses those dead air pockets. The completeness of isolation of the dead air pockets from outside currents of air adds great technical value to the insulation material. The material should be non-combustible and antagonistic to a tolerance of vermin. It should remain rigid. It should be light. Last of all it should be inexpensive in itself and be applied inexpensively.

The coefficient heat transmissivity of air-dried Plastosil is about the same as that of prime cork. Subjected to atmospheric pressure on one side and vacuum on the other, Plastosil and prime cork are in a class by themselves with respect to transfer of air through the substance body. No other insulator approaches them in this excellent quality.

On account of the inexhaustible supply of silica from which Plastosil may be prepared, the inexpensiveness of the product, and its excellence and adaptability to so many and varied calls for an insulating material of its properties, we look for its wide use in house and building construction.

# Electronic Transient Visualizers

Herbert J. Reich

*University of Illinois, Urbana, Illinois*

The field of application of the cathode-ray oscillograph can be greatly increased by the use of auxiliary equipment which makes possible the visual observation of circuit and line transients. The author has described a transient visualizer which accomplishes this result by means of a relay opened and closed by the sweep oscillator.<sup>1</sup> This device, while functioning perfectly at low frequency, had the limitations which are imposed by relay inertia and contact chatter. Experiments then in progress on the replacement of the relay by a vacuum tube circuit were not advanced sufficiently to justify more than a mention in that paper. The present paper covers a discussion of several types of electronic transient visualizers which have been developed during the past two and a half years.

In order to be of most general application it is essential that an electronic transient visualizer should have, at least during the initiation and duration of the transients, the characteristics of a switch. It should possess neither inductance, capacity, nor resistance, and should serve merely to open or close the circuit without in itself affecting the behavior of the circuit during the duration of the transient. This requirement immediately prohibits the use of devices in which the discharge or charge of a condenser or inductance is inherently associated with the action of that part of the switching circuit through which the transient current flows. The well-known parallel type of two-tube thyatron inverter circuit<sup>2</sup> fulfills the requirement if properly used. Since the operation of this circuit has been adequately discussed by a number of writers it does not seem advisable to discuss it here further than to state that the application of periodic voltage pulses to the grids results in a periodic transfer of anode current from one tube to the other.

Unmodified transients may be initiated in a transient circuit connected in series with the anode of either tube. If the grid excitation voltage is obtained from the sweep circuit which provides the linear time axis, then one transient can be produced for each sweep of the oscillograph spot, and a stationary image be obtained.

<sup>1</sup> "A Combination Sweep Circuit and Periodic Contactor, etc."; H. J. Reich; R. S. I.; 5; 7-9; (1934).

<sup>2</sup> "Hot Cathode Thyratrons"; A. W. Hull; G. E. Rev.; 32; 399; (1929) *Electron Tubes in Industry*; Keith Henney; 205-215; (McGraw-Hill; 1934).

A number of circuits based on the parallel type of inverter were developed by the author at the University of Illinois and by Mr. John Bennett at Cornell University<sup>3</sup> during the years of 1934 and 1935.

Although the operation of these parallel switching circuits was found to be excellent at high anode currents, the author observed that the action was somewhat erratic when an attempt was made to work with small currents. Further investigation revealed that the difficulty resulted from the fact that at small currents the anode current of grid-controlled arc-discharge tubes is not independent of grid bias, but that the current may be decreased and even cut off by the application of negative grid voltage.

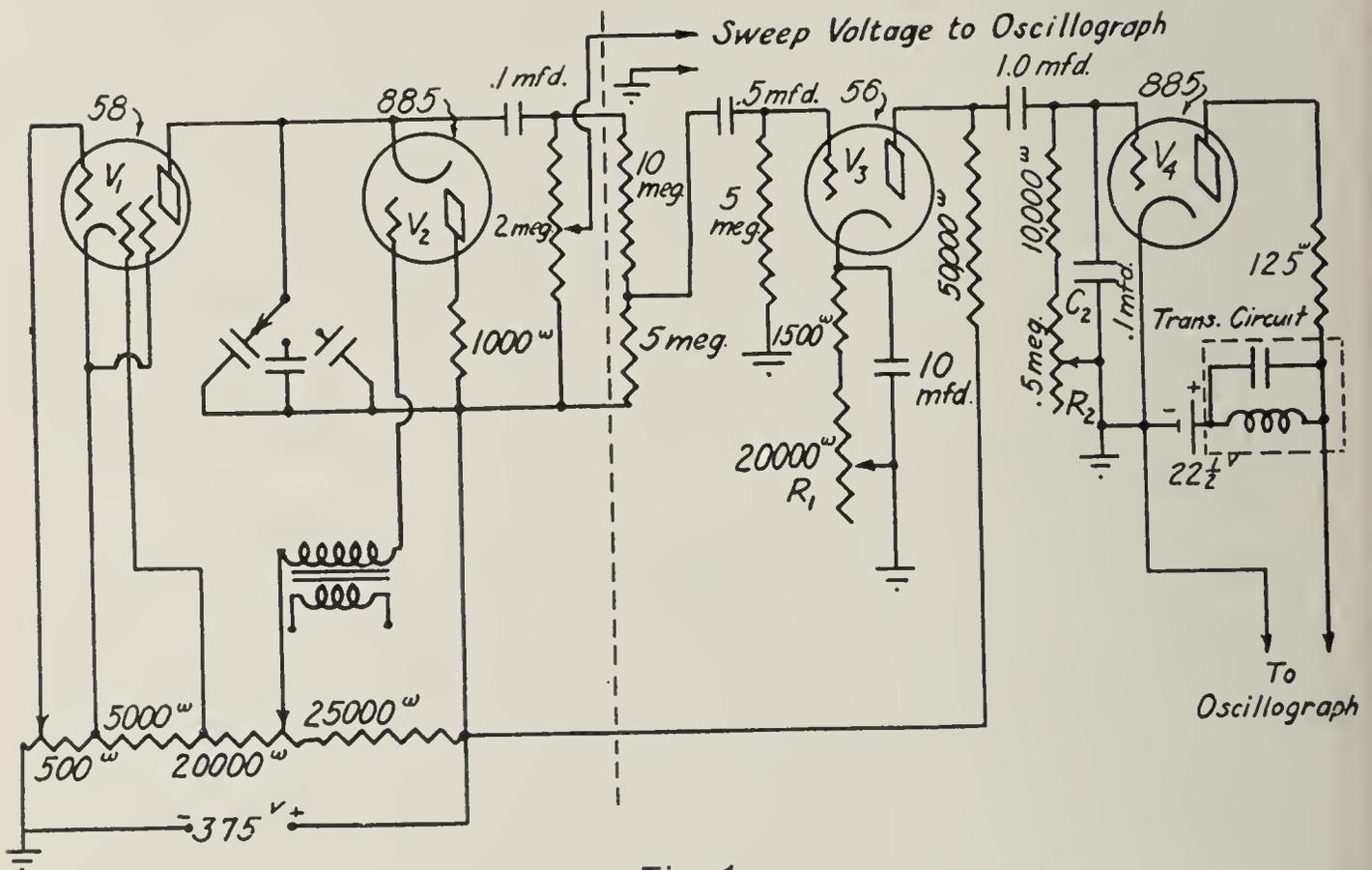


Fig. 1.

Fortunately this dependence of anode current upon grid voltage, although it is undesirable in a two-tube parallel circuit, makes possible the design of a simplified single-tube circuit. If the saw-tooth voltage of the sweep oscillator is applied to the grid of an 885 tube in such a direction that the sudden voltage jump at the end of the sweep makes the 885 grid negative, then, because of the rapidity of this change in voltage, the anode current of the 885 tube will fall to zero in a small fraction of a second. The tube fires instantaneously when the negative grid voltage has fallen to a critical value, the magnitude of which depends upon the applied anode voltage. The tube therefore has the required switching characteristics both for starting and interrupting current flow, and may be used in initiating repeated transients in synchronism with the sweep voltage. The complete combined sweep-circuit and single-tube transient visualizer is shown in the accompanying

<sup>3</sup> A thesis submitted for the degree of Master of Science at Cornell University, June, 1935, by John Bennett.

diagram. The portion of the circuit to the left of the dotted line is a standard sweep oscillator; the portion to the right represents the addition which must be made to the circuit for transient visualization. In many transient studies the  $22\frac{1}{2}$  volt battery in the visualizer circuit may be replaced by a tap on the main supply-voltage divider. The 125-ohm resistor in the anode circuit of  $V_4$  may be reduced or eliminated if the resistance of the transient circuit is sufficient to limit the anode current to a value small enough so that the grid can extinguish the tube (50 milliamperes or less). The function of  $C_2$  is to delay the firing of  $V_4$  until after the cathode spot has returned to the beginning of its timing sweep. The conduction time of  $V_4$  is adjusted by varying either  $R_1$  or  $R_2$ .

The circuits which have been described in this paper have been found to be of considerable value in the lecture demonstration and laboratory study of circuit and line transients. The possibility of observing directly the effects of variation of circuit parameters is an especial advantage. Photographic records may be obtained by photographing the oscillograph screen, an uncorrected  $2\frac{1}{2}$ -inch double-convex lens giving very satisfactory results. The high stability of the circuits is proved by the fact that sharp photographs are obtained with exposures of 15 seconds or more. An important feature of these circuits is that they can, with little complication, be added to a standard sweep oscillator.

## Does the Crystal Structure of Solid Single Crystal Bismuth Exist After the Bismuth Crystal is Melted?

J. Henry Schroeder

*Southern Illinois State Normal University, Carbondale, Illinois*

Several investigators have asked this question because they have found that single crystal bismuth exhibits striking or peculiar physical properties near the melting point. Some of these physical properties, peculiar to solid single crystal bismuth, seemed to exist after the bismuth crystal had become molten. For example, Soroos,<sup>1</sup> working in the University of Iowa Laboratories, found that the thermo electric properties characteristic of solid single crystal bismuth existed to some extent in the molten bismuth until it reached a temperature about 8° C. above the melting point.

This would seem to indicate that the crystal structure of solid bismuth existed to some degree after the bismuth crystal had become molten.

Inasmuch as crystal structure also affects resistance it seems reasonable to expect that the resistance, characteristic of solid single crystal bismuth, should exist to some degree after the bismuth becomes molten.

The writer<sup>2</sup> of this paper conducted a series of experiments in which he measured the resistance of seven single crystals of bismuth of various orientations, at successive short intervals of time, as the temperature of the crystal slowly rose to about 10° C. above the melting point.

One of the chief difficulties encountered in this investigation was the determination of the exact time at which melting began and ended. Four different methods were used to determine these points. (1) The temperature was measured near the center of the crystal by a copper constantan thermo-couple. (2) A curve showing the temperature and time was plotted and the flat portion indicated the period in which melting took place. (3) Both junctions of a thermo-couple were placed within the furnace, one near the crystal and the other on the lid of the box holding the crystal. During melting the difference in temperature of these junctions became much greater. (4) The junctions of a thermo-couple were placed near each end of the crystal. The

<sup>1</sup> Adolph Soroos, *Phys. Rev.* 41, 516 (1932).

<sup>2</sup> J. Henry Schroeder, Master's Thesis, University of Iowa.

temperature of each junction was nearly the same until melting began, then the difference in temperature steadily increased until melting was complete.

The fourth method seemed to be the most accurate method because the junctions were near the ends of the crystal where the lead wires conducted heat away from the crystal, thus causing the ends to melt last.

In each of the methods described above, the low thermal conductivity of the bismuth crystal coupled with the relatively high thermal conductivity of the lead wires attached to each end of the crystal was the chief disturbing factor. The inaccuracy due to this cause was estimated to be at most about  $2^{\circ}$  C. It was also found that the resistance change expected of bismuth when it became completely melted, occurred within this  $2^{\circ}$  temperature range. This leads the writer to believe that liquid bismuth does not exhibit resistance characteristic of solid bismuth and that the crystal structure of bismuth does not exist in the molten bismuth.

## A Laboratory Switchboard of Low Cost

Clarence R. Smith

*Aurora College, Aurora, Illinois*

The need for a laboratory switchboard is usually met either by some crude and incomplete makeshift, or some elaborately designed equipment involving considerable expense. For the school laboratory there are on the market several switchboards of excellent design, but at prices which, during recent economic conditions at least, many small laboratories could not afford to pay. The apparatus here described was devised after it became necessary to give up the purchase of a proposed equipment which would have cost approximately \$300. In the physics department of Aurora College an equipment of the present design is in service and giving satisfaction. The total cost was about \$50, not including labor, line wiring, or battery.

The purpose was to supply various laboratory and lecture room outlets with special voltages from a central part of the building. The voltages in this case consisted of regular A. C., generator D. C., and storage battery in steps of 2, 4, 6, 12, 18, and 24 volts. These were to be available at any or all of the outlets, which happened to be eight in number. The general layout is shown in Fig. 1 where the receptacles and connecting conduits are shown without wiring. Standard 4-inch steel outlet boxes are used throughout, with  $\frac{1}{2}$ -inch conduit pipe for carrying the connecting wires. The box covers are of the type which is fitted with Hubbell polarized porcelain flush receptacles. Connections are made by rubber cords fitted with Hubbell polarized plug caps. The type with a cord grip should be used. The multipliers consist of two sets of receptacles, the five receptacles of each set being connected in parallel but distinct from the other set. They are used only when it is desired to have the same voltage on more than one outlet at a time. The conduit lengths shown connecting the multipliers to the rest of the system are merely for grounding and do not carry wires. An inspection of Fig. 1 will reveal that many combinations are possible. For example, suppose it is desired to have 4 volts on outlets 1, 2, 3, and 4; 12 volts on Nos. 5, 6, and 7; and 18 volts on No. 8. To accomplish all of this, the 4-volt terminal is plugged to one of the multipliers and thence to each of the four required outlets; the 12 volt terminal is plugged to the other multiplier and thence to outlets 5, 6, and 7, while the 24-volt terminal is plugged directly to outlet No. 8.

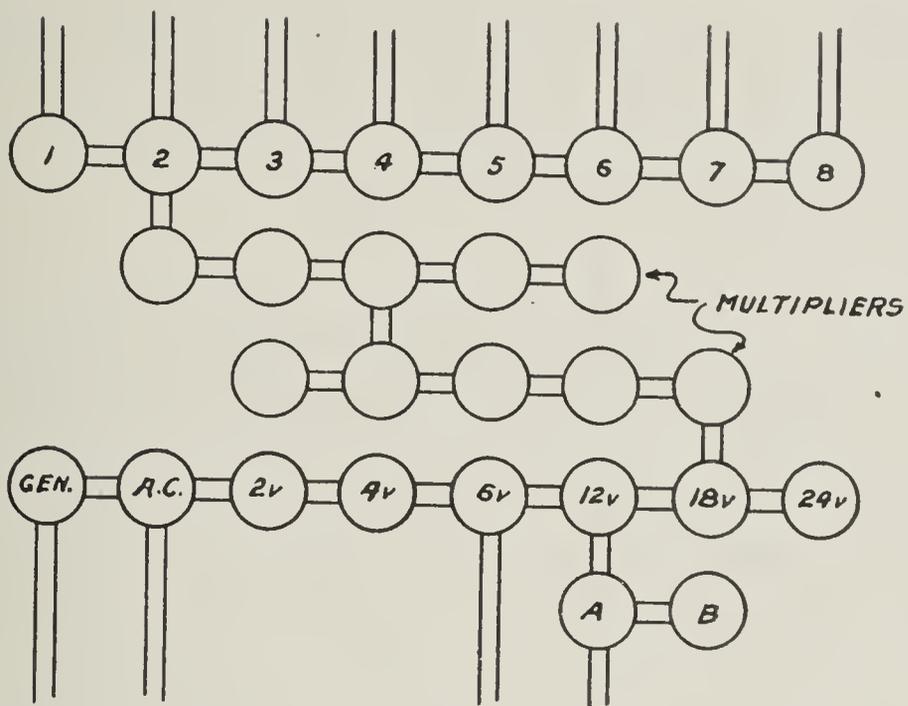


Fig. 1.—ARRANGEMENT OF OUTLETS AND CONDUITS. NO WIRING SHOWN.

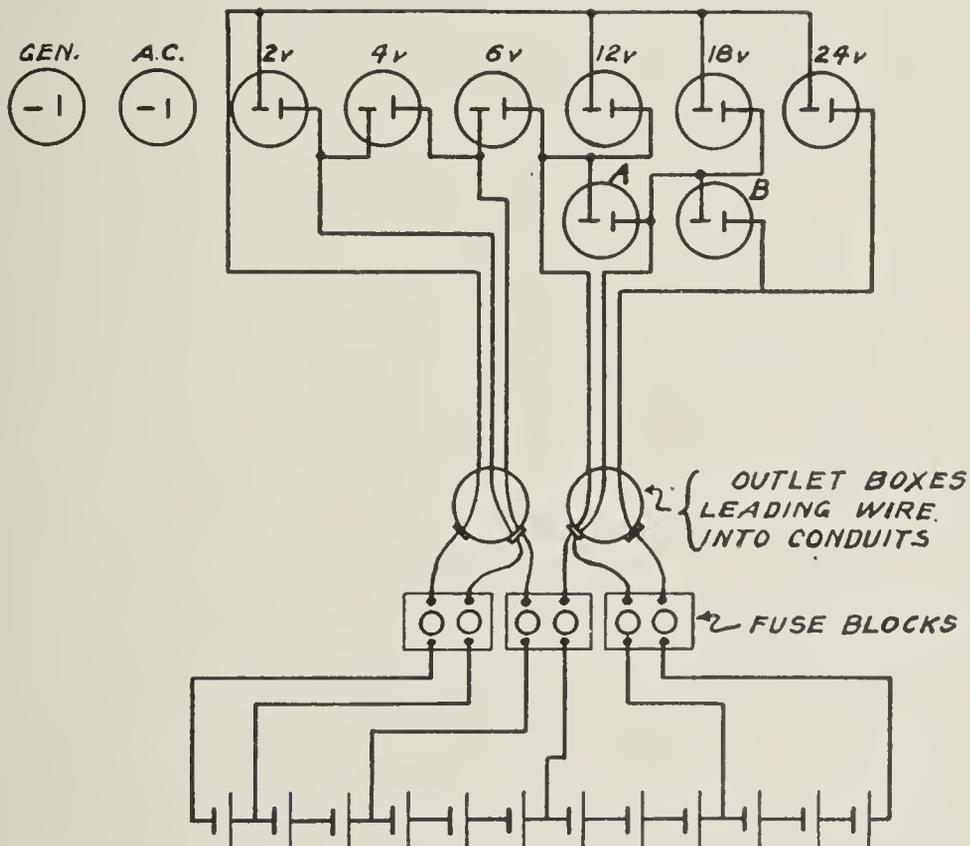


Fig. 2.—WIRING DIAGRAM FOR BATTERY OUTLETS.

The battery is charged by connecting the generator D. C. with the proper terminal. Receptacles A and B are included so that the last two battery units may be charged independently as is already possible with each of the other units. Storage cells of the glass jar type were at first used but are now being replaced by the regular automobile type which are of much lower cost, and even the cheapest grade gives excellent service for ordinary laboratory uses. Fig. 2 shows how the battery cells are wired to secure the various voltages.

The outlet boxes and receptacles may be mounted near together and so as to make a neat appearance, on a wood or steel panel or even on a plaster wall as was done in the present instance. The entire equipment consists of fittings which are standard with the electrical trade.

It will be observed that there are no binding posts, switch blades or other live parts exposed and all wires (except the leads to the storage battery) are completely enclosed so as to pass all rules of city inspection and insurance. This equipment is not quite as convenient as the more expensive switchboards and probably would not hold up as long under extensive service, but it has answered its purpose well and its possibilities have been much appreciated during a period when more elaborate equipment could not be had. It is hoped that this description may be suggestive to other teachers who may have similar interests. Acknowledgment is due to Mr. Charles Singleterry, a student, who did most of the mechanical work and whose suggestions were valuable in revising the design.

## Flexural Vibrations of Piezoelectric Quartz Bars

J. T. Tykociner and M. N. Woodruff

*University of Illinois, Urbana, Illinois*

Stabilization of high frequency oscillators by means of vibrating quartz crystals became the most important application of piezoelectricity. All radio broadcasting stations are piezoelectrically controlled oscillators in order to enable simultaneous radio transmission by hundreds of stations and to keep each of them within  $\pm 50$  cycles of the allotted frequency channel. The range of frequencies used in broadcasting extends from 550 to 21,520 KC. There are, however, other applications of oscillators of much lower frequencies in the range from 1 to 100 kc. Very little has been done to extend the methods of stabilization for these low frequencies. The main difficulty consists in the necessity of using very large crystals which are required if the usual longitudinal vibrations are applied. For frequencies below 15 kc quartz crystals of required dimensions are not available. To avoid this difficulty it is suggested to apply flexural vibrations of quartz bars. For this purpose an experimental study was made on twenty-one bars and plates cut of a large quartz crystal. Their length coincident with the electrical axis was from 0.7 to 13 cm., their height coincident with the optical axis was from 0.75 to 1.8 cm. and their thickness varied from 0.15 to 0.27 cm.

Two methods were used for the determination of natural frequencies of these crystals. For frequencies above 15 kc. a variable frequency oscillator driven by a thermionic tube was coupled with an aperiodic circuit. The latter consisted of a coupling inductance, the crystal bar mounted in a four-electrode holder and a copper oxide rectifier output meter. The quartz bar acted as an electro-mechanical resonator whenever the oscillator approached the fixed vibration frequency of the quartz bar. The polarity of the four electrodes placed parallel to the electrical axis of the bar was such that the direction of the electric field across the upper pair of electrodes was opposite to the field direction in the lower pair of electrodes. The piezoelectrically active quartz bar was thus subjected to compression in the upper part whenever tension was produced in the lower part and vice versa in accordance with alternating potentials produced by the oscillator at the two pairs of electrodes.

A pulse observed on the output meter indicated resonance for the particular setting of the variable condenser of the oscillator. For the determination of natural frequencies of flexurally vibrating bars which had a natural frequency below 15 kc. a compensating bridge method proved more sensitive. The crystal was mounted in a holder with two

pairs of electrodes placed parallel to the length axis of the crystal and inserted in one arm of the bridge in series with a resistance of the second arm. The third arm consisted of a variable condenser in series with a resistance of the fourth arm. The connection between the two adjacent resistances and that between the crystal holder and the variable condensers were used as points of potential difference at which energy was supplied from an oscillator of variable frequency. The potential difference at the two points where one resistance was connected to the variable condenser and the other resistance to the crystal mounting served to energize the input circuit of an amplifier. The output circuit of the latter was connected to a copper oxide rectifying detecting instrument which similarly, as in the first method, indicated a pulse whenever the frequency of the oscillator was made equal to the natural frequency of the resonating quartz bar. For each quartz bar rebalancing of the bridge was required. Longitudinal vibrations were also measured by a simpler method. The results of measurements confirmed the known relation that the natural frequency of the bars vibrating longitudinally is independent of the height ( $a$ ) or thickness ( $t$ ) of the bar and is a linear function of the length ( $b$ ) of the bar. As to the flexural vibrations it was found that their natural frequencies do not correspond to the known

relation  $f = A \frac{a}{b^2}$ . Frequencies calculated according to this relation

gave values from 2 to 75 per cent larger than the measured ones. The deviation depended on the ratio  $a/b$  of the crystal. For crystals whose length was over ten times larger than its height, the measured fundamental frequency was in close agreement with the above relation. For crystals with a ratio  $a/b = 0.5$  the discrepancy amounted to 40 per cent and for a square plate,  $a/b = 1$ , the discrepancy reached 60 per cent.

For the development and design of piezoelectrically controlled low frequency oscillators it was important to find precise relations between the natural frequencies and the dimensions of flexurally vibrating quartz crystals. By considering the rotary inertia of each cross-section of a vibrating bar in addition to its energy of translation Rayleigh derived a correction factor which is a function of  $a/b$ . Timoshenko extended the basic differential equations by including the effect of shear. The frequencies calculated with Rayleigh's correction were still too high and those calculated on the basis of the equations given by Timoshenko and Goens were too small as compared with the measured frequencies. From the experimental data collected on the twenty-one crystals a satisfactory expression was obtained for the frequency of flexural vibration. The following procedure was used.

Assuming that the relation searched for has the form  $f = \frac{A}{B} \frac{a/b}{b}$

where  $A$  is a constant and  $B$  is a function of  $a/b$ . The ratios  $A/B$  were calculated for each crystal from the measured frequencies  $f$  and the

geometric dimensions  $a$  and  $b$ . These values  $A/B$  were then plotted against  $a/b$ . For  $B = 1$  the value of the constant  $A = 5.52 \times 10^5$  was obtained by extrapolation. Because of the uncertainty of extrapolating, this value which represents 1.03 times the velocity of propagation in the length direction was checked experimentally by measuring for each crystal its natural frequency of longitudinal vibration. The average experimental value was found to be  $A = 5.54 \times 10^5$  cm. Dividing each of the values  $A/B$  by  $A$ , a curve for the relation  $B$  as function of  $a/b$  was obtained. It was found that it represents closely the relation  $B = \sqrt{1 + 5.22 (a/b)^2}$ . Thus the natural frequency for flexural vibrations may be calculated from the expression  $f = \frac{5.52 \times 10^5 a}{\sqrt{1 + 5.22 (a/b)^2} b^2}$

where  $a$  and  $b$  are the height and length of the crystal measured in cm.

The frequencies calculated from this formula deviate little from measured values. For 15 quartz bars this deviation was less than  $\pm 1\%$ , for 4 crystals it was from  $\pm 1\%$  to  $\pm 1.8\%$  and for two crystal plates which were the smallest ( $a = 1.05$ ,  $b = 1.103$  and  $0.721$  cm.) the deviation was  $-6.83\%$  and  $+4.85\%$  respectively. These latter two crystals with  $a/b = 0.957$  and  $1.467$  respectively cannot be regarded as bars. They were included in this investigation for the purpose of determining the range of  $a/b$  within which the above formula can be applied.

The following conclusions may be made from this investigation:

(1) It is possible to produce flexural vibrations of quartz crystals in a plane containing its two largest dimensions even if the height ( $a$ ) exceeds the length ( $b$ ).

(2) A relation was obtained for the calculation of the natural frequencies of flexural vibrations from the dimensions of the crystals.

(3) This relation enables the determination of the dimensions of quartz resonators necessary for piezoelectric control of oscillators within a range of frequencies from about 3 to 120 kc. Its accuracy is better than  $\pm 1.5$  per cent for crystals whose ratio  $a/b$  does not exceed 0.5.

More details will be published in a bulletin of the University of Illinois Engineering Experiment Station.

## Merits of a National Radio Fraternity in a Non-Technical College

O. B. Young

*Southern Illinois State Normal University, Carbondale, Illinois*

In the Physics Department of the Southern Illinois State Normal University, is being constructed a 1000 watt C.W. transmitter and a 500 watt phone set. The R.F. final stage will consist of two 852 tubes in push-pull and will be plate modulated, class B, by two 203A tubes in push-pull. At the present time a 100 watt C.W. transmitter is in operation and is licensed under the call, W9UIH.

As a consequence, this school is receiving wide publicity of high quality, appealing particularly to those who appreciate technical or applied work.

In connection with the radio equipment, has been organized the Epsilon Chapter of Synton, a National, Professional, Radio Fraternity. The benefits to the student members of this fraternity and of actual experience manipulating the set are many, some of which are unique. No other college organization, within the knowledge of the writer, answers so many needs of the members.

The student, to a considerable extent, masters the field of radio, which is a practical application of physics. He learns better the fundamentals of the theory courses. He develops manipulative technique and resourcefulness, which lead toward skillful laboratory and research work. He is made to assume responsibility of valuable equipment and to operate it in strict compliance with the rules and regulations of the Federal Communications Commission. This last type of training is not gained elsewhere in the non-technical college.

Amateur radio provides an excellent hobby—one in which a person may communicate easily with many other persons who have the same avocation. Frequently this hobby becomes a vocation and thus adds skilled workmen to the large industrial field of radio.

A member of the fraternity has professional advantages which aid in securing and in holding positions. Other qualifications being equal, he will be given preference over one who has no special interest in his major or minor subjects.

There are, of course, the usual social attractions of the college group. There is the gold key or emblem, patterned after the 204 tube. Little imagination is needed to find many other reasons—even though considerable time and expense are involved—why the installation of such an organization as Synton should be considered, particularly in the non-technical college.

## PAPERS IN PSYCHOLOGY AND EDUCATION

---

### EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN

All four of the papers presented on the program of the Section in Psychology and Education are here represented.

The maximum attendance at the meeting was about twenty-six.

The present chairman, Dr. Robert H. Gault, Department of Psychology, Northwestern University, Evanston, Illinois, was reelected to serve as chairman of the 1937 meeting.

(Signed) ROBERT H. GAULT, *Chairman*



## Problems Connected With Administration and Supervision of Special Schools and Classes

Frank L. Beals

*Assistant Superintendent of Schools, Chicago, Illinois*

I shall begin by saying that the first and greatest problem is that created by combining the functions of the executive with those of the supervisor. Administration and supervision are not synonymous, nor do they imply a similarity of duties. To me the cleavage between the two is well defined.

Administration implies all of those activities which are concerned with organization and management, while supervision should be concerned only with the improvement of instruction. It may be that administration and supervision can be combined successfully in one of the narrow fields of atypical children, but certainly not where the two functions are all embracing.

In the larger fields supervision is a necessity if progress is to be made in instructional methods. However, there is divided opinion on that score. There are those who look upon supervision as a necessary evil, others who think of it as an unnecessary evil, while still others regard it as just plain evil. However, there are a few who see in supervision the basis of much good. The forward looking principal or teacher is not afraid of supervision. It is only the poorly prepared who resent it.

Let us consider nine atypical classifications:

- (1) Schools and classes for crippled children.
- (2) Schools and classes for truants and delinquents.
- (3) Schools and classes for the deaf and hard of hearing.
- (4) Open window rooms for anaemic children.
- (5) Ungraded divisions for retarded or backward children.
- (6) Corrective speech classes.
- (7) Classes for epileptics.
- (8) Classes in hospitals, homes, and camps.
- (9) Classes for the blind and partially sighted.

It is easy to understand that with such a wide variety of exceptional children grouped under those various headings the problems for the executive and the supervisor are many and complex. Out of some two hundred fifty listed problems I have selected ten for discussion.

(1) **State laws and State support.**—Most laws governing the education of atypical children are enabling only. However, in some

instances, they are mandatory. In Illinois the law providing for the education of crippled children in special schools or classes is enabling only, although it is mandatory that provision be made for the instruction of crippled children. For each crippled child the State allows the sum of three hundred dollars over and above the amount necessary for the education of a normal child.

All schools and classes established under the law are subject to the supervision of the Superintendent of Public Instruction. Delinquent children also are cared for by a law which is enabling. The State provides for excess cost in the amount of \$190.00 a year. For the blind and deaf and dumb children the State provides, under a Board of Education, for blind and deaf and dumb, for a minimum of \$300.00 and a maximum of \$500.00 each a year.

A big problem in this connection is to secure the actual money from the State.

(2) **Boards of Education.**—Naturally the school executive derives his authority from his Board of Education and he is responsible to it. Cost is a matter of concern to all boards, and keeping the cost of educating the atypical child down is a prime concern of the executive. In other words he is faced with the problem of furnishing the best in education at the least possible cost. However, Boards of Education are sympathetic toward exceptional children which helps somewhat to ease the difficulties with which the executive is faced.

(3) **Administrative staff.**—In any large scale undertaking an adequate administrative staff is a necessity. If such staff is to function most effectively, provision must be made for research, study, and planning. Obviously the busy executive can not do these things well and at the same time carry on his administrative duties. The problem here is to secure the staff. The staff, once it becomes available, is not a problem, but a solution.

(4) **Supervisory staff.**—The distinction between administration and supervision has been discussed and it is so well understood that there is no need to dwell on it here. However, there is need to stress the necessity for educational supervision of the proper kind in every atypical child. This is a problem controlled by Boards of Education, and, it will not be solved until they understand the necessity for trained supervisors.

(5) **Teacher selection.**—Within each state there should be a fixed standard of requirements for teachers of exceptional children. This applies particularly to teachers for the blind and partly sighted, for the deaf and hard of hearing, and for the mentally retarded. Here the supervisor could render an invaluable service in the matter of teacher selection.

(6) **Budget.**—So far as local Boards of Education are concerned they are loath to provide more for the handicapped than they do for the normal children. They take the stand that it is the State's business

to provide for exceptional children. This increases the number of problems connected with administration and supervision.

Where funds for the education of atypical children are tied down by hard and fast budget rules it makes operation to the best advantage of the children themselves impossible.

(7) **Housing.**—The difficulties here are almost too obvious to require comment. We may include with housing all of those facilities which should go with it.

Special housing and special facilities mean extra money, and money is all too difficult to come by. In the meantime we improvise and make most of existing buildings inadequate though they may be.

(8) **Curriculum.**—In the preparation of curricular material for the different deviates the supervisor in his particular field can render a most valuable service. In fact, the supervisor should play such an important part in the education of the heterologous child that I keep stressing the need for the supervisor. Perhaps nothing is more difficult than providing the best possible curriculum for each kind of exceptional child, and certainly the expert should have a hand in its preparation. Simply modifying existing curricular material does not solve the problem.

(9) **Personnel.**—This involves teacher selection and supervision for which we have little provision at present. It means that the whole matter is dumped in the lap of the executive, and he may do the best he can with it. Obviously the arrangement could be improved, although from the standpoint of the executive the problem is not difficult.

(10) **Elementary and secondary education.**—Until we can shake off the shackles of what is considered normal elementary and secondary education we shall make little progress in educating the child who is different. The dominance by standard types of education in the atypical fields retards progress in the latter. This situation will not be improved until education for the exceptional child is divorced from that for the normal child and wholly new methods of and materials for instruction are provided.

I hope that I have given a sufficient sampling of the problems involved in the administration and supervision of special schools and classes to make clear the necessity for a differentiation of administrative and supervisory functions and to interest you in the education of the handicapped child.

## Preparing the Adolescent Mind for Living

David Condron

*High School, Quincy, Illinois*

The subject of adolescent psychology is too broad to do more than touch briefly. It is my purpose merely to show how one high school teacher in the field of Social Science has tried to prepare the adolescent mind for living.

Before one can live one must eat. It is hard to enjoy life when we have to worry about finances, food, clothing and shelter, our jobs, our bank accounts, and our old age. One of our most important problems is to make this economic system of ours work so that not just a few at the top, but that the millions of "common folks" can enjoy economic liberty (to work) and independence.

But while our economic problems are important, there are other parts of living that are equally as important, chief of which is character development. One of the greatest tragedies of the depression is our loss of confidence in each other. We lose faith in our politicians when they enter on such disgraceful campaigns as are being waged today between our major political parties. We lose faith in our business institutions when our Senate uncovers the policies of some of our munitions makers, and our utilities. Do we not owe it to our high school students to bring to their attention such beautiful and courageous characters as Christ, Pasteur, Washington, Lincoln, Thomas Mott Osbourne, Jane Addams, and many others.

Another important part of living is the appreciation of beauty. As Dr. Shannon pointed out in speaking on "The House of the Educated Man," we would do well to pause each day to see something beautiful, to remember something beautiful, and to do something beautiful. If we are to aid our adolescents to live we must help them to appreciate those acts that are beautiful, that lift one onto a higher plane of mental and emotional experience.

In attempting to prepare the adolescent mind for living I have striven to bring about the realization of (1) certain problems, (2) ideals in the solution of those problems, (3) methods of approaching those ideals. If we look at a very few of those problems selecting one in each field, economic, social and political it is not difficult to find excellent examples.

In the field of economics we may take the paradox of want in the midst of plenty. In bringing about the realization of this problem the students in Social Science are encouraged and assisted in a wide read-

ing. We study this problem from a local, national and international standpoint. We try to appreciate, for example, that according to conservative estimates the nations of the world as a whole are capable of supporting the people of the world as a whole on a reasonably high plane of living. In the United States we attempt to comprehend the phenomenon of a national capacity to produce an actual quantity of goods and services to an estimated value of well over 100 billion dollars while in 1932 we produced about 39 billion dollars worth.

When that problem has been understood we attempt to establish ideals. It is quite possible that on many of these ideals there may be a difference of opinion. Consequently they are somewhat elastic rather than hard and fast. The attempt is made to draw these ideals from the students themselves rather than attempting to force them to accept those of their instructor. The ideals are established through reading of books, study of the goals reached by other countries, and class discussion.

For example, at the present time we are devoting considerable time to the study of the consumers' cooperative movement. The students are reading books and pamphlets on the Consumers' Cooperative Movement in Japan, Sweden, Finland, Denmark, England and America. In some the ideal has caught the imagination and these young people are now ready for the third step namely that of ways and means of approaching that ideal.

Those who believe that the cooperative movement will result in the better and more equitable distribution of goods and services are learning that that goal can not be reached by mere fanciful wishing. They are learning first that they must educate themselves on the movement so that they will understand it and be able to discuss it intelligently. The next goal is that of educating other people. Here again a few are getting a practical lesson in the field of education through the realization of the conservatism of their friends, parents, and neighbors. They are learning that it will take a great deal of time, of work and effort in order to bring about their goal—the establishment of a Consumers' Cooperative in Quincy. There are some who are actively trying to educate others to what they believe a desirable movement. How much they will accomplish time alone will tell.

Those who do not believe in the movement are given every opportunity to study and state their side of the case. The class conflict of opinion is often very interesting and at times exciting.

In the field of social problems we might take the family and the subject of marriage and divorce. In this field the problem of broken and divorced homes, having children of divorced parents is not difficult to realize. The ideal of a family in which husband, wife, and children are joined together in happy union and cooperation is easily appreciated. The difficulty lies in the method of approaching that ideal. In attempting to understand the solution of the problem the student is brought back to the economic function of the family. He is encouraged

to study ways of fulfilling that function through reading such books as those of Ralph Borsodi, "This Ugly Civilization" and "Flight From the City." The effort is made to help the prospective brides and grooms understand the financial obligations of married life and the necessity of a budget, how they can raise their plane of living even though their wages may not be as high as desired through the production of goods in the home.

The student comes to know that married life is more than three meals a day and the physical attraction of each for the other. He sees that he must give and take, sacrifice as well as receive, understand the other's problems and moods as he expects the other to understand his, and to make life beautiful and worth while.

In the political field civil service furnishes a good example. The problem of men totally unfit morally, intellectually and all too frequently inadequately trained. The goal, public employees honest and upright in character, interested in social welfare, intellectually qualified to do the job.

In order to approach that goal he sees the need for abandoning the spoils system, for abolishing greed in the attaining of jobs, for educating the public to the waste and inefficiency of our present method of appointing public servants, and educating the public to the desire for a better system.

I do not wish to indicate that I am one hundred per cent successful in my attempt to help my students develop the correct attitude toward life. There are many many times when the results are particularly discouraging. The true value of our efforts however can not be measured at this time or by the report cards. When these adolescents actually begin to work, to establish their own homes, to live in a world outside of school, when some of the ideals they have established in school remain the guiding goals of their lives, then and then only can we feel gratified that our efforts have not been entirely wasted.

# Motivated Remedial Reading in the High School

David Kopel

*Northwestern University, Evanston, Illinois*

In recognition of the large number of children who enter the high school with reading ability so low as to handicap materially (if not preclude success in) their work in most courses, an attempt is being made to devise an effective and feasible method of teaching these children to read efficiently. It is hoped that from the experimental work will emerge a remedial technique applicable in all high schools. This project is being developed at the Steinmetz High School.

The children selected for this special work are 1B and 1A students whose reading level, on standardized tests, is below that of the 7th grade, and who possess IQ's over 80. These youngsters have been placed in special English classes; their English period is devoted to remedial work in reading. In individual interviews teachers have made a thorough inventory of each child's vital interests, activities, and experiences: favorite leisure activities, hobbies, play preferences, vocational ambitions, wishes, personal problems and relationships, movie and radio preferences, and reading habits and experiences. These interviews, conducted during the regular English and study periods of the first few weeks of the semester, have served the purpose of: (1) Providing a basis for the teacher's real understanding of the individual; (2) effecting a friendly, sympathetic teacher-pupil relationship, important in all school endeavor, and essential in remedial work with children who have failed, who are frequently maladjusted, antagonistic, or indifferent, and whose *attitudes* consequently must be changed; and (3) obtaining an index to books and periodicals which the children will *want* to read, because these materials relate to the *children's* problems, *their* activities and interests, the things they want to know about.

Many new and vital materials, representing diverse interests, and appropriate for these children of limited reading ability, have been selected and are being made available. The library has cooperated in this phase of the program.

Day by day classroom procedures are carefully and specifically planned in advance (in weekly units). However, these schedules are flexible and may be adapted to special conditions and needs which may arise. Detailed descriptions of the daily programs, and samples of the forms devised for recording children's progress, are made available to those who visit the school. Typical procedures will be portrayed.

One very important phase of the project is a clinical set-up which provides for thorough physiological and psychological diagnosis of each child. The clinic, an extension of the Northwestern University Psycho-Educational Clinic directed by Dr. Witty and Dr. Kopel, is held weekly. Every Tuesday, from 10 A. M. to 3 P. M., visitors may observe examinations of children's vision, hearing, lateral dominance, intelligence, reading and general adjustment.

An informal conference of the entire staff (consisting of the director—Professor Witty, the psychologist—the writer, the four remedial teachers and their apprentice assistants, and an administrative assistant in immediate charge) takes place each Tuesday from 12:30 to 1:15 P. M. Problems and experiences of the previous week are discussed, and plans for the following week are formulated. Visitors are invited to attend these conferences and to observe the classes at work.

It should be understood that the program to be described is in the *developmental* stage; it is *experimental*, *tentative*, and *exploratory*, and only a *preliminary* to a mature and expanded program which will be initiated in various schools in 1936-1937.

## Contributions of Physical Education to Adolescence

L. G. Kranz

*Northwestern University, Evanston, Illinois*

The first part of this paper attempts to build a physiologic and anatomic background for heart and circulatory considerations that are discussed in relation to physical education activities. This material is a summarization from such authorities as Percy Dawson, R. Tait McKenzie, Edward C. Schneider, John Mason Tyler, William H. Howell, Henry Gray and James H. McCurdy. The material is summarized in order to present the idea that there is a natural weakness of the heart during adolescence that would make necessary a protective program in activities. Heart conditions vary greatly and prescriptions should vary accordingly. Certain children of Junior and early Senior High School age develop a murmur of the heart with considerable irregularity of cardiac action. There is no organic disease and the condition is recognized as adolescent heart. These cases improve markedly under regular, fairly vigorous exercise that avoids continuance after fatigue. Competition for these children is not desirable, particularly competition of the inter-scholastic type. Many boys are sacrificed on the alter of successful athletic teams through lack of control of high school inter-scholastic competition.

The paper then discusses the values of prescribed exercise in relation to the heart, the lungs, and the weight of adolescent boys as shown by experimental data from the United States Public Health Service.

At this point the physiologic values of training are related, again emphasizing the values chiefly to the circulatory apparatus. In protecting the adolescent boy and girl it would be well to regulate games according to age. There has been some idea that this age boy should be taking part in less highly organized games. It must be remembered that children are great imitators. Boys and girls want to imitate activities of the grown up. This is evident in all types of child play—playing house, doctor, gardner, mother, "Babe Ruth", etc. They are not content to play in doll houses with playthings that are for children. Failure to follow up this idea into adult games has been too much discouraged to the child copying adult play. If play for the child were conducted properly, the protective element physiologically would result and greater interest would attain. Children would learn to play skillfully, rather than feeling discouraged and awkward.

Why should a child play volley ball on a court worked out for adults? Why play badminton on a court and with a net worked out for adults? The paper emphasizes the importance of games played on courts and with equipment fitted to the child.

We continue to take part in activities we do well or hope to do well. We encourage skills then so that the individual will continue regular activity because knowledge and skill in some activity has been acquired. Basic changes take place during adolescence. Preparation for and guarding of adolescent youth is urgent in terms of physical activity. Let's not be so greatly concerned with stream lined trains, all-wave radio sets, air flow cars, television and the like and more concerned with sound bodies, through regulated exercise particularly during adolescence.

## PAPERS IN ZOOLOGY

---

### EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN

The program of the Zoology Section included fourteen papers and three demonstrations of which nine papers are here represented. The other five papers and the demonstration were as follows:

*The Problem of Self-Fertilization Among Hermaphrodite Snails*, by Clarence L. Furrow, Knox College, Galesburg.

*Mastodons of the Mississippi Valley*, by O. D. Thurber, Quincy High School, Quincy.

*Evolution in the Habits of Lycaenid Butterflies*, by W. V. Balduf, University of Illinois, Urbana.

*A Study on the Migration of Birds*, by T. E. Musselman, Gem City Business College, Quincy.

*A Note on the Staining of the Excretory System of Trematodes* (paper and demonstration), by Donald B. McMullen, Monmouth College, Monmouth.

*Some Parasites of Florida Amphibia* (demonstration), by A. C. Walton, Knox College, Galesburg.

*Preparations of Camallanus trispinosus (Leidy)* (demonstration), by Wiley W. Crawford, Blackburn College, Carlinville.

About sixty persons were present at the meeting.

George Moreland, Greenville College, Greenville, Illinois was elected chairman of the Zoology Section for the 1937 meeting.

(Signed) DONALD B. McMULLEN, *Chairman*



## Remains of Animal Life From the Kingston Kitchen Midden Site Near Peoria, Illinois

Frank Collins Baker

*University of Illinois, Urbana, Illinois*

The kitchen midden pits in the Illinois Valley near Kingston, fifteen miles southwest of Peoria, have yielded a large number of species of animals, both vertebrate and invertebrate. Through the kindness of Mr. A. M. Simpson of Peoria quantities of this material have been submitted for study. Studies of this kind are of value not only to the archeologist but also to the zoologist for species now rare in the locality are found to have been common at the time the Indians made the kitchen middens. Also some species may be found to have had a wider distribution previously, as in the case of the rice rat herein recorded. Some material was reported from this site in a previous paper in the *Transactions of the State Academy* (Vol. 23, page 231, 1931).

The invertebrates consist only of Mollusca, principally the naiades or river mussels. Twenty-one different species and races of clams and two species of snails were found in the material. Nearly all of the species are now living in the Illinois River below Peoria. This is the largest number of species of mussels reported from any kitchen midden deposit yet recorded.

The vertebrates are divided among the fishes, reptiles, birds, and mammals. Of the fish at least six species are represented, all common in the Illinois River at the present time. Of the reptiles only turtles were represented, belonging to the genera *Chrysemys* or *Pseudemys*, and *Amyda*. Of the birds 31 species and races are recorded, a very large number for one locality and more than twice as many as previously recorded. Among the bird groups represented are 11 ducks and geese, three hawks, and two swan. Of special note are the trumpeter swan, wild turkey, sandhill crane, and long-billed curlew, now rare in Illinois. The bones most usually preserved are the wing and the leg bones.

Of the mammals, 13 species are represented. Of special interest in this group is the beaver, now extinct in Illinois. This mammal must have been a favorite animal with the Indians for its skull or other bones are not uncommon among kitchen midden material. The otter, also, is now rare in southern Illinois and practically absent from the rest of the state. The rice field mouse (*Oryzomys*) is at present known only from southern Illinois and the record from near Peoria carries the former dis-

tribution well up into the middle of the state. The mammal bones preserved in these deposits consist usually of parts of the skull, leg bones, pelves, and vertebrae.

All of the species contained in the kitchen midden material is listed below. The vertebrate material was identified by specialists in the United States National Museum, and the thanks of the writer are due these specialists for their trouble in identifying such fragmentary material. The naming of the several groups should be credited to the following people:

*Birds.* Dr. A. Wetmore, Assistant Secretary of the Smithsonian Institution, in charge United States National Museum.

*Mammals.* Mr. Gerrit S. Miller, Curator of Mammals, United States National Museum.

*Fishes.* Dr. G. S. Myers, Assistant Curator of Fishes, United States National Museum and Mr. Earl D. Reid, Aide in the Division of Fishes of the same institution.

*Turtles.* Miss Doris M. Cocran, Assistant Curator of Reptiles and Batrachians, United States National Museum.

*Mollusca.* Frank C. Baker, University of Illinois.

The asterisk preceding a name indicates that it was listed in the previous paper published in the Transactions of the Illinois Academy of Science.

#### SYSTEMATIC LIST OF SPECIES REPRESENTED

##### MOLLUSCA (Clams and snails)

*Fusconaia undata trigona* (Lea). Three left valves, adult.

*Fusconaia ebenus* (Lea). One right valve, adult.

\**Megalonaias gigantea* (Barnes). One left valve, small specimen.

*Amblema rariplicata* (Lamarck). Two right valves, adult. One left valve, immature.

*Quadrula pustulosa* (Lea). One left, one right valve, adult.

*Quadrula quadrula* Rafinesque. One left valve, adult.

*Cyclonaias tuberculata* Rafinesque. One right valve, adult.

*Pleurobema pyramidatum* (Lea). One left valve, half grown shell.

*Pleurobema coccineum mississippiense* F. C. Baker. One left valve of an adult shell does not differ from this common variety of the Mississippi River. It has not been found alive in the Illinois River near Peoria.

*Plethobasus cyphus* (Rafinesque). One left valve, half grown.

\**Elliptio crassidens* (Lamarck). One right valve.

*Elliptio dilatatus* (Rafinesque). Five right and four left valves, adult.

*Alasmidonta marginata truncata* (B. H. Wright). One left valve, adult.

*Arcidens confragosus* (Say). One left valve, adult but small.

*Actinonaias carinata* (Barnes). Three right and three left valves, adult.

*Plagiola lineolata* Rafinesque. One left valve, adult.

\**Proptera alata megaptera* (Rafinesque). One right and one left valve, about half grown.

\**Ligumia recta latissima* (Rafinesque). One left valve, adult but small.

*Lampsilis fallaciosa* (Smith) Simpson. One right valve, small.

*Lampsilis siliquoidea* (Barnes). Two left valves, small.

*Lampsilis ventricosa occidens* (Lea). Two right valves, adult.

*Campeloma rufum* (Haldeman). One specimen, adult.

*Pleurocera acuta lewisii* (Lea). One specimen, adult.

## PISCES (Fish)

- \**Amia calva* Linn. Dogfish. Dentary, clavicle, opercle, preopercle, suborbital.
- Lepisosteus osseus* (Linn.) Long-nosed gar. Dentary and interopercle.
- \**Ameiurus* species. Bullhead. Dentary, pectoral spine, clavicle.
- Micropterus* species. Black bass. Interhaemal spine.
- Ictiobus bubalus* (Rafinesque). Small-mouth buffalo. Hypural, shoulder girdle, opercle, pelvic girdle, ribs, pectoral finrays, preopercle, interopercle, subopercle, supraclavicle, postclavicle, branchial arch, neural spine, interhaemal spine.
- \**Aplodinotus grunniens* Rafinesque. Fresh-water drum. Interneural spine, anal spine, hypural.
- Stizostedion* species. Pike perch. Dentary.

## REPTILIA (Turtles)

- Chrysemys* or *Pseudemys* species. Scapula, coracoid, humerus, lower jaw.
- Amyda* species. Humerus.

## AVES (Birds)

- Nycticorax hoactli* (Gmelin). Black-crowned night heron. Humerus and ulna.
- Botaurus lentiginosus* (Montagu). American bittern. Ulna.
- \**Cygnus buccinator* Richardson. Trumpeter swan. Humerus and ulna.
- \**Cygnus columbianus* (Ord) Whistling swan. Metacarpus and femur.
- \**Eranta canadensis* (Linn.). Canada goose. Metacarpus and coracoid.
- \**Anas platyrhynchos* Linn. Mallard duck. Humerus, metacarpus, tibio-tarsus.
- Dafila acuta tzitzihua* (Vieillot). Pintail duck. Metacarpus.
- \**Nettion carolinense* (Gmelin). Green-winged teal. Ulna.
- \**Querquedula discors* (Linn.) Blue-winged teal. Coracoid, humerus, metacarpus.
- Aix sponsa* (Linn.) Wood duck. Humerus.
- Nyroca valisineria* (Wilson). Canvas-back duck. Metatarsus and metacarpus.
- Nyroca affinis* (Eyton). Lesser scaup duck. Metacarpus.
- Nyroca (affinis or collaris Don.)* Caracoid and femur.
- Charitonetta albeola* (Linn.) Bufflehead. Metatarsus and tibio-tarsus.
- Lophodytes cucullatus* (Linn.) Hooded merganser. Humerus (2).
- Buteo lineatus* (Gmelin). Red-tailed hawk. Metacarpus.
- Buteo borealis* (Gmelin). Red-shouldered hawk. Metacarpus.
- Buteo platypterus* (Vieillot). Broad-winged hawk. Metacarpus.
- Haliaeetus leucocephalus* (Linn.) Bald eagle. Humerus and ulna.
- \**Tympanuchus cupido americanus* (Reich.) Prairie chicken. Tibio-tarsus, scapula, metacarpus, ulna.
- Colinus virginianus* (Linn.) Bobwhite. Humerus and femur.
- \**Meleagris gallopavo silvestris* (Vieillot). Wild turkey. Humerus, femur, metacarpus, coracoid, tarso-metatarsus, ulna, and tibio-tarsus.
- Grus canadensis* (Linn.) Sandhill crane. Part of ulna.
- Porzana carolina* (Linn.) Carolina rail. Tibio-tarsus and furcula.
- Fulica americana* Gmelin. Coot. Metacarpus and tibio-tarsus.
- Numenius americanus* Bechstein. Long-billed curlew. Ulna.
- Philohela minor* (Gmelin). Woodcock. Tibio-tarsus.
- Limnodromus griseus* (Gmelin). Dowitcher. Humerus.
- Colaptes auratus luteus* Bangs. Flicker. Ulna.
- Agelaius phoeniceus* (Linn.) Red-winged blackbird. Humerus.
- Quiscalus quiscula* (Linn.) Grackle. Ulna.

## MAMMALIA (Mammals)

- \**Odocoileus virginianus* (Bodd.). Virginia deer. Teeth, part of skull, part of lower jaw, heel and toe bones, vertebrae.
- Sciurus niger rufiventer* (Geoffroy). Fox squirrel. Humerus, radius, tibia, ramus of lower jaw.
- \**Sciurus carolinensis* Gmelin. Gray squirrel. Humerus.
- \**Castor canadensis* Kuhl. Beaver. Pelvis, humerus, radius, tibia, fibula, ulna, rib, vertebrae.
- \**Ondatra zibethica* (Linn.) Muskrat. Part of skull and lower jaw, pelvis, sternum, humerus, femur, tibia-fibula.
- \**Mustela vison luteocephalus* (Harlan). Mink. Skull and lower jaw, femur, humerus, ulna, foot bones.
- Lutra canadensis* (Schreber). Otter. Skull.
- Procyon lotor* (Linn.) Raccoon. Left ramus of jaw, radius.
- Lynx rufus* (Guldenstaedt). Wild cat. Bob cat. Humerus.
- \**Canis familiaris* Linn. Skull and jaws, scapula, part of pelvis, femur, humerus, ulna, radius, tibia, rib, toe, bones, atlas.
- Scalopus aquaticus cf machrinus* (Raf.) Prairie mole. Jaw, tibia.
- Sylvilagus floridanus mearnsii* (Allen). Mearn's cotton-tail rabbit. Lower jaw, scapula.
- Oryzomys palustris* (Harlan). Rice field mouse. Femur, tibia-fibula, skull.

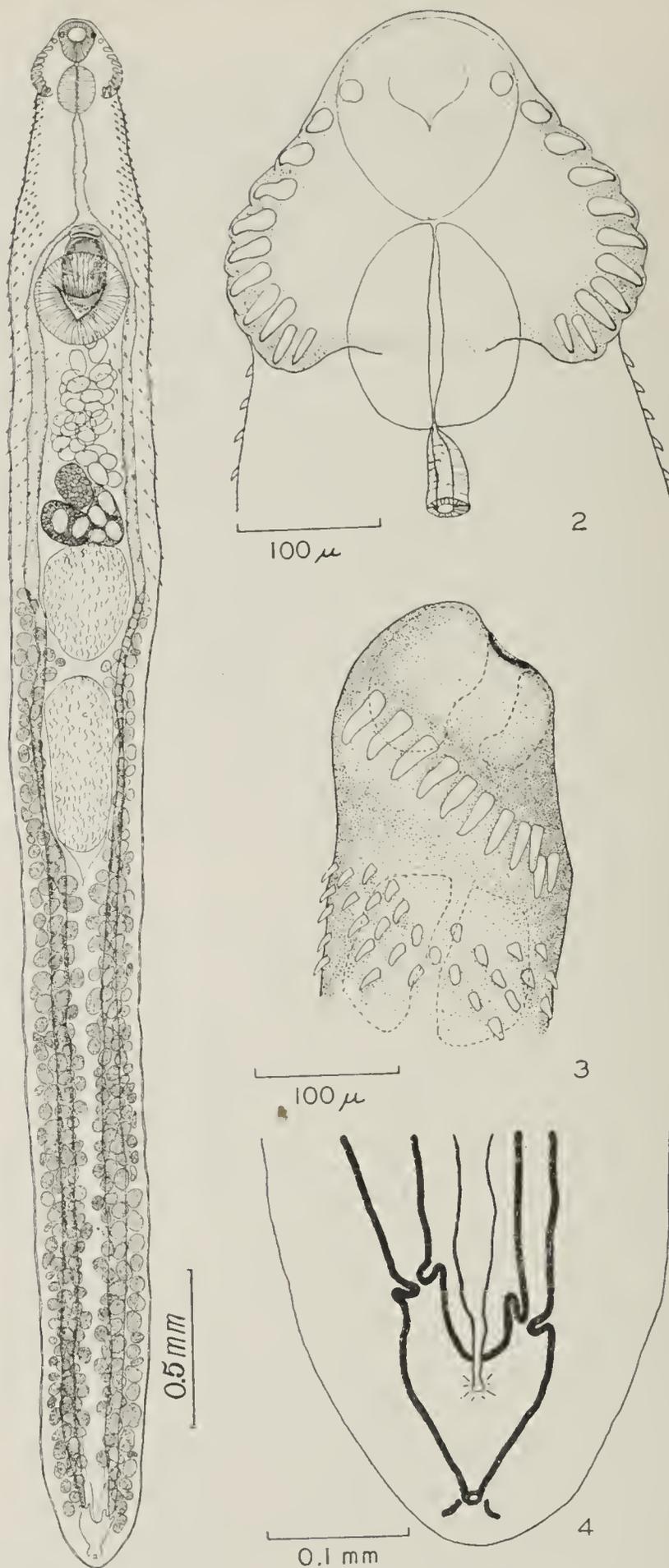
## Notes on *Stephanoprora polycestus* (Dietz) From the American Crow

Paul Beaver

Oak Park Junior College, Oak Park, Illinois

In March, 1934, three crows (*Corvus brachyrhynchos brachyrhynchos*) were received from Havana, Illinois. They had been taken in a cage trap and were fed "fish" for several days before they came into my hands through the kindness of Dr. David H. Thompson and other members of the research staff of the Illinois State Natural History Survey. Trematode ova were found in the feces of each crow on the third day after they were received which was roughly two weeks after their capture and first feeding of fish. Three weeks later, 19, 19, and 6 specimens of *Stephanoprora polycestus* Dietz, 1909 were taken from the middle ileum of each of them respectively. Since each carried the same species of worm and the specimens were in the same stage of development (all mature and very uniform in size) it is possible that all became infected at the same time, from the same source, and therefore from the fish on which they were fed.

Although there are but a few points on which my observations differ from previous descriptions of *S. polycestus*, a brief description is added to the report of its incidence. Body length, 4.4 to 4.8 mm; length 10 X greatest width at level of anterior testis. Measurements in microns on an average specimen 4.8 mm long are: width of collar, 249; diameter of acetabulum, 275; oral sucker, 146 by 130; pharynx, 144 by 118; ovary, 130 by 100; anterior and posterior testes respectively, 378 by 283 and 522 by 193; ova, 52 by 84 to 58 by 80. In all specimens, body length 8.28 to 6.60 X pre-acetabular region, 2 to 2.2 X post-testicular region and 11.2 to 12.6 X the region between acetabulum and ovary. Rather stout cuticular spines, 12 to 16  $\mu$  in length, are restricted to the pre-acetabular region dorsally but reach to the anterior testis ventrally. The mid-ventral pre-acetabular area is without cuticular spines. There are 22 cephalic spines of nearly equal size arranged into right and left rows separated dorsally and ventrally by a space about equal to the width of the oral sucker. The two posteriormost spines on each side are smaller than, and are distinctly aboral or posterior to the 9 remaining ones (Fig. 2, 3). The largest cephalic spine is 40 to 42  $\mu$  by 12 to 14  $\mu$ . The uterus is of moderate length and contains from 40 to 75 ova. The length of the cirrus sac is roughly equal to the diameter of the acetabulum and reaches to about the center of that organ (Fig. 1). In good preparations this species may be seen to possess a uroproct. This structure is partially covered by the vitellaria, which probably accounts for the fact that it has not been observed previously in this species (Fig. 1, 4).



- Fig. 1.—*Stephanoprora polycestus*. VENTRAL VIEW OF TYPICAL SPECIMEN FROM THE CROW. CAMERA LUCIDA DRAWING.
- Fig. 2.—HEAD CROWN. VENTRAL VIEW. CAMERA LUCIDA DRAWING OF CLEARED SPECIMEN.
- Fig. 3.—HEAD CROWN. LATERAL VIEW. CAMERA LUCIDA DRAWING OF OPAQUE SPECIMEN.
- Fig. 4.—POSTERIOR END SHOWING CONNECTIONS OF EXCRETORY BLADDER AND INTESTINAL CECA WITH UROPROCT.

**Discussion.**—There are ten or less valid species of echinostomes that belong to the genus *Stephanoprora* Odhner, 1902 (= *Mesorchis*, Dietz, 1909 = *Monilifer* Dietz, 1909 nec *Mesorchis* Linton, 1910) as it was originally described (Odhner, 1902, 1910). One finds in the literature several other species that might cause some confusion with the true members of this genus. *Mesorchis urna* Linton, for example is a member of the Allocreadiinae, Linton's genus *Mesorchis* being created independent of the genus *Mesorchis* Dietz, 1909 (= *Stephanoprora* Odhner, 1902); *Monilifer pitangi* Lutz, 1924 is taxonomically misplaced, it being a member of the genus *Echinochasmus* Dietz, 1909; and *S. anomala* Travassos, 1922 is too imperfectly known to allow systematic treatment. As a result of a study of the variability to be observed in specimens of *S. denticulatus* (Rud., 1802) from various hosts from different regions Odhner (1910) was led to regard *Ech. pseudoechinatum* (Olss., 1876), *Mesorchis polycestus* Dietz, 1909 and (?) *Ech. spinulosum* (Rud. nec Dietz) as synonyms of *S. denticulatus*, and he also regarded *Monilifer spinulosus* Dietz, 1909 (nec Rud.) as a synonym of *S. spinosa* Odhner, 1910, it being necessary to create the new name because "spinulosa" was preoccupied. My own study of this group as well as an earlier study (Beaver, 1936) of the genus *Echinostoma* leads me into agreement with Odhner on all species excepting *S. polycestus*. I regard it as distinct from *S. denticulatus* because of its more anteriorly disposed vitellaria, more extensive uterus and relatively smaller suckers and head crown. *S. gilberti* Ward, 1917, which was reported and briefly described by Gilbert (1905) as *Ech. spinulosum* and renamed by Ward (1917, 1918) is apparently identical with *S. spinosa* Odhner. Although I regard *S. polycestus* as a valid species I am inclined to disregard the one point of description on which it may be considered to disagree with the worms described above from the crow. In both text and figure (Dietz, 1910, p. 453, Textfig. M<sup>2</sup>) its cephalic spines are represented as having distinctly flat bases. All of the related species have bluntly rounded bases which sometimes appear to be nearly flat. I am doubtful if this can be a real difference. *S. reynoldi* Bhalerao, 1926 and *S. merulae* Yamaguti, 1933 are doubtless both identical with *S. polycestus*. The author of the first mentioned separated it from *S. polycestus* because of very slight differences in the ratio of the suckers and position of the cirrus sac, both of which are variable within limits which are quite unavoidable even when uniform methods of fixation are used. Egg size, length of spines, and extent of the vitellaria were regarded as unique in *S. merulae*. There is a difference of only 6 to 9 microns in the size of the eggs in the three species (*merulae*, *reynoldi*, *polycestus*). The spines of each are about equal in size when compared with the size of the worm, the longest being about one one-hundredth the total length of the body in each. The vitellaria in each reaches well up along the sides of the anterior testis. *S. merulae* and *S. reynoldi* were each described from single specimens that were fairly immature, having just begun egg

formation. *S. denticulatoides* Isaitschikow, 1924 from the dog is apparently also identical with *S. polycestus*, although it is somewhat smaller. Its maximum length is only 4.2 mm.

It is therefore probable that the nine species included in the following key constitute the only valid species of the genus *Stephanoprora*; and the worms described above from the crow, *Corvus b. brachyrhynchos*, are North American representatives of the species *S. polycestus*.

KEY TO THE SPECIES OF THE GENUS STEPHANOPRORA ODHNER, 1902  
(= Mesorchis, Monilifer)

- |     |       |  |                                    |    |
|-----|-------|--|------------------------------------|----|
| 1.  | (2)   | Cephalic spines 26 in number.....  | <i>ornata</i> Odhner, 1902         |    |
| 2.  | (3)   | Cephalic spines 24 in number.....  | <i>ozakii</i> (Asada, 1926)        | 4  |
| 3.  | (1,2) | Cephalic spines 22 in number.....  |                                    | 5  |
| 4.  | (11)  | Vitellaria distinctly posterior to junction of testes.....   | <i>singularis</i> (Lutz, 1924)     |    |
| 5.  | (6)   | Acetabulum wider than body proper.....   |                                    | 7  |
| 6.  | (5)   | Acetabulum not wider than body proper.....   |                                    | 8  |
| 7.  | (10)  | Angle spines distinct from border spines.....  |                                    |    |
| 8.  | (9)   | Vitellaria extend to middle of posterior testis.....   | <i>denticulatus</i> (Rud., 1802)   |    |
| 9.  | (7)   | Vitellaria confined to post-testicular region.....   | <i>microtestius</i> (Kurova, 1927) |    |
| 10. | (4)   | Angle spines not distinct from border spines.....  | <i>pendula</i> (Looss, 1899)       |    |
| 11. | (3)   | Vitellaria at junction of testes or more anterior.....   |                                    | 12 |
| 12. | (15)  | Uterus very short, being less than length of region of body anterior to genital pore.....              |                                    | 13 |
| 13. | (14)  | Body stout; testes large, occupying $\frac{1}{4}$ to $\frac{1}{2}$ of hind-body.....                   | <i>spinosa</i> Odhner, 1911        |    |
| 14. | (12)  | Body slender; testes occupying less than $\frac{1}{4}$ of hind-body.....                               | <i>conciliata</i> (Dietz, 1909)    |    |
| 15. | (11)  | Uterus of medium length, being greater in length than the region of body anterior to genital pore..... | <i>polycestus</i> (Dietz, 1909)    |    |

- BEAVER, P. 1936. Experimental Studies on *Echinostoma revolutum* (Froelich), a Fluke from Birds and Mammals. Ill. Biol. Monogr. 15: No. 1.
- BHALERAO, G. 1926. The Trematodes of *Corvus insolens* (A Burmese Housecrow), with a Description of Four New Species. Parasitol. 18:387-398; 5 Fig.
- DIETZ, E. 1909. Die Echinostomiden der Vögel. Zool. Anz. 34:180-192.
1910. Ibid. Zool. Jahrb. Suppl. 12:265-512; Pl. 10-15, 78 Textfig.
- GILBERT, N. 1905. Occurrence of *Echinostomum spinulosum* Rud. Amer. Nat. 39:925-927; 1 Fig.
- ISAITSCHIKOW, I. M. 1924. Parasitic Worms of Domestic Animals in the Crimea (Russian). Trudy Sibir. Vet. Inst. Omsk 6:47-104; 8 Fig.
- KUROVA, O. 1927. Contributions à la connaissance des Trematodes (fam. Echinostomidae) des oiseaux du Turkestan. Ann. Mus. Zool. Leningrad 27:113-130; Pl. IX-X.
- LINTON, E. 1910. Helminth Fauna of the Dry Tortugas. II. Trematodes. Carnegie Inst., Wash., Publ. No. 133:11-98; 28 Pl.
- LOOSS, A. 1899. Weitere Beiträge zur Kenntnis der Trematoden-Fauna Aegyptens, zugleich Versuch einer natürlichen Gliederung des Genus *Distomum* Retzius. Zool. Jahrb. Abt. f. Syst., 12:521-784; Pl. 24-32.
- LUTZ, A. 1924. Untersuchung über die Entwicklungsgeschichte brasilianischer Trematoden. Spezieller Teil I. Echinostomidae. Mem. Inst. Oswaldo Cruz. Rio de Janeiro 17:75-93; Pl. 5-12.
- ODHNER, T. 1902. Trematoden aus Reptilien nebst allgemeinen systematischen Bemerkungen. Ofversigt Kongl. Vetensk.-Akad. Förhandl. Stockholm, I:19-47.
1910. Results of the Swedish Expedition to Egypt and the White Nile, 1901. No. 23A. Nordostafrikanische Trematoden, grösstenteils vom Weissen Nil. I. Fascioliden. 170 pp.; 6 Pl.; 14 Textfig.
- TRAVASSOS, L. 1922. Informacoes sobre a fauna helminthologica de Matto Grosso. Folha Medica 3:188.
- WARD, H. B. 1917. On the Structure and Classification of North American Parasitic Worms. Jour. Parasitol. 4:1-12; 1 Pl.
- and Whipple, G. C. 1918. Fresh-Water Biology. 1111 pp. Boston.
- YAMAGUTI, S. 1933. Studies on the Helminth Fauna of Japan. I. Trematodes of Birds, Reptiles, and Mammals. Japan. J. Zool. 5:1-134; 57 Fig.

# The Illinois Species of *Brachymeria* (Hymenoptera, Chalcididae)

B. D. Burks

*Illinois State Natural History Survey, Urbana, Illinois*

The genus *Brachymeria* Westwood includes a number of primary and secondary parasites often encountered in rearing Lepidoptera and cyclorrhaphous Diptera. *Brachymeria* has usually been treated as the genus *Chalcis*; the hind coxae are elongate and round in cross-section, the hind femora are enlarged and provided with a row of teeth on the lower side, the hind tibiae are arcuate and have a single apical spur, the abdomen is sessile, and the antennae are inserted above the lower margins of the compound eyes. The body is black, but the hind femora are usually colored in part yellow or red.

In the following table of the Illinois species, it is to be noted that the apparent first abdominal segment is actually the third; the malar ridge is a carina running parallel with the fronto-genal suture of the head; the inner tooth of the hind femur is a small projection, ventro-proximad, on the ental surface. All statements regarding color should be taken loosely. In order to verify identifications it is frequently necessary to examine the internal genitalia of the male. In the drawings given of these genitalia, figures 10-14, only the oedagus is shown, the inner and outer sheaths and sagittae being omitted. The sagittae are too variable to be useful for the separation of species.

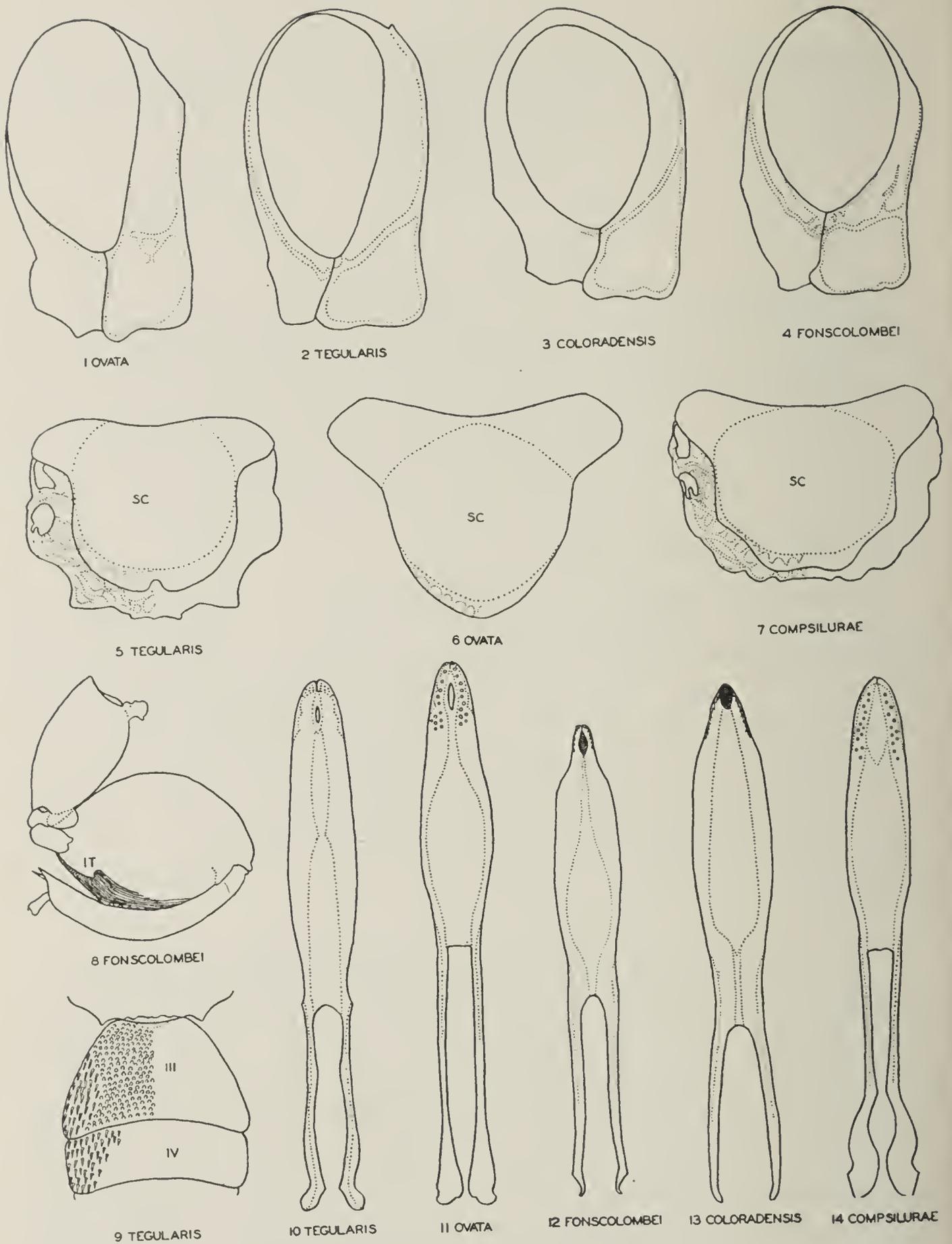
## KEY TO ILLINOIS SPECIES OF *BRACHYMERIA*

1. Dorsal surface of third abdominal segment conspicuously punctate, fig. 9 ..... *tegularis*  
Dorsal surface of third abdominal segment smooth or only very faintly reticulated ..... 2
2. Malar ridge not branched or deflected backwards before reaching compound eye, fig. 1..... *ovata*  
Malar ridge branched or deflected backwards before reaching compound eye, figs. 2-4..... 3
3. Frontal carina absent, fig. 3..... *coloradensis*  
Frontal carina present, fig. 4..... 4
4. Hind femora with a distinct, sharp inner tooth, fig. 8..... *fonscolombei*  
Hind femora without an inner tooth..... *compsilurae*

*Brachymeria tegularis* (Cresson) *new combination*

*Chalcis tegularis* Cresson, *Trans. Am. Ent. Soc.*, 4:60, 1872. Type, number 1825, Philadelphia Academy of Natural Sciences, ♀.

This species is more common west of the Mississippi than in Illinois. The hind femora of the female are almost entirely yellow. The male has not before been described.



EXPLANATION OF PLATE

Figs. 1-4. Lateral aspect of the head, mouth parts omitted.  
 Figs. 5-7. Dorsal aspect of the scutellum (SC).  
 Fig. 8. Ental aspect of the hind femur, IT, inner tooth.  
 Fig. 9. Dorsal aspect of the third and fourth abdominal segments.  
 Figs. 10-14. Male genitalia.

*Male*.—Diagnostic characters as in female. Hind femora black with an apical and a small dorsal yellow spot. Malar ridge branched, fig. 2, scutellum bidentate, fig. 5. Oedagus as in fig. 10.

*Allotype*.—Male; Zion, Ill., July 6, 1932, T. H. Frison et al. Deposited in the collection of the Illinois State Natural History Survey.

Algonquin: Aug. 1, 1895, 1 ♂. Champaign: July 30, 1891, 1 ♀. Dayton: July 18, 1879, 1 ♂. Normal, 1877, 1 ♂. Urbana: Sept. 1, 1886, 1 ♀. Zion: July 6, 1932, 1 ♂.

### *Brachymeria ovata* (Say)

*Chalcis ovata* Say, *Long's Second Expedition*, 2:326, 1824.

The type of this species is lost, but some of the material on which Cresson (1872) based his redescription has been seen in the Philadelphia Academy of Natural Sciences. This species has been synonymized with *flavipes* Fabr., but Dr. Olav Schröder of the Kiel Museum has kindly compared specimens of *ovata* with the Fabrician type of *flavipes* and states that they are not the same species.

This is by far the most common Illinois species of *Brachymeria*. The malar ridge is unbranched, the scutellum is not bidentate, fig. 6, the antennal scape is longer than in most other species, and there is a single, somewhat irregular row of setae near the anterior margin of the dorsum of the fourth abdominal segment. The hind femora of both the male and female are black with an apical yellow (or red) spot. The male genitalia are shown in fig. 11. This species is a primary parasite of Lepidopterous pupae.

Common throughout the state from June to October; taken in hibernation as an adult. The following material has been reared: Normal: July 8, 1905, from Strawberry leaf-roller, 1 ♂. Springfield: Sept. 17, 1909, from Bag Worm, 1 ♀. Urbana: Sept. 10, 1900, from Bag Worm, 1 ♀; July 6, 1922, from Celery Leaf-tyer, 1 ♂, 1 ♀; July 25, 1924, from Tussock Moth, 1 ♂, 1 ♀; July 26, 1924, from Tussock Moth, 1 ♂; Oct. 30, 1935, from Fall Web-worm, 1 ♀; July, 1936, from Tussock Moth, 5 ♂, 4 ♀.

### *Brachymeria coloradensis* (Cresson) *new combination*

*Chalcis coloradensis* Cresson, *Trans. Am. Ent. Soc.*, 4:60, 1872. Type, number 1826, Philadelphia Academy of Natural Sciences, ♀.

*Chalcis dalmanii* Thomson, *Hymen. Skand.*, 4:17, 1875. *New synonymy*.

Mr. A. B. Gahan of the U. S. National Museum suggested that *dalmanii* and *coloradensis* might be the same species, and paratypes of the former, kindly loaned for study by Dr. Rene Malaise of the Stockholm Museum, have proven identical with the type of Cresson's species. This species is a secondary parasite of grasshoppers, having been reared by Kelly (1914) in America, Vinokurov (1927) in Eastern Siberia, Olsuf'er (1929) in Russia, and Rukavishnikov (1930) in Turkestan.

The hind femora of the female are red with an apical yellow spot; in the male they are black with the apex red or yellow, or both. The malar ridge is directed backwards before reaching the compound eye, and the scutellum is emarginate. The male genitalia are shown in fig. 12.

Havana: June 23, 1926, 1 ♂. Mason City: June 21, 1926, 2 ♂, 1 ♀. St. Anne: Aug. 4, 1936, 4 ♂, 2 ♀.

**Brachymeria fonscolombeii** (Dufour)

*Chalcis fonscolombeii* Dufour, *Ann. Soc. Ent. Fr.*, 10:11, 1841. Lectotype ♂ and Lectoallotype ♀ in the Dufour collection, Muséum National d'Histoire Naturelle, Paris. *Present designation.*

M. Lucien Berland has kindly compared specimens with the type series in the Dufour collection, and found the specimens sent to be identical with part of the type series; as this series also includes a specimen of *coloradensis*, lectotypes have been designated for *fonscolombeii*.

This is a holarctic species, a primary parasite of blow flies. A life history has been published by Roberts (1933). The hind femora of both the male and female are red with an apical yellow spot. The malar ridge is branched, and the scutellum is bidentate or emarginate at the apex. The male genitalia are shown in fig. 13.

Urbana: Oct. 5, 1925, 1 ♀.

**Brachymeria compsiluræ** (Crawford)

*Chalcis compsiluræ* Crawford, *Proc. U. S. Nat. Mus.*, 41:272, 1911. Type, 13802, United States National Museum, ♀.

This species occurs in the north central states and New England; it is a secondary parasite of Lepidoptera. A life history has been published by Dowden (1935). The malar ridge is branched, the scutellum is emarginate, fig. 7, and the basal tooth of the hind femur is larger than the others. The hind femora are black with an apical yellow spot in both sexes. The male genitalia are shown in fig. 13.

Algonquin: 1 ♀. Champaign: May 25, 1890, 1 ♀. Oregon: Aug. 23, 1935, 1 ♀. Urbana: Brownfield Woods, July 25, 1924, 1 ♂; University Woods, July 24, 1934, 1 ♀; July 12, 1935, 1 ♀.

## Descriptions of Two Larval Nematodes of Family Camallanidae Found in Damselfly Naiads, (*Enallagma* sp.)

W. W. Crawford

*Blackburn College, Carlinville, Illinois*

The two larval nematodes described in this paper were found in the stomach of damselfly naiads (*Enallagma* sp.), collected from Glenwood Lake near Minneapolis, Minnesota, on April 25, 1933. Of the 11 naiads that were collected at this time and examined for parasites only 2 were infested, each with 2 immature worms. One specimen from each host was successfully mounted for future study and they are described as follows:

*Specimen One from first host:* Body tapering gradually posteriorly, 2.16 mm. long by .08 mm. broad. Mouth prominent and equipped with two conspicuous yellow scallop-shaped valves .06 mm. long by .05 mm. broad. Each valve is marked with 10 or more longitudinal lines. Anus .12 mm. in front of caudal tip which bears a single minute spine. Esophagus bipartite. Anterior esophagus muscular and club-shaped, .2 mm. long by .04 mm. broad. Posterior esophagus granular and cylindrical, same size as preceding. Intestine 1.7 mm. long. Reproductive organs obscure or undeveloped.

*Specimen Two from second host:* Body 2.40 mm. long and .09 mm. broad. Anus .3 mm. from the caudal tip which bears 3 minute spines. Mouth and esophagus same as in the preceding specimen. Anterior esophagus .24 mm. long and .05 mm. broad. Posterior approximately same size. Intestine 1.5 mm. long. Reproductive organs obscure or undeveloped.

The presence of the characteristic heavy oral armature readily identifies these worms with the family Camallanidae. In the absence of feeding experiments it is difficult to be certain about the more specific taxonomic relationships. However, the presence of the three minute caudal spines in the second specimen indicates that it is a female and may be identical with the form described by Leidy (1853) as *Camallanus trispinosus*.<sup>1</sup> If this is true the first specimen is a male as the males of this species lack the spines.

In view of the scarcity of knowledge concerning the early development of the Camallanidae in general, this discovery may lead to the extension of such information.

Turtles of the genus *Emys*, known to be the host of *Camallanus trispinosus*, were observed in the same lake in the vicinity where the infested nymphs were collected.

<sup>1</sup>Diesing (1851) recognized *trispinosus* as a synonym of *microcephalus* (Duj. 1845) and Leidy subsequently followed him in this usage.

## The Effect of Winter Temperatures of 1935-1936 on Some of the Common Illinois Insects

W. P. Flint

*State Natural History Survey, University of Illinois Agricultural  
Experiment Station, Urbana, Illinois*

The winter of 1935-36 established a record in the state for long periods of low temperatures. According to statements given in the Climatological Data sheet put out by the U. S. Department of Agriculture Weather Bureau, Illinois section, January 1936 was one of the coldest January's on record, with a minimum temperature at Freeport in Stephenson county of -27 degrees F. on January 23rd.

February was equally cold and quoting from this publication: "This was not only the coldest February since 1905, but disregarding calendar month divisions and taking the 31 day period from January 22d to February 21st a mean temperature of approximately 8.3 degrees is obtained, which is 4.3 degrees lower than the extremely cold calendar month record of January, 1917. Considering the entire winter, December to February, inclusive, State averages dating back to 1878 show only the winters of 1880-81, 1884-85, and 1917-18, to have been colder. While more severe extreme temperatures have previously prevailed over the State, frequency of zero-weather this winter exceeds that of any winter since 1884-85. Presenting the cold picture in another way, extreme north-western Illinois from January 19th to February 22d. had only four days free of zero readings, Chicago had 273 hours of zero weather, Peoria 312 hours, Springfield 168 hours, and zero readings were quite general in the southern division on 10 days."

Throughout the northern two-thirds of the state there were many days of sub-zero temperature recorded at all stations. In the northern division minimums of -66 to -21 occurred at many stations in January and about the same temperatures were recorded during two different periods in February.

In the southern division minimums were as usual higher, the January minimums for the section from Carbondale south being from -1 to -7, and the February minimum from -7 to -10. In this part of the state the cold periods were of much shorter duration. Such unusually cold weather, extending as it did over practically a 31-day period, could not help but have a marked effect on some of the hibernating insects that normally occur in this state.

During the past two months attempts to check the effect of these low temperatures on some of the more important economic species have been made. In southern Illinois Mr. S. C. Chandler, Southern Illinois

Field Entomologist, Illinois State Natural History Survey, made numerous examinations of codling moth and Oriental fruit moth larvae. For points north of Carbondale his examinations showed approximately 52 per cent of the codling moth dead. In Greene County, however, which was the most northern point covered by his examinations, 64.5 per cent of the codling moth were dead.

Of the Oriental fruit moth, 100 per cent of the larvae hibernating in cocoons on the trunks of the trees or at other points above the snow line were killed at all points where examinations were made north of Jackson, Union and Johnson counties. In Jackson County from 20 to 33 per cent of the larvae were dead and about 20 per cent were dead in Johnson County.

Our examinations in the vicinity of Urbana failed to show any living codling moth above the snow line.

San Jose scale was unusually abundant in the Fall of 1935, the warm October permitting a late development of this insect. Two weeks after the first period of sub-zero temperatures, attempts were made to determine the per cent of mortality of this scale. At this time, however, the scale was found still in a plump condition and the usual examinations made by removing the waxy scale covering from the insect did not show conclusively whether the scale was alive or dead. Three weeks later another examination was started and by this time, due to a period of warm weather, it was very easy to distinguish the dead from the living scale. A large number of samples of scale from different orchards in the southern and central parts of the state were examined during March. These examinations showed from Centralia north better than 99 per cent of the scale had been killed, the actual figures showing only 0.3 of 1 per cent of the scale alive as the average for this area of the state.

From Centralia to Carbondale between 2 to 3 per cent of the scale remained alive. In Jackson County, approximately 4 per cent of the scale was alive. In Saline County about 7 per cent survived. In Galatin County 19 per cent were alive.

In the extreme southern part of the state in Union, Massac and Johnson counties, the per cent of scale alive was 12, 10 and 16 per cent respectively.

There was, as was expected, a considerable variation in samples in this southern area, some samples showing only 1 or 2 per cent of the scale alive while others showed as high as 22 per cent of the scale alive. In cases where the San Jose scale was protected by a covering of snow around the base of the trunks of young trees, a much higher per cent of scale survived. In Pike County, for instance, we examined one sample of scale taken from under the snow cover about the base of young trees. This sample showed 35 per cent of the scale alive. Three samples taken from the same general area but not below the snow line showed 99 + per cent dead, the actual figures being 1 scale alive out of 1,300 examined.

The Oyster Shell Scale, which passes the winter in the egg stage instead of in the partly grown nymphal stage, showed only a very slight mortality from cold weather. Samples of this scale taken from central Illinois which have been hatched in the laboratory have given no more than the normal per cent of winter kill.

Tussock moth eggs and aphid eggs were not injured by the cold weather. Aphid eggs in general have shown a normal hatch in the early Spring of 1936.

In Northern Illinois, where the European elm scale has become abundant, it was hoped that the temperatures of -25 to -27 might have destroyed at least a part of the overwintering, immature scale of this species. Our examinations, however, show this was not the case. Of the samples so far examined less than 10 per cent had died during the winter. This is little if any higher than the normal winter mortality. It seems unusual that this scale should survive so well when the San Jose scale in the same area was almost completely killed out.

There was no great kill of insects that hibernate on the surface of the ground and which are protected more or less by snow during the periods of lowest temperatures.

Mr. J. H. Bigger, Western Illinois Field Entomologist, Illinois Natural History Survey, has made a number of examinations of chinch bugs and finds the winter mortality running about 15 to 20 per cent. Figures from our examinations in the eastern part of the state showed about the same mortality. Where the bugs were hibernating in clumps of grass that were exposed to the full force of the wind and were clean of snow, the mortality would run very high, in some cases over 90 per cent. As a rule, the chinch bug does not choose hibernating quarters of this type and in many of the protected areas the mortality was less than 5 per cent.

Of the other field crop insects of particular importance, Hessian fly suffered a mortality of possibly 30 to 40 per cent although where protected by snow not more than 10 per cent of the overwintering flies were killed.

Cutworms and flea beetles survived the low temperatures without any particular harm. So far as we have been able to tell the continued low temperatures and deep freezing of the ground, did not have any effect on larvae that normally hibernate beneath the surface soil, such as the white grub.

Summing up the results of our examinations to date, the abnormally cold weather had the effect of greatly reducing San Jose scale and brought about a considerable reduction of codling moth and a marked reduction of Oriental fruit moth. They had little or no effect in reducing the numbers of any of the other injurious insects on which it has been possible to make any definite check.

# Studies on the Lymnaeid Snail, *Fossaria parva* (Lea).

## Part I: Winter Habits

C. Clayton Hoff

Peoria Heights, Illinois

During the winter of 1934-1935, the writer made monthly collections of the Lymnaeid Snail, *Fossaria parva* (Lea) for the purpose of studying the life history. Information relating to the winter habits was also gathered during twenty-six field trips in the period between December 18, 1934, and May 16, 1935, and six trips from November, 1935, to March, 1936.

Collections of *Fossaria parva* were made from an intermittent stream which has a maximum depth of about twelve inches and a maximum width of two feet. Clear, cool surface water fills the stream from the middle of November until the last of June. At times of excessive rain, the stream may spread over the bottoms which are 50-75 feet wide. The discharge, however, is so rapid that the bottoms are inundated for only short periods. The stream is located in what was formerly a meadow at Peoria Heights, Illinois.

The molluscan fauna of the stream consists of a single species, *Fossaria parva*. The only other aquatic mollusc in the vicinity is *Physa halei* which is found in large numbers in an artificial pond located out of the bottom area, about fifty feet from the stream, and at an elevation of about eight feet higher. Although the overflow from this vernal autumnal pond runs into the stream, it is a significant fact that no *Physa halei* have been taken from the stream.

The margins of this stream furnish a characteristic habitat for *Fossaria parva* which is said to inhabit wet, marshy places, generally out of the water on sticks, stones, or muddy flats (Baker, 1928, p. 287). In the specific locality in which the study was made, this statement applies during certain months of the year; but the writer has found that *Fossaria parva* lives almost entirely in the water from December to March of each year. This fact apparently does not contradict the statements of other writers, but rather illustrates a definite lack of information regarding the winter habits of the species.

The presence of *Fossaria parva* in this locality was first discovered on December 18, 1934, when several snails crawled up the sides of a jar containing bottom material from the stream. In the autumn of 1935, the snails were observed in the stream during the first week in December. At that time, water had been flowing in the stream for only ten days,

as the stream had been dry since July 1, 1935. Early in December, the snails were found in the quiet, shallow areas of the stream but as ice began to form permanently on the surface of the water, each increase in the extent and thickness of the ice caused a migration of the snails to deeper water where there was no danger of being frozen in the ice. During periods of partial thaw, the ice receded and the snails returned to more shallow water.

Throughout January, in both 1935 and 1936, snails were collected through holes chopped in the ice which covered the stream and in severe weather stopped the flow of water. The snails were found only in the quiet, deep pools where there was a layer of water under as much as six to eight inches of ice. Snails have been taken from bottom mud in pools whose surfaces have been continuously frozen for a month. During the periods of ice cover, the water is far from being devoid of oxygen because of the development of dense growths of the filamentous alga, *Schizomeris*. Being rather inactive and requiring small amounts of oxygen, it is possible that the oxygen required by the snails is absorbed directly by the bodies of the animals.

It is evident, during the months of January, February, and part of March, that *Fossaria parva* feeds very little if at all. This statement is the result of the observation of the following facts: (1) Collections of the buoyant, bottom-anchored *Schizomeris* showed that very few of the snails inhabited the algal growths but they were found beneath the growths on the bottom mud. This would indicate that the filamentous alga was not being used as food. Examination of the bottom mud indicated a lack of food until the last of March, where there was a development of uni-cellular forms such as diatoms and *Euglena*. (2) Examination of the alimentary canal of snails taken during the period showed no indication of recent feeding and no snails collected during January and February voided feces after their capture. (3) Studies of size distribution of individuals of the monthly collections show that there was little growth. The mean and the median of the individual collections showed an increase of 0.3 mm and 0.27 mm respectively between the January 6-7 collection and the March 8-10 collection in 1935. As the distribution curves in both cases are uni-modal and there was no increase in population due to birth or decrease due to natural death, it is evident that actual growth is indicated by the progress of the arithmetic mean and the median. As snails 8 mm in length are very common during certain months, it is clear that a growth of only 0.3 mm in two months is very small in comparison with the growth which takes place during more favorable seasons of the year.

Associated with *Fossaria parva* during December, January and February are the invertebrates characteristic of the intermittent stream. These include copepods, *Planaria*, and the larvae of the caddis-, horse-, soldier-, and midge-fly. The nymph of the stone-fly, *Perla*, is also

found. It is not until the second week in March that collections include the Isopod, *Asellus*.

During the year 1935, the first week in March marked a radical change in the physical condition of the stream. The corresponding change occurred, during 1936, in the last week of February. At this time, most of the ice disappeared from the stream except in the quiet pools and along the shore. Collections made on the 8th and 10th of March, 1935, showed that *Fossaria parva* was no longer found in the deep pools but had migrated to the more shallow areas. Here the snails remained, evidently feeding to some extent, until the warm days of late March when they were seen along the edges of the stream out of the water. They are never found out of the water, however, unless the water is free from ice and the atmospheric temperature is 40 degrees Fahr. or above. A change in the temperature of the air to less than 40 degrees appears to furnish the stimulus required for a return to the water. After cool nights, especially when a thin sheet of ice has been frozen along the shore, the snails will be found in the shallow water immediately under the layer of ice. As the ice melts under the action of the sun, the snails migrate from the water, only to return again when the nocturnal temperature falls below 40 degrees. This migration from water to land and back again is often a daily occurrence during the last two weeks of March and most of April.

As a check on field observations, experiments were performed to demonstrate the reaction of *Fossaria parva* to changes in temperature. Snails taken with bottom material in March and placed in jars at room temperature crawled out of the water and up the sides of the jars. When these containers were placed in a refrigerator, the snails returned to the water. At another time, fifteen snails, including both mature and juvenile individuals, were picked from mud flats during June and placed in shallow water in a large beaker cover. In less than one-half hour, all of the snails had crawled out of the water. The cover was then quietly removed from room temperature and placed directly on ice in a refrigerator. In less than three-fourths of an hour, all of the snails had crawled back into the water. The cover was then removed to room temperature and the experiment twice repeated with the same individuals. During the last repetition, many of the snails became moribund, evidently as a result of the rough treatment received by the radical and sudden changes in temperature.

As a result of heavy rains, a flood occurred on May 1-2, 1935, and the snails were scattered over a considerable portion of the flood plain. On May 12, the stream was well within its banks and the bottom was examined for the presence of snails. It was found that the occurrence of snails in the water was very rare and that they were concentrated about a foot from the water, on muddy flats consisting of silt carried in by the flood. These flats were small areas of one to two square feet, isolated by strips of grass, and between six and twelve inches above the

surface of the stream. In damp weather, snails could be found on such areas as far as ten feet from the stream. The snails apparently avoid vertical banks or areas with a slope greater than thirty degrees. After the middle of May, the snails remain, almost without a single exception, on these bare, muddy flats.

It is obvious that the winter aquatic habitat of *Fossaria parva* is of distinct advantage to the species, especially since the individuals found during the winter are immature and of a small size. Such a protective measure is in direct contrast to the condition found in the closely related species, *Fossaria modicella*, as observed by VanCleave (1935, p. 103) who states that there was no evident tendency for *Fossaria modicella* (living on vertical sandstone cliffs in Turkey Run State Park) to seek shelter during the winter. Such a contrasting condition which exists between two related, often confused (Baker, 1911, p. 245) species might offer another character for specific distinction between the habits of the two snails. Such a general statement, however, must not be made until there are further investigations of the species from other localities.

The writer wishes to thank Mr. F. C. Baker for determining the identity of *Fossaria parva* and *Physa halei* from specimens submitted to him and T. Dale Foster and Dr. H. J. VanCleave for many helpful suggestions.

#### BIBLIOGRAPHY

- BAKER, F. C. 1911. The Lymnaeidae of North and Middle America, recent and fossil. *Chicago Acad. Sci., Spec. Pub., No. 3*: i-xvi, 1-539.
- . 1928. The fresh water Mollusca of Wisconsin. Part I. Gastropoda. *Wis. Geol. and Nat. Hist. Surv., Bull. 70*: i-xx, 1-494.
- VANCLEAVE, H. J. 1935. The seasonal life history of an amphibious snail, *Fossaria modicella*, living on sandstone cliffs. *Ecology 16*: 101-108.

# The Nearctic Sawflies of the Genus *Fenusa* (Hymenoptera, Tenthredinidae)

Herbert H. Ross

*Illinois State Natural History Survey, Urbana, Illinois*

The sawflies of this genus are leaf-miners so far as known, as follows: *ulmi* on elm, *pusilla* on birch, *dohrnii* and perhaps *inspiratus* on alder. They have been in considerable taxonomic confusion and this brief synopsis has been prepared in an effort to straighten matters out. A key is given for the recognition of the species, together with illustrations of the genitalia, which are essential for checking identifications. The species are all small, less than four millimetres in length, and are mostly black.

Types designated in this paper are deposited in the collection of the Illinois State Natural History Survey except where noted.

## KEY TO NEARCTIC SPECIES

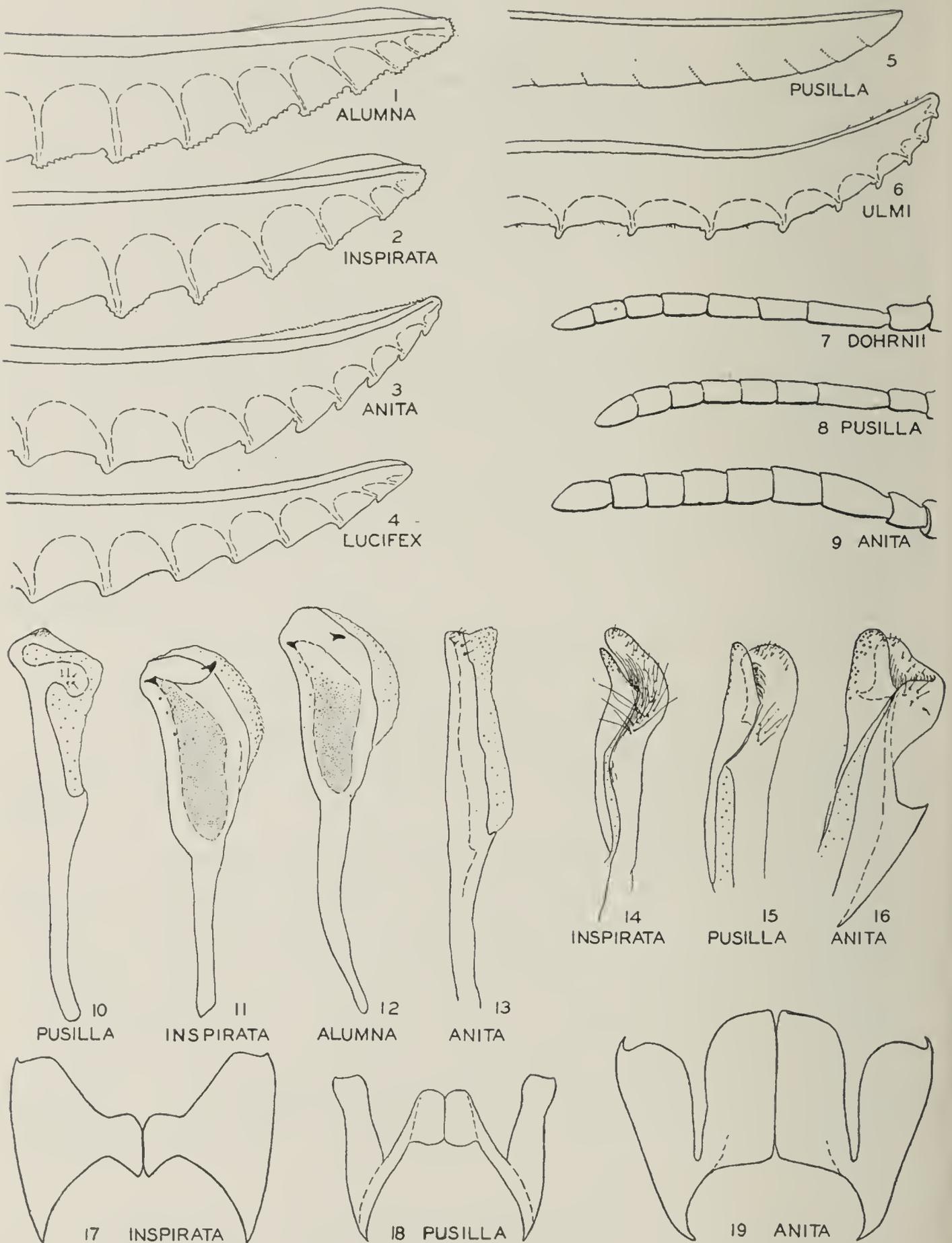
1. Femora and coxae yellow..... 2  
Femora and coxae black..... 3
2. Abdomen entirely black..... *lucifex*  
Abdomen with sternites yellow or brownish yellow..... *anita*
3. Front wing with *2r* joining *R<sub>s</sub>* beyond *3r-m*, or *3r-m* absent..... 4  
Front wing with *2r* joining *R<sub>s</sub>* before *3r-m*, the latter always present.. 5
4. Antennae shorter, the middle segments reduced as in fig. 8..... *pusilla*  
Antennae longer, the middle segments more elongate as in fig. 7.. *dohrnii*
5. Head with a pair of conspicuous diagonal tubercles above antennal sockets. Female saw with digitate processes on ventral margin, fig. 6 ..... *ulmi*  
Head with diagonal tubercles almost or entirely absent. Female saw with ventral margin broken up into lobes which are not digitate, figs. 1, 2..... 6
6. Tibiae entirely cream color. Wing strongly infusate..... *alumna*  
Tibiae dark brown with their apices paler. Wings only slightly infusate ..... *inspiratus*

### *Fenusa dohrnii* (Tischbein)

*Kaliosysphinga dohrnii* Tischbein, Stetting. ent. Zeitg., vol. 7, 1846, p. 80.

*Fenusa curtus* Norton, Proc. Ent. Soc. Phil., vol. 1, 1861, p. 199, ♀.  
*New synonymy.*

A true holarctic species which is usually but erroneously considered introduced. Nearctic records: B. C., Colo., Mass., Me., Mich., Ont., Sask.



EXPLANATION OF PLATE

- Figs. 1-6.—Apices of saws.
- Figs. 7-9.—Antennae.
- Figs. 10-13.—Penis valves.
- Figs. 14-16.—Sagittae and volsellae.
- Figs. 17-19.—Parapenes and gonostipes.

*Fenusa pusillus* (Lepeletier)

*Tenthredo* (*Emphytus*) *pumila* Klug, Magaz. Ges. naturf. Fr. Berlin, vol. 8, 1814, p. 277. Preoccupied.

*Dolerus* (*Fenusa*?) *pusillus* Lepeletier, Monogr. Tenthred., 1823, p. 120.

Klug described two species *Tenthredo* (*Allantus*) *pumila* and *Tenthredo* (*Emphytus*) *pumila* in the same genus. The former is now known as *Entodecta pumila*, but the latter is obviously a direct homonym and Lepeletier's name *pusilla* must be used instead.

A European species which has probably been introduced into North America. Nearctic records: Mass., Me., N. Y., Que.

*Fenusa ulmi* Sundewall

*Fenusa ulmi* Sundewall, Förh. Skand. Naturf., 1844, p. 249.

*Messa alsia* MacGillivray, Univ. Ill. Bull., vol. 20, no. 50, August 13, 1923, p. 22, ♀. *New synonymy*.

Status similar to above. Nearctic records: N. Y.

*Fenusa alumna* (MacGillivray) *new combination*

*Messa alumna* MacGillivray, Univ. Ill. Bull., vol. 20, no. 50, August 13, 1923, p. 23, ♀.

*Messa amica* MacGillivray, *ibid.*, ♀. *New synonymy*.

*Messa appota* MacGillivray, *ibid.*, p. 24, ♂. *New synonymy*.

Distribution.—Ill., Mass., N. H., N. Y.

*Fenusa inspiratus* (MacGillivray) *new combination*

*Parabates inspiratus* MacGillivray, Ann. Ent. Soc. Amer., vol. 2, no. 4, Dec., 1909, p. 264, ♀.

*Male*.—Similar in size, color and general structure to female. Genitalia with parapenes almost undifferentiated, fig. 17. Sagittae narrow and pointed at apex, volsellae digitate and rounded at apex, fig. 14. Penis valves wide, with two variable "horns" near apex, and no large, unpigmented area in central area, fig. 11.

*Allotype*.—Male; Hatchet Mt., Shasta county, Calif., July 14, 1933, on *Alnus*, K. A. Salman. Deposited in the U. S. National Museum.

*Distribution*.—Cala., Nev.

*Fenusa anita* (MacGillivray) *new combination*

*Messa anita* MacGillivray, Univ. Ill. Bull., vol. 20, no. 50, August 13, 1923, p. 23, ♀.

*Male*.—Similar in size, color and general structure to female. Genitalia extremely aberrant for both genus and subfamily. Parapenes large and plate-like, fig. 19. Sagittae and volsellae both enlarged and rounded at apex, fig. 16. Penis valves slender, straight, with a few minute setae at apex and a ventral membranous fringe, fig. 13.

*Allotype*.—Male; Montreal, Quebec, June 3, 1906.

*Distribution*.—N. Y., Que., Wis.

*Fenusa lucifex* n. sp.

This species most closely resembles *anita* (MacGillivray) but may be distinguished from that species by the black venter of the abdomen and the more slender antennae. From all members of the genus it differs in the smooth-lobed saw, fig. 4.

*Female*.—Length 3.5 mm. Color black, with the pronotum, tegulae and legs almost entirely yellow; legs with apices of their segments slightly infuscated; clypeus yellow with mesal fourth brown. Front wings fairly heavily infuscate with brown, hind wings only slightly so; stigma and veins brown.

General structure as for genus. Head robust, shining. Antennae slender, with first, second, fourth and fifth segments subequal, third twice length of each; flagellum filiform, closely set with apparent sense pores. Front wings with first abscissa of Rs and looped portion of 2A & 3A atrophied. Hind wings with apical portion of 2A almost atrophied, the loop connecting it with 1A reduced to a faint line. Abdomen shining. Sheath long, with ventral and dorsal margins parallel and straight, and apex diagonal. Saw, fig. 4, with 13 segments in lance, 12 in lancet, lancet with no teeth on lobes, forming a regularly serrate margin, ducts long and narrow.

*Holotype*.—Female; Fox Lake, Illinois, June 30, 1935, DeLong and Ross.

## Notes on the European Starling in Illinois

Joseph B. Sommer

Peoria High School, Peoria, Illinois

### ABSTRACT

In an attempt to investigate the possibility of the European Starling as a carrier of avian parasites from one poultry flock to another in Illinois, one hundred thirty-two (132) birds were examined during the months from September (1935) to January (1936).

Fifty-one of the Starlings examined were hosts to one or more cestodes (*Hymenolepis farciminosa* and *Rhabdometra nullicollis*), and three to Acanthocephala (*Mediorhynchus grandis*—Van Cleave). No evidence of the gapeworm (*Syngamus trachea*) so common to poultry was forthcoming.

A probable conclusion to this limited survey might suggest that the possibility of the Starling becoming a menace in carrying cestodes and nematodes to poultry flocks in Illinois, is at present, not very great.

The writer wishes to acknowledge the valuable assistance of Prof. Lyell J. Thomas, Department of Zoology, University of Illinois, and Dr. David H. Thompson of the State Natural History Survey, in this investigation.



STATE OF ILLINOIS  
HENRY HORNER, Governor

THE LIBRARY OF THE  
APR - 8 1937  
UNIVERSITY OF ILLINOIS

TRANSACTIONS  
OF THE  
ILLINOIS STATE  
ACADEMY OF SCIENCE

VOLUME 29

MARCH, 1937

NUMBER 3

Announcement  
Thirtieth Annual Meeting  
Officers and Committees, General Program  
Section Meetings, Junior Section  
General Information



Friday and Saturday, May 7-8, 1937  
ROCKFORD, ILLINOIS

PUBLISHED BY THE ACADEMY  
AFFILIATED WITH THE STATE MUSEUM DIVISION  
DEPARTMENT OF REGISTRATION AND EDUCATION  
CENTENNIAL BLDG., SPRINGFIELD, ILL.

PUBLISHED QUARTERLY

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

## OFFICERS AND COMMITTEES

1936-1937

*President*, C. L. FURROW, Knox College, Galesburg  
*First Vice-President*, H. R. WANLESS, University of Illinois, Urbana  
*Second Vice-President*, EVELYN I. FERNALD, Rockford College, Rockford  
*Secretary*, WILBUR M. LUCE, University of Illinois, Urbana  
*Treasurer*, GEORGE D. FULLER, University of Chicago, Chicago  
*Librarian*, A. S. COGGESHALL, State Museum, Springfield  
*Editor*, DOROTHY E. ROSE, State Geological Survey, Urbana

*The Council* is composed of the President, the two Vice-Presidents, the Secretary, the Treasurer, the Librarian, the last two retiring Presidents and the retiring Secretary.

*Committee on Conservation:*

T. H. FRISON, University of Illinois, Urbana, *Chairman*  
 HENRY C. COWLES, University of Chicago, Chicago.  
 M. M. LEIGHTON, State Geological Survey, Urbana  
 W. H. HAAS, Northwestern University, Evanston  
 JENS JENSEN, Ravinia  
 PAUL HOUDEK, 710 N. Gross Street, Robinson  
 BRUCE W. MERWIN, Southern Illinois State Teachers College, Carbondale  
 R. S. SMITH, University of Illinois, Urbana  
 H. J. VAN CLEAVE, University of Illinois, Urbana  
 W. C. ALLEE, University of Chicago, Chicago  
 E. L. STOVER, Eastern Illinois State Teachers College, Charleston

*Committee on Legislation and Finance:*

DON CARROLL, State Geological Survey, Urbana, *Chairman*  
 FAY-COOPER COLE, University of Chicago, Chicago  
 EDSON S. BASTIN, University of Chicago, Chicago  
 B. SMITH HOPKINS, University of Illinois, Urbana

*Committee on Affiliation:*

CLARENCE BONNELL, Harrisburg Township High School, Harrisburg,  
*Chairman*  
 H. H. RADCLIFF, 1346 W. Macon Street, Decatur  
 ROSALIE M. PARR, University of Illinois, Urbana  
 MARY M. STEAGALL, Southern Illinois State Teachers College, Carbondale  
 H. O. LATHROP, Normal University, Normal

*Committee on Membership:*

JOHN VOSS, Manual Training High School, Peoria, *Chairman*  
 FRANCES JOHNSON, Rockford College, Rockford  
 L. I. BOCKSTAHLER, Northwestern University, Evanston  
 H. J. VAN CLEAVE, University of Illinois, Urbana  
 CLARENCE SMITH, Aurora College, Aurora  
 W. O. BECKNER, Elgin High School, Elgin  
 JOHN COE, Lake View High School, Chicago  
 BLANCHE MCAVOY, Illinois Normal University, Normal

*Delegate to the American Association for the Advancement of Science:*

GEORGE D. FULLER, University of Chicago, Chicago

*Delcgate to the Conservation Council of Chicago:*

V. O. GRAHAM, 4028 Grace Street, Chicago

*Committee on High School Science and Clubs:*

- ROSE M. CASSIDY, Maine Township High School, Des Plaines, and MABLE SPENCER, Granite City High School, Granite City, *Co-chairmen*  
 ROSALIE M. PARR and LYELL J. THOMAS, University of Illinois, Urbana, *Advisory Committee*  
 ROSALIE M. PARR, University of Illinois, Urbana, *Radio Service*  
 LOUIS A. ASTELL, University High School, Urbana, *Editor*  
 ROSE M. CASSIDY, Maine Township High School, Des Plaines, and HARRY L. ADAMS, Bloomington High School, Bloomington, *Co-chairmen in Charge of Competition*  
 AGNES BROWN and S. ALETA McAVOY, Rockford Senior High School, Rockford, *Local Arrangements*

## GENERAL PROGRAM

All Addresses and Section Meetings Are Open to the Public

### THURSDAY, MAY 6, 1937

- 6:00 p. m. Council dinner at Rockford College.  
 7:30 p. m. Meeting of the Council (*Rockford College*).

### FRIDAY, MAY 7, 1937

#### ROCKFORD COLLEGE, ROCKFORD, ILLINOIS

- 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 (*Middle Hall*).  
 8:00 a. m. Meeting of the Council with local committee and delegates from affiliated societies (*Room E, Adams Hall*).  
 8:30 a. m. Preliminary business meeting of the Academy (*Talcott Hall*).

#### GENERAL SESSION, TALCOTT HALL, ROCKFORD COLLEGE

- 9:00 a. m. *Address of Welcome*—PRESIDENT CHALMERS, Rockford College.  
*Presidential Address: The Evolution of Sex in the Mollusca (Illustrated)*—PROFESSOR C. L. FURROW, Knox College, Galesburg.  
*Address: The 1937 Flood in Southern Illinois (Illustrated)*—MR. DON L. CARROLL, State Geological Survey, Urbana.  
*Address: Science and the Garden (Illustrated with colored movies)*—MR. J. H. HANLEY, University of Illinois, Urbana.  
*Address: A Vacation in Alaska (Illustrated with colored movies)*—PROFESSOR CHARLES F. HOTTES, University of Illinois, Urbana.  
 12:00–1:00 p. m. Luncheon. Dining-room, Rockford College. Price 50 cents. Reservations should be made in advance. Use the card sent out with this program.  
 1:00–2:00 p. m. *Exhibits: Junior Section, High School Science Club exhibits on display, Boys' Gymnasium, Rockford Senior High School, Madison and Chestnut Streets.*  
 1:30 p. m. *Section Meetings: Election of Chairmen for 1937-38; papers, demonstrations and discussions.*  
 4:00–5:00 p. m. *Tea and Book Exhibit.* Maddox House, Rockford College.  
 5:00 p. m. *Annual Business Meeting.* Announcement of grantees for A. A. A. S. Research Awards. Talcott Hall.

- 6:15 p. m. *Annual Banquet* (Informal), Dining-room of Church of the Christian Union, North Main and Mulberry Streets. Price 75 cents. Reservations should be made in advance by personal application or mail. Apply to Evelyn Fernald, Rockford College, Rockford, Illinois. Tickets should be called for before 10:30 a. m., May 7.
- 7:45 p. m. *Annual Public Lecture*: Changes in Concepts of States of Matter—PROFESSOR GEORGE W. STEWART, Head, Department of Physics, University of Iowa, Auditorium of the Church of the Christian Union.

## SATURDAY, MAY 8, 1937

- 8:00 a. m. Meeting of the new Council, Rockford College.
- 9:00 a. m. Inspection trips leave from Rockford Senior High School, Madison Street entrance. The local committee can arrange transportation for some who do not have their own means of transportation if reservations are made in advance.

*Geological Trip\**—Under the auspices of the State Geological Survey, a geological field trip will be offered in the Rockford locality which will be of special interest to the membership of the Academy. The trip will give opportunity for observing the local bedrock stratigraphy, the glacial and loess deposits, the physiographic features, and also for fossil collecting. The historical geology of the area will be summarized. Dr. M. M. Leighton, Chief of the State Geological Survey, and Dr. George E. Ekblaw will be in charge.

*Apple River Canyon Trip\**—Apple River Canyon State Park and the surrounding region of JoDaviess County in Northwestern Illinois has many attractions. The scenic beauty of this region is most unusual. Also, since it is in the southern portion of the "driftless" area there is much of interest for the biologists and for the geologists. The trip will be under the direction of Professor George D. Fuller, Botany Department, University of Chicago, Chicago, and Dr. H. W. Pepoon, Chicago, and will require the morning and afternoon.

*Industrial Trip*—The Rockford Chamber of Commerce is making arrangements for visits to two factories, the Landstrom Furniture Corporation, manufacturers of some of the nation's finest bedroom, dining-room and upholstered furniture; and the Woodward Governor Company, the nation's foremost manufacturer of waterwheel governors, and builders of the governors for the Boulder Dam and many other large Government power projects. If time permits, other factories will be visited and a tour of Rockford's industrial sections made. Rockford has eighteen furniture plants, is the second machine tool center of the country and produces more than 6000 diversified products. Listed among its outstanding manufacturers are: J. I. Case Company, Roper Corporation, manufacturers of the famous Roper gas stoves; Chappel Bros., Inc., manufacturers of Ken-L-Ration; Bird Piston Ring Company, Manufacturers of the Ha-Dees hot water car heaters; Ingersoll Milling Machine Company, manufacturers of the world's largest machine tools; Haddorff Piano Company; New Home Sewing Machine Company; and many others, including knitting mills, hardware manufacturers, foundries, leather goods manufacturers.

*Sewage Disposal Plant*—T. G. Linquist, superintendent of the Sanitary District of Rockford, will direct this trip through the city's modern \$2,500,000 sewage disposal plant and grounds.

*Anthropological Trip*—A field trip for the inspection of mounds of the region will be offered. If possible, a mound will be excavated, showing the technique used. In addition, a trip is contemplated to the Logan Museum at Beloit, Wisconsin. Dr. J. B. Ruyle, Champaign, is in charge.

---

\* *Note*: Participants on these trips should wear clothes and shoes suitable for hiking and should bring packed lunches.

*Forest Preserve and Garden Trip*—Winnebago County's nine forest preserves are by far the finest of any in the State of Illinois and the City of Rockford abounds with fine residential gardens, and maintains beautiful garden spots in its parks. The Rockford Garden Club is preparing this trip under the direction of Mrs. J. H. Mansfield, president of the club. In addition to the vast amount of geological and biological interest in the forest preserves, some of them have an historical background of wide interest. There are numerous Indian mounds located in this territory.

Complete details of the field trips will be announced in the final program.

## PROGRAM OF SECTION MEETINGS

FRIDAY, MAY 7—1:30 P. M.

### AGRICULTURE

Room T

C. W. HUDELSON, Illinois State Normal University, Normal, Illinois,  
*Chairman*

Election of Chairman for 1937-38.

Each speaker will be allowed ten minutes.

1. Differences in Corn Indicated by Preferences Exhibited by Animals—  
E. ROBERTS, University of Illinois, Urbana.
2. Farm Tenancy in Minonk Community; Its Effects on Future Farmer  
Ownership—HAROLD WRIGHT, Vocational Agriculture Instructor,  
Minonk Community High School, Minonk.
3. Improvement in Hybrid Corn as Indicated by Entries in the Illinois  
Corn Performance Tests—GEORGE H. DUNGAN, University of Illinois,  
Urbana.
4. The Program for Controlling Bang's Disease (infectious abortion) with  
Consequent Reduction of the Undulant Fever Hazard—HAROLD M.  
CAVINS, Eastern Illinois State Teachers College, Charleston.
5. Temperature and Moisture Effects on Grasshoppers—ROBERT J. MAURER,  
Illinois State Normal University, Normal.
6. Comparative Productiveness of Some Twelve Varieties of Tomatoes on  
Fertile Prairie Soils—T. J. DOUGLASS, Illinois State Normal Uni-  
versity, Normal.
7. Experimental Studies with Vegetable Soybean Varieties—LAWRENCE  
HASTINGS, Illinois State Normal University, Normal.
8. The Production of Hybrid Corn in DeKalb County—LINDEN H. BOTKIN,  
Vocational Agriculture Instructor, Waterman Community High  
School, Waterman.
9. Pasture Demonstration Studies—C. W. HUDELSON, Illinois State Normal  
University, Normal.
10. The Onion Set Industry in Cook County—E. H. HOWELL, Vocational  
Agriculture Instructor, Palatine Township High School, Palatine.
11. The Art and the Science of Agriculture—EUGENE DAVENPORT, Dean and  
Professor Emeritus, University of Illinois, Urbana.
12. Profitable Swine Production as Demonstrated by Boys' Project Work—  
CLYDE FRY, Vocational Agriculture Instructor, Polo Community  
High School, Polo.
13. Agriculture for All Rural Schools—CHARLES H. OATHOUT, Western Illi-  
nois State Teachers College, Macomb.
14. The Part-time School and the Community—RUSSELL E. LAMOREUX, Vo-  
cational Agriculture Instructor, Savanna Township High School,  
Savanna.
15. Influence of Chemical Composition of Soils Upon the Maintenance of  
the Turf on Lawns and Golf Courses—H. J. SNIDER, University of  
Illinois, Urbana.

16. A Practical Approach to the Study of Heredity in a High School Curriculum—C. L. KUTIL, Vocational Agriculture Instructor, Antioch Township High School, Antioch.
17. Hybrid Corn Experiment—Sterling—J. A. TWARDOCK, Vocational Agriculture Instructor, Sterling Township High School, Sterling.
18. Some Proposed Curriculum Changes in Vocational Agriculture—L. V. SLOTHOWER, Vocational Agriculture Instructor, Ashton High School, Ashton.
19. Farm Tenancy Legislation—EARL G. REEVES, University of Illinois, Urbana.
20. Tazewell County Industries as a Market for Farm Commodities—W. H. DOWELL, Vocational Agriculture Instructor, Pekin Community High School, Pekin.
21. Evening Schools for Adult Farmers—PAUL ARNDT, Vocational Agriculture Instructor, Marengo High School, Marengo.
22. Agricultural Land Utilization in the Chicago Metropolitan Area—MARSHALL G. CLARK, Soil Analyst.
23. Agriculture and Our Farm Youth—ALFRED HERSTRUM, Vocational Agriculture Instructor, Durand High School, Durand.
24. Adult Education in Agriculture—JOHN N. WEISS, Vocational Agriculture Instructor, Dixon High School, Dixon.
25. Rates of Natural Increase of Population in Illinois—Rural and Urban—D. E. LINDSTROM, University of Illinois, Urbana.
26. Soil Conservation of Carroll County, Illinois—MILTON DUNK, Vocational Agriculture Instructor, Milledgeville High School.

## ANTHROPOLOGY

Room G

J. B. RUYLE, D. D. S., Champaign, *Chairman*

Election of Chairman for 1937-38.

1. Culture of the Sand Dune Area of Lake Michigan Region—WARREN C. VAN MALE, Waukegan.
2. Subject to be announced—JULIA OUTHOUSE, Professor of Home Economics, University of Illinois, Urbana.
3. Monolithic Axes—CLAUDE U. STONE, Peoria Academy of Science, Peoria.
4. Burials, Artifacts, and Culture of Southern Kentucky—KENNETH KNIGHT, Illinois State Normal University, Normal.
5. Various Types of Kingston Site Burials—ANTON M. SIMPSON, Peoria Academy of Science, Peoria (lantern).
6. Stone Artifacts of the North American Indian—C. W. HUDELSON, Illinois State Normal University, Normal.
7. Artifacts typical to Winnebago County—F. L. BARLOGA, Peoria High School and Peoria Academy of Science, Peoria.
8. Ornamental Uses of the Banner Stone—BYRON KNOBLOCK, LaGrange.
9. Diseased Conditions Found in Prehistoric Skulls—DR. L. H. WOLFE, Quincy.
10. The Future of Archaeology in Illinois—DR. J. B. RUYLE.

This program is incomplete as there will be five or six additional speakers on important research archaeological problems.

## BOTANY

NEIL E. STEVENS, Department of Botany, University of Illinois,  
Urbana, *Chairman*

Election of Chairman for 1937-38.

On account of the number of papers offered, this program will be given in two sections.

## SECTION A—TEACHING

Room R

SISTER MARY ELLEN O'HANLON, Rosary College, River Forest, *Chairman*

Each speaker will be allowed ten minutes.

1. Nature Education in Parks—ELIZABETH WHITE, Blue Island Community High School, Blue Island.
2. Botany as Part of the Program of a Summer Camp School—JOHN W. LEEDY, Wheaton College, Wheaton.
3. Botany in a Small Country High School—SISTER CLARETTA EASTER, Aquin High School, Freeport.
4. Botany in a Large City High School—RUTH WILLISTON, Oak Park and River Forest Township High School.
5. A Unique Plan in the Teaching of Botany—MARGERY CARLSON, Northwestern University, Evanston.
6. Teaching of General Botany in a Liberal Arts College for Women—SISTER MARY THERESE, B. V. M., Mundelein College
7. Biology in a Teacher Training Institution—OPAL C. HARTLINE, Illinois State Normal University, Normal.
8. Elementary Botany at the University of Illinois—HARRY J. FULLER, University of Illinois, Urbana.
9. The Medical Student's Background in Biology—THESELE T. JOB, Loyola University, Chicago.
10. Testing for Organization Ability in Biology—C. E. MONTGOMERY, Northern Illinois State Teachers College, DeKalb.
11. A Study of the Teaching of Botany in College and Universities—E. L. STOVER, Eastern Illinois State Teachers College, Charleston.

## SECTION B—RESEARCH

Room Q

Each speaker will be allowed twelve minutes.

1. The Growing Region of Hypocotyls—CHARLES BRIAN and E. L. STOVER, Eastern Illinois State Teachers College, Charleston.
2. Effects of Heat and Cold Treatment upon Enzyme Activity in Bulbs and Corms—HARRY J. FULLER and JOHN H. HANLEY, University of Illinois, Urbana.
3. Spore Germination and Thallus Formation in Porella—PAUL D. VOTH, University of Chicago, Chicago.
4. A New Method for the Qualitative Measurement of Gases in Photosynthesis and Respiration—ERNEST M. R. LAMKEY, Illinois State Normal University, Normal.
5. A Comparative Study of Certain Fungi Cultivated on Carbohydrate Media—A. E. EDGEcombe, Northwestern University, Evanston.
6. Forest Conservation in the Ohio Valley—H. W. MAUNTEL, Mendota Township High School, Mendota.
7. Ferns and Fern Environments in LaSalle County, Illinois—H. W. MANUTEL, Mendota Township High School, Mendota.
8. Forests of the Yarmouth and Sangamon Interglacial Periods—JOHN Voss, Central High School, Peoria.
9. Illinois Liverworts—STELLA HAGUE, University of Illinois, Urbana.
10. Humidity Variation Affecting Transpiration—H. F. THUT, Eastern Illinois State Teachers College, Charleston.
11. Germination of Pollen Grains for Class Use—ICA MARKS, Eastern Illinois State Teachers College, Charleston.

## CHEMISTRY

Rooms J and N

W. F. BAILEY, MacMurray College, Jacksonville, *Chairman*

Election of Chairman for 1937-38.

1. Fractional Distillation—D. B. KEYES, University of Illinois, Urbana (10 minutes, lantern).
2. An Albino Rat Demonstration of Mineral and Vitamin Deficiencies in a Common Human Diet—W. P. ELMSLIE and W. R. BUNTING, Moorman Manufacturing Company, Quincy (15 minutes).
3. The Vitamin F Requirements of Animals—AUGUST J. PACINI, Pharmaceutical Specialities Company, Chicago (10 minutes).
4. The Pyrethrum Content of Pyrethrum Flowers Grown in Illinois—NICHOLAS D. CHERONIS, The Synthetic Laboratories, Chicago (15 minutes).
5. Methods of Determining Fluorine—L. D. McVICKER, State Geological Survey, Urbana (10 minutes).
6. Synthetic Cryolite—G. C. FINGER and F. H. REED, State Geological Survey, Urbana (10 minutes).
7. Apparatus to Show Increase of Ionization with Dilution—J. H. RANSOM, James Millikin University, Decatur (10 minutes).
8. Lecture Demonstration on Projective Electrolysis—G. W. THIESSEN, Monmouth College, Monmouth (10 minutes).
9. Convenient Chemistry Apparatus—JULIUS J. GOUZA, Edwardsville High School, Edwardsville (10 minutes).
10. The Place of X-ray Diffraction in Clay Mineralogy—W. F. BRADLEY, State Geological Survey, Urbana (10 minutes).
11. Recent Work on Silicate and Related Systems Involving Chemical Components of Illinois Sedimentary Rocks—F. V. TOOLEY, State Geological Survey, Urbana (10 minutes).
12. Properties of Heated Coal—P. E. GROTTIS, State Geological Survey, Urbana (10 minutes).
13. Experiments in Training Chemists for Industry—MABLE SPENCER, Granite City High School, Granite City (10 minutes).
14. Modern Motor Fuels—GUSTAV EGLOFF, Universal Oil Products Company, Chicago (20 minutes).
15. An Experiment in Chemiluminescence—Oxidation of Pyrogallol—LYLE K. WARD and C. W. BENNETT, Western Illinois State Teachers College, Macomb (10 minutes).

## GEOGRAPHY

East Studio

H. O. LATHROP, Illinois State Normal University, Normal, Illinois,  
*Chairman*

Election of Chairman for 1937-38.

Each speaker will be allowed fifteen minutes.

1. The Distribution of the Apple Orchards in Calhoun County, Illinois—ALFRED W. KASEL, Moline High School, Moline (lantern).
2. The Soybean Industry of Illinois—MABEL CROMPTON, Illinois State Normal University, Normal.
3. Major Elements in the Geography of Porto Rico—W. H. HAAS, Northwestern University, Evanston.
4. Geography of Strathallan, Scotland—JANE PATERSON, Bloomington High School, Bloomington.
5. The Functional Pattern of Corn Belt Villages—CLARENCE B. ODELL, University of Chicago, Chicago.
6. Systems of Land Tenure in the Llanos of Venezuela—R. E. CRIST, University of Illinois, Urbana.

7. Reforestation in Southern Illinois—THOMAS F. BARTON, Southern Illinois State Normal University, Carbondale.
8. An Inland Inundation—CLARENCE BONNELL, Harrisburg Township High School, Harrisburg (lantern).
9. Illinois Council of Geography Teachers—CLARE SYMONDS, Quincy High School, Quincy.

## GEOLOGY

West Studio

L. E. WORKMAN, State Geological Survey, Urbana, *Chairman*

Election of Chairman for 1937-38.

1. Geology and Ground Water Resources of the Bedrock at Rockford—J. NORMAN PAYNE, State Geological Survey, Urbana (10 minutes, slides).
2. The Preglacial Rock River Valley as a Source of Ground Water for Rockford—L. E. WORKMAN, State Geological Survey, Urbana (10 minutes, slides).
3. The Glacial History of the Rockford Region—M. M. LEIGHTON, State Geological Survey, Urbana (10 minutes, slides).
4. Exhumed Ordovician Hill near Joliet—D. J. FISHER, University of Chicago, Chicago (10 minutes, slides).
5. Taxonomy of Mississippian Productidae—A. H. SUTTON, University of Illinois, Urbana (10 minutes, slides).
6. The Megacycle, a Complex Rhythm in Pennsylvanian Sediments—HAROLD R. WANLESS, University of Illinois, Urbana (10 minutes, slides).
7. A Method for the Examination of Coal Dusts—C. C. BOLEY, State Geological Survey, Urbana (10 minutes, slides).
8. Structural Significance of the Isabel Channel Sandstone in the Beardstown and Chandlerville Quadrangles of Western Illinois—WILLIAM A. NEWTON, State Geological Survey, Urbana (10 minutes, slides).
9. The Recent Impetus to Oil Prospecting in Illinois—GEORGE V. COHEE, State Geological Survey, Urbana (10 minutes, slides).
10. A Study of the Stratigraphy and the Pre-Glacial Topography of the DeKalb and Sycamore Quadrangles—LOREN T. CALDWELL, Northern Illinois State Teachers College, DeKalb (10 minutes).
11. Physiography and Surficial Geology of the Carlinville Quadrangle, Illinois—JOHN R. BALL, Northwestern University, Evanston (10 minutes, slides).
12. Preliminary Studies of Lake Michigan Sediments at Evanston, Illinois—JEAN P. TODD, Northwestern University, Evanston (10 minutes, slides).
13. Engineering Aspects of the Geology of the Vienna City Reservoir—GEORGE E. EKBLAW, State Geological Survey, Urbana (10 minutes, slides).
14. Value of Micro-Geology in Economic Deposits and Research—V. A. LATHAM, State Microscopical Society of Illinois, Chicago (10 minutes).
15. Pre-Cambrian Rocks of Colorado; Their Correlation by Means of Heavy Mineral Analyses—RICHARD H. JAHNES, Northwestern University, Evanston (10 minutes, slides).
16. An Extension of the Driftless Area in Northeast Minnesota—W. FARRIN HOOVER, University of Illinois, Urbana (10 minutes, slides).

## PHYSICS

Room N

HAROLD Q. FULLER, Department of Physics, Illinois College,  
Jacksonville, *Chairman*

Election of Chairman for the year 1937-38.

1. Physics and Human Welfare—L. S. SMITH, Illinois State Normal University, Normal (12 minutes).
2. Micro-photographs of Single Crystals of Binary Alloys of Zinc—H. E. WAY, J. DEVRIES, and C. L. FURROW, Knox College, Galesburg (15 minutes).
3. Recent Astronomical Research and the Photo-Electric Cell—JAKOB KUNZ, University of Illinois, Urbana (20 minutes).
4. The Effect of Frequency and Temperature on the Velocity of Ultrasonic Waves in Gases—GLEN W. WARNER, Woodrow Wilson Junior College, Chicago (15 minutes).
5. A Study of Crooke's Dark Space in a Hot Lime Cathode Ray Beam—CHARLES T. KNIPP and JOSEPH F. MADOLE, University of Illinois, Urbana (10 minutes).
6. A Demonstration of Color Fatigue of the Eye—FRANK L. VERWIEBE, Eastern Illinois State Teachers College, Charleston (10 minutes).
7. Title to be announced—R. F. PATON, University of Illinois, Urbana.
8. Some Focal Plane Shutter Distortions—J. H. SAMMIS, Peoria High School, Peoria (10 minutes).
9. A List of Demonstration Experiments Suitable for Lecture Table Use in First and Intermediate College and University Courses—CHARLES T. KNIPP, University of Illinois, Urbana (10 minutes).
10. Lecture Table Demonstrations in Physics Taken from the above List—CHARLES T. KNIPP, University of Illinois, Urbana.
  - a) Cloud apparatus (1 minute)
  - b) Positive rays (1 minute)
  - c) Singing tubes (6 minutes)
  - d) Liquid oxygen (6 minutes)
  - e) Inductive effect (2.5 minutes)
  - f) Active nitrogen (2.5 minutes)

## PSYCHOLOGY AND EDUCATION

Room O

ROBERT H. GAULT, Department of Psychology, Northwestern University,  
Evanston, *Chairman*

Election of Chairman for 1937-38.

1. Teaching Community Civics Through Areas of Interest—ROBERT S. ELLWOOD, Illinois State Normal University, Normal.
2. Problem of Learning in Small High Schools—S. A. HAMRIN, Northwestern University, Evanston.
3. Etiology of Behavior Difficulties—HAROLD A. KOHN, Mooseheart Laboratories, Mooseheart.
4. Personnel Methods and the High School Student—C. F. MALMBERG, Eastern Illinois State Teachers College, Charleston.
5. The Use of Supervised Study in High School Biology—BLANCHE McAVOY, Illinois State Normal University, Normal.
6. Our Young Adults Challenge the Doctor—MILA PIERCE, Northwestern University School of Medicine, Evanston.
7. The High School as Seen Through the Eyes of Its Recent Graduates—EMMA REINHARDT, Eastern Illinois State Teachers College, Charleston.
8. A Configurational View of Learning—J. E. THOMAS, Illinois Wesleyan University, Bloomington.

## ZOOLOGY

Room E

GEORGE E. MORELAND, Greenville College, Greenville, *Chairman*

Election of Chairman for 1937-38.

1. A Scientific Experiment to Increase the Bluebird Population—ROBERT A. EVERS, Quincy.
2. Hybrid Crosses in Sunfishes—WILBUR M. LUCE, University of Illinois, Urbana.
3. Derbid Field Days—C. S. SPOONER, Eastern Illinois State Teachers College, Charleston (15 minutes, lantern).
4. Some Game Management Principles as Applied to Orchards—HARRY E. GEARHARD, U. S. Department of Agriculture, Soil Conservation Service, Edwardsville.
5. Studies on the Lymnaeid Snail, *Fossaria parva*, (Lea). Part II: Seasonal Life History and Annual Migratory Cycle—C. CLAYTON HOFF, Peoria.
6. Taxonomic Studies of the Sawfly genus *Pristiphora* (Hymenoptera Tenthredinidae)—HERBERT H. ROSS, State Natural History Survey, Urbana.
7. A Note on the Life Cycle of the Turtle Trematode, *Auridistomum chelydrae*—DONALD B. McMULLEN, Monmouth College, Monmouth (10 minutes, lantern).
8. The North American Species of *Acanthochalcis* and *Phasgonophora* (Hymenoptera, Chalcididae)—B. D. BURKS, Assistant Entomologist, State Natural History Survey, Urbana.
9. A Suggested Change in the High School Biology Laboratory Time—SISTER M. FABIAN, O. P., Chicago.
10. Distribution and Migration of the Great Blue Heron (*Ardea herodias herodias*) in Illinois—H. L. ANGUS, Quincy Senior High School (lantern).
11. The Somewhat Mysterious Tissue-Paper Bug—C. L. METCALF, University of Illinois, Urbana.
12. The Changing Status of Illinois Birds as Regards the Abundance—C. W. G. EIFRIG, Concordia Teachers College, River Forest (30 minutes, lantern).
13. Studies on the Life Cycle of *Loxogenes arcanum*, a Trematode Parasite of Frogs—W. W. CRAWFORD, Blackburn College, Carlinville (12 to fifteen minutes, lantern).
14. Southern Illinois Superstitions Regarding Animals—W. M. GERSBACHER, Southern Illinois State Normal University, Carbondale.
15. Lapland Larkspurs in Illinois in the Early Spring of 1937—C. W. HUDELSON, Illinois State Normal University, Normal (5 minutes).
16. Another Appearance of Fresh-water Medusa in Illinois, Including a Structural Study—MARY MINERVA STEAGALL, Southern Illinois State Normal University, Carbondale.
17. Regeneration and Repair in Experimentally Traumatized Trematodes—PAUL BEAVER, University of Illinois and Oak Park Junior College, Oak Park.
18. A Key to the Adult Salamanders of Illinois—C. J. GOODNIGHT, University of Illinois, Urbana (introduced by H. J. VAN CLEAVE, University of Illinois, Urbana).
19. Notes on Ectoparasitic Trematodes of Fishes—JOHN MIZELLE, University of Illinois, Urbana.

ILLINOIS STATE ACADEMY OF SCIENCE  
JUNIOR SECTION

HIGH SCHOOL SCIENCE AND CLUBS

(Committee chairmen listed on page 2)

Rockford Senior High School

FRIDAY, MAY 7, 1937

- 8:00 a. m. Registration (*Rockford Senior High School, entrance on Madison Street, Room 109*).
- 8:00–11:00 a. m. Arrangement of Competitive Entries. Exhibits of Scientific Equipment of Scientific Companies. Boys' Gymnasium, Rockford Senior High School.
- 11:30–12:00. Luncheon, Cafeteria, Rockford Senior High School.
- 1:00–2:00 p. m. Reception for Senior Academy in Exhibit room.
- 2:00–4:00 p. m. Exhibit, display open to parents and friends of local club members.
- 1:30–2:30 p. m. Annual Business Meeting. *Auditorium*, Rockford Senior High School.  
Presentation of Junior Academy officers.  
Presentation of clubs.  
Community singing, led by MR. PAUL CONKLIN, Assistant Principal, Rockford Senior High School.
- 2:30–3:30 p. m. "*Experiences in Africa*" (illustrated lecture)—PROFESSOR GEORGE S. BRYAN, Botany Department, University of Wisconsin, Madison, Wisconsin. (Lecture furnished by Rockford Senior High School Science Clubs.)
- 3:30–4:30 p. m. Short trip about city of Rockford.
- 4:30–5:00 p. m. Removal of exhibits.
- 5:30–7:30 p. m. Annual Banquet, Dining-room, John Barnes Hall, Rockford College. Price 65 cents.  
Toasts and community singing.  
Stunts by Rockford High School students.  
Music by Rockford College students.
- 7:30 p. m. Lecture, Talcott Hall, Rockford College.
- 8:30 p. m. Presentation of awards.

SATURDAY, MAY 8, 1937

See trips for Senior Academy.

HEADQUARTERS OF THE ACADEMY  
ROCKFORD COLLEGE, ROCKFORD, ILLINOIS

SENIOR ACADEMY

Registration Desk in Middle Hall, Rockford College

Telegrams and other messages may be sent to individuals in care of Evelyn I. Fernald, Rockford College, Rockford, Illinois, and called for at the Senior Academy registration desk. Changes of schedule or program and other special announcements will be posted near the registration desks.

Secure tickets for luncheon and banquet before 10:30 a. m., Friday, May 7th. If you cannot arrive by that time and wish tickets, send check or money order for them so as to be sure to reach Evelyn I. Fernald, Rockford College, Rockford, Illinois before Wednesday, May 5th. For your convenience in making reservations a printed form is enclosed with this program.

JUNIOR ACADEMY

Registration Desk, Room 109, Rockford Senior High School

TRANSACTIONS  
OF THE  
ILLINOIS STATE  
ACADEMY OF SCIENCE

---

VOLUME 29

JUNE, 1937

NUMBER 4

---

Minutes of Council Meetings  
Minutes of Thirtieth Annual Meeting  
Reports of Officers and Committees



EDITED BY DOROTHY E. ROSE

PRINTED BY THE ILLINOIS STATE ACADEMY OF SCIENCE

Affiliated with the

STATE MUSEUM DIVISION, CENTENNIAL BUILDING

SPRINGFIELD, ILLINOIS

---

PUBLISHED QUARTERLY

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

STATE OF ILLINOIS  
HENRY HORNER, *Governor*  
DEPARTMENT OF REGISTRATION AND EDUCATION  
JOHN J. HALLIHAN, *Director*  
STATE MUSEUM DIVISION

---

ILLINOIS STATE ACADEMY OF SCIENCE  
AFFILIATED DIVISION OF THE  
STATE MUSEUM

OFFICERS FOR 1936-37

*President*, CLARENCE LEE FURROW,  
Knox College, Galesburg, Illinois

*First Vice-President*, HAROLD ROLLIN WANLESS,  
University of Illinois, Urbana, Illinois

*Second Vice-President*, EVELYN IDA FERNALD,  
Rockford College, Rockford, Illinois

*Secretary*, WILBUR M. LUCE,  
University of Illinois, Urbana, Illinois

*Treasurer*, GEORGE D. FULLER,  
University of Chicago, Chicago, Illinois

*Acting Librarian*, GILBERT WRIGHT  
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.

## CONTENTS

	PAGE
Minutes of Meetings of the 1936-1937 Council . . . . .	285
First meeting . . . . .	285
Second meeting . . . . .	285
Third meeting . . . . .	286
Fourth meeting . . . . .	287
Reports of Officers and Committees for 1936-1937 . . . . .	288
Minutes of the Thirtieth Annual Meeting . . . . .	288
Morning business meeting . . . . .	288
Annual business meeting . . . . .	288
Section meetings and general sessions . . . . .	289
Report of the Treasurer . . . . .	290
Report of the Auditing Committee . . . . .	291
Report of the Editor . . . . .	291
Report of the Committee on Compilation of Ecological Bibliography . . . . .	291
Report of the Librarian . . . . .	292
Report of the Committee on Publications . . . . .	293
Report of Committee on Legislation and Finance . . . . .	293
Report of the Committee on Membership . . . . .	293
Report of the Junior Academy . . . . .	293
Report on <i>Science Club Service</i> . . . . .	294
Junior Section Meeting . . . . .	295
Winners of Awards . . . . .	295
Report of the Delegate to the Academy Conference of the A.A.A.S. . . . .	299
Report of the Delegate to the Conservation Council . . . . .	299
Report of the Committee on Resolutions . . . . .	301
Affiliated High School Science Club . . . . .	302
Scientific Societies Affiliated with the Academy . . . . .	303

For Index to Vol. 29, see Vol. 30, No. 1.



# MINUTES OF MEETINGS OF THE 1936-1937 COUNCIL

## FIRST MEETING

The Council was called to order by President Furrow at 8 a. m., May 2, 1936 at the Lincoln-Douglas Hotel in Quincy, Ill. Others present were Dr. Sneller, Dr. Fuller, Dr. Wanless, and Dr. Luce.

It was voted to accept the invitation of Rockford College to hold the 30th Annual Meeting at Rockford May 7-8, 1937, and to hold the 31st Meeting in May, 1938, at Southern Illinois State Normal University, Carbondale.

The report of the Committee on Research Grants was accepted and approved. In accordance with its recommendation \$125.00 of the A.A.A.S. Research Grant was allotted to Dr. John Voss for aid in his studies on the ecology of peat bog deposits.

An honorarium of \$25.00 was voted for Dr. Andrew Conway Ivy for the Annual Public Lecture, and one of \$10.00 was voted to Mr. Louis A. Astell in recognition of his services in connection with the activities of the Committee on High School Science and Clubs (Junior Academy).

The Treasurer was authorized to pay the bills in connection with the publicity campaign for the Quincy meeting.

The Secretary was instructed to have memorials prepared for Mr. Thomas L. Hankinson and Dr. Walter G. Bain.

The question of the continuance of sections in Medicine and Public Health and in Economics was discussed but no action was taken.

The selection of the second vice-president was deferred until a later date.

Meeting adjourned at 9:15 a. m.

## SECOND MEETING

The second meeting of the Council was called to order by President Furrow at 1:30 p. m., November 14, 1936, at the University Club, Urbana, Illinois. President Furrow, Dr. Fuller, Dr. Wanless, Dr. Fernald, and Dr. Luce were present.

At the first meeting of the Council in Quincy no second vice-president had been elected. In October, 1936, the members of the Council, voting by mail, elected to the position Dr. Evelyn I. Fernald of Rockford College.

The first business to be taken up was a discussion of the editorial fee and its collection. It was decided that the Council would suggest to the editor that she send out together with notices of the fee a mimeographed sheet explaining the necessity for the fee. The Secretary was instructed to notify Miss Rose of these suggestions.

In the absence of the editor, the Secretary reported that Volume 29, Number 2, which contains the papers presented before the section meetings at Quincy, was in press and should be ready for distribution in January.

In connection with the general publication plan of the Academy it was suggested that the Committee on Publications investigate the possibilities as to a reorganization which would allow a more efficient use of the appropriation allotted us by the General Assembly.

Professor Robert H. Gault was appointed Chairman of the section in Psychology and Education,

It was voted to ask Dr. T. H. Frison, Chief of the State Natural History Survey, for the services of Mr. Carroll Chouinard, Editor, as publicity chairman for the annual meeting at Rockford.

Honoraria of \$150.00 each were voted for the Editor and the Secretary for their services if funds were available after the other expenses of the Academy had been paid.

It was voted to instruct the Committee on Legislation and Finance to ask for the appropriation for the next biennium as a part of the budget of the State Museum, with which the Academy is affiliated. In view of the very restricted plan of publication which is in operation at present because of the small amount now appropriated by the General Assembly for the support of the publication of the *Transactions*, it was voted to instruct the Committee on Legislation and Finance to ask for an increase in our appropriation for the next biennium.

Dr. Wilbur M. Luce resigned as delegate to the A.A.A.S. Academy Conference. His resignation was accepted and Professor George D. Fuller was appointed delegate to fill the vacancy.

In accordance with the recommendations made in the report of the retiring Committee on Research Grants a new committee was set up. Dr. Harold R. Wanless was appointed chairman and given power to select the other members.

It was suggested that a notice of the Research Grant of the A.A.A.S. be inserted in Volume 29, Number 3 of the *Transactions*.

Plans for the annual meeting at Rockford were discussed.

It was voted that the Secretary be instructed to draw up resolutions on the death of Mr. Fred R. Jelliff. It was further voted that these resolutions become a part of the minutes of the Council meeting and that a copy of them be sent to Mrs. Jelliff.

In accordance with these instructions the Secretary prepared the following:

The members of the Council of the Illinois State Academy of Science wish to express their sorrow and sense of great loss at the death of Mr. Fred R. Jelliff. Mr. Jelliff was a charter member of the Academy and ever since its beginning had been a loyal and energetic supporter of the activities of the Academy. He served as its president; he was active in the work of many of its committees; he religiously attended its annual meetings; he presented numerous papers before the section meetings; and he was ready at all times to aid the officers of the Academy in the solution of their problems. Altogether Mr. Jelliff took such an active part in the functions of the Academy that his passing leaves a place which it will be impossible to fill.

The meeting adjourned at 4:45 p. m.

### THIRD MEETING

The third meeting of the Council was called to order by President Furrow at 1:30 p. m. at the Quadrangle Club in Chicago on February 27, 1937. Others present were Dr. Behre, Dr. Sneller, Dr. Fuller, Dr. Wanless, Dr. Fernald, and the Secretary.

Plans for the program of the annual meeting were discussed. It was voted to ask President Furrow to invite Professor George W. Stewart, Head of the Department of Physics of Iowa State University, to give the annual public lecture.

It was suggested that the President send copies of the preliminary program to the Wisconsin and Iowa Academies extending to their members an invitation to attend the annual meeting of the Illinois Academy.

Funds were voted to the Committee on High School Science and Clubs not to exceed \$50.00 for expenses in connection with the annual meeting.

Dr. Wanless, Chairman of the Committee on A.A.A.S. Research Grants, reported that his committee was considering twelve different projects which he summarized for the information of the Council. It was voted that one member of the Committee on A.A.A.S. Research Grants be retired each year; and that an attempt be made to represent the various fields of science in some regular order on the committee.

The Auditing Committee, Nominating Committee, and Committee on Resolutions, which are to serve at the annual meeting, were appointed by President Furrow.

Professor Charles H. Behre, Jr., representing Northwestern University, extended a cordial invitation to the Academy to hold its annual meeting in 1939, or at any time in the future, at Evanston.

Adjournment was voted at 5:00 p. m.

#### FOURTH MEETING

The fourth Council meeting was called to order by President Furrow at Rockford College, Rockford, at 7:45 p. m., May 6, 1937. President Furrow, Dr. Sneller, Dr. Fuller, Dr. Wanless, Dr. Fernald, and Dr. Luce were present.

Miss Fernald reported that the Committee on Local Arrangements had everything ready for the annual meeting.

It was voted that the editorial fee of one dollar per paper published in the *Transactions* be continued and that in addition non-members should present an application for membership accompanied by the proper fees in order to have their papers eligible for publication in the *Transactions*.

Several invitations for the 1939 annual meeting were discussed but no action was taken.

The Council considered it desirable that the Committee on High School Science and Clubs be given the status of a standing committee with the chairman to serve as a member of the Council. The Council recommends that such action be taken by constitutional amendment in the near future.

Dr. Wanless, Chairman of the Committee on A.A.A.S. Research Grants, made the following recommendations for the Grantees for the fund for 1937:

Mr. A. M. Simpson, Peoria.....	\$ 27.00
Professor John DeVries and Professor Harold Way, Knox College, Galesburg.....	\$123.00
Dr. Paul Beaver, Oak Park Junior College, Oak Park.....	\$100.00

These recommendations were unanimously approved by vote of the Council.  
The meeting adjourned at 10:30 p. m.

(Signed) WILBUR M. LUCE, *Secretary*.

## REPORTS OF OFFICERS AND COMMITTEES FOR 1936-1937

### REPORT OF THE SECRETARY

#### MINUTES OF THE THIRTIETH ANNUAL MEETING, ROCKFORD, MAY 7-8, 1937

##### MORNING BUSINESS MEETING

The preliminary business meeting of the Academy was called to order by President C. L. Furrow at 8:35 a. m. in Talcott Hall, Rockford College, Rockford. The President announced the appointment of the following committees:

*Auditing Committee:* Paul D. Voth, *Chairman*; A. C. Noé; Scott V. Eaton.

*Nominating Committee:* Charles H. Behre, Jr., *Chairman*; J. C. Hessler; C. D. Sneller.

*Resolutions Committee:* Clarence Bonnell, *Chairman*; H. H. Ross; John R. Ball. The meeting was adjourned until 5 p. m.

##### ANNUAL BUSINESS MEETING

The annual business meeting of the Academy was called to order by President Furrow at 5 p. m. in Talcott Hall, 75 members being present. The first item of business was the reports of officers. The Treasurer's report was given by the Treasurer, Dr. George D. Fuller. The report of the Editor, Miss Dorothy Rose, was read by the Secretary. The report of the Librarian was given by Dr. Gilbert Wright, Acting Librarian. These reports were accepted and approved by vote of the members present.

The reports of the standing committees were then given. Mr. Clarence Bonnell, Chairman, read the report of the Affiliations Committee. The report of the Membership Committee was given by its Chairman, Dr. John Voss. The report of the Publications Committee was presented by the Secretary. These reports were approved and accepted.

For the information of the Academy members the following reports of special committees were given: Conservation, by Dr. T. H. Frison, Chairman; Compilation of Ecological Bibliography, read by the Secretary for Professor A. G. Vestal, Chairman; High School Science and Clubs, read by the Treasurer for Miss Mable Spencer and Miss Rose Cassidy, Co-Chairmen; A.A.A.S. Research Grants, by Dr. H. R. Wanless, Chairman.

Dr. George D. Fuller, Delegate to the American Association for the Advancement of Science Academy Conference presented a report of the Academy Conference held at Atlantic City, December 28, 1936. Dr. V. O. Graham gave his report as the Delegate representing the Academy on the Conservation Council of Chicago. Their reports were approved and accepted.

The report of the Auditing Committee was read by Chairman Paul D. Voth. This report was voted approved and accepted. The Chairman of the Resolutions Committee, Mr. Clarence Bonnell read the report of that committee which was approved and accepted. The President called for items of unfinished business. None were reported.

The Nominating Committee report was read by the Secretary for the Chairman, Dr. Charles H. Behre, Jr. The following nominations were made:

*President,* Harold R. Wanless, University of Illinois, Urbana

*First Vice-President,* George D. Fuller, University of Chicago, Chicago

*Second Vice-President and Chairman of Committee on Local Arrangements,*

Otis B. Young, Southern Illinois State Normal University, Carbondale

*Secretary,* Wilbur M. Luce, University of Illinois, Urbana

*Treasurer,* Paul D. Voth, University of Chicago, Chicago

*Editor,* Dorothy E. Rose, State Geological Survey, Urbana

*Elective Member of the Publications Committee,* B. Smith Hopkins, University of Illinois, Urbana

*Committee on Affiliations,*

Clarence Bonnell, Harrisburg Township High School, Harrisburg, *Chairman*

H. H. Radcliff, 1346 W. Macon St., Decatur

Rosalie M. Parr, University of Illinois, Urbana

Mary M. Steagall, Southern Illinois State Normal University, Carbondale

H. O. Lathrop, Illinois State Normal University, Normal

*Committee on Membership,*

F. M. Fryxell, Augustana College, Rock Island, *Chairman*

M. L. Clikeman, Rockford Senior High School, Rockford

Frances Johnson, Rockford

T. F. Barton, Southern Illinois State Normal University, Carbondale

W. V. Balduf, University of Illinois, Urbana

Further nominations from the floor were called for by President Furrow. The nominations were declared closed and the Secretary was instructed to cast a unanimous ballot for the election of the nominees as read. The President called for other items of new business. The meeting adjourned at 6 p. m.

(Signed) WILBUR M. LUCE, *Secretary.*

## SECTION MEETINGS AND GENERAL SESSIONS

For the program at the general session on Friday morning, after an address of welcome by Dr. Gordon Chalmers, President of Rockford College, Professor C. L. Furrow, Knox College, Galesburg, President of the Academy, gave an illustrated lecture on *The Evolution of Sex in the Mollusca*. This was followed by an address by Mr. Don L. Carroll of the State Geological Survey, Urbana, on *Some Observations on the 1937 Flood in Southern Illinois*. This address was illustrated by lantern slides of aerial photographs and maps of the area. The final address of the Friday morning session was a lecture, illustrated by colored moving pictures, on *Science and the Garden* by Mr. John H. Hanley, University of Illinois, Urbana. The Friday morning session of the Junior Academy was given over to the display and judging of the projects which were presented for competition in the annual exhibition. For the general session on Friday evening Professor H. A. Vagtborg of the Armour Institute of Chicago addressed the Junior Academy members and guests on the topic *The Story of Sanitation*. Professor George W. Stewart, Head, Department of Physics, University of Iowa, Iowa City, Iowa, addressed the Senior Academy on the subject *Changes in Concepts of States of Matter*.

On Friday afternoon 145 papers were presented before nine section meetings. On Saturday all six field trips were especially well attended. The geological trip under the direction of Dr. M. M. Leighton and Dr. George E. Ekblaw, of the State Geological Survey, visited points of geological interest in the vicinity of Rockford. An industrial trip, sponsored by the Rockford Chamber of Commerce, visited some of the city's many interesting industrial plants. A trip to the Rockford Sewage Disposal Plant was conducted by Mr. T. G. Lindquist, superintendent of the Sanitary District of Rockford. An anthropological trip with Dr. J. B. Ruyle, D.D.S., Champaign, as leader, visited the Logan Museum of Beloit, Wisconsin, and studied the various kinds of Indian mounds in the vicinity. A trip under the leadership of Mrs. J. H. Mansfield, President of the Rockford Garden Club, visited some of the many fine residential gardens of Rockford, the public

parks, and the nine forest preserves of Winnebago County. The botanical trip under the direction of Dr. H. W. Pepon, Chicago, and Dr. George D. Fuller, University of Chicago, Chicago, visited and studied the interesting flora of Apple River Canyon State Park.

REPORT OF THE TREASURER  
For the year ending April 30, 1937

RECEIPTS

Balance on hand April 25, 1936.....	\$	220.88	
Initiation fees and dues.....		759.00	
Sale of <i>Transactions</i> .....		12.50	
Editorial fees and excess pages.....		85.35	
Junior Academy.....		123.06	
			\$1,200.79

EXPENDITURES

Expenses of Annual Meeting, 1936:

Programs .....	\$	76.86	
Officers' expenses.....		29.90	
Speakers .....		35.00	
Publicity .....		24.47	
Section chairmen .....		18.40	
Junior Academy.....		42.99	
			\$ 227.62
Editor's honorarium.....		150.00	
Secretary's honorarium.....		150.00	
Secretary's expenses.....		75.73	
Treasurer's expenses .....		75.12	
Printing <i>Transactions</i> .....		167.96	
Postage on <i>Transactions</i> .....		33.02	
Junior Section.....		83.14	962.59
Balance in University State Bank.....			238.20
			\$1,200.79

STATEMENT OF RESOURCES, APRIL 30, 1937

Balance in University State Bank.....	\$	238.20
Mortgage Bonds, face value \$600.00; probable value.....		200.00
Office supplies .....		5.00
Total resources.....	\$	443.20

In presenting this, his last annual financial statement, the Treasurer is pleased to report that the income from members' dues shows a small (\$50.00) increase over that of last year. It is also his pleasing duty to congratulate the Junior Academy in becoming self supporting. The expenses of the Academy, however, tend to increase and although an editorial fee of \$1.00 for each article published was charged this year, it paid less than one-half the expense of editing. It is recommended that this fee be continued as well as the charge for excess pages in the *Transactions*. The need for a larger income is still urgent.

The present membership of the Academy consists of 75 life members, 485 fully paid up annual members, 148 members one year in arrears, 94 members two years in arrears, and 50 members who are three years in arrears and who are

being dropped from the roll at the present meeting. We have received 125 new members during the year, 25 have resigned and 8 annual and 4 life members have died.

The net membership on April 30, 1937, not including those dropped at the present meeting but including the new members, consists of 927 personal members, a net gain of 53 during the year. There are also some 20 affiliated societies and 40 clubs in the Junior Academy.

In retiring from the treasurership the Treasurer would express his appreciation of the hearty cooperation of the other officers of the Academy throughout the ten years he has occupied this office and would bespeak the same friendly support for his successor.

The entire report is respectfully submitted.

GEO. D. FULLER, *Treasurer.*

REPORT OF THE AUDITING COMMITTEE

This is to certify that we have audited the report of the Treasurer and have examined his accounts which appear to have been correctly kept. All expenditures have been authorized by vouchers signed by the President and the Secretary. The balance in the University State Bank of \$238.20 agrees with the statement.

(Signed) PAUL D. VOTH, *Chairman,*  
A. C. NOÉ,  
SCOTT V. EATON.

Chicago, Illinois,  
May 5, 1937.

REPORT OF THE EDITOR

The cost of printing the Academy's *Transactions* the past biennium has been as follows:

	<i>State</i>	<i>Academy</i>
Vol. 28, No. 1.....	\$ 114.79	
2.....	704.02	
3.....		} \$159.14
4.....		
Vol. 29, No. 1.....	95.79	
2 (estimate).....	1,309.00	
3 (estimate).....		83.00
Envelopes .....	41.57	
	\$2,265.17	\$242.14

The state printing allowance of \$2,000 for the present biennium which closes June 30, 1937, has been overdrawn by the amount of \$265.17. The present limitation of authors to 1,000-word abstracts and no more than one illustration will have to be continued until increased funds can be secured.

Increased cost of printing is also affecting the issues for which the Academy pays.

Respectfully submitted,

May 6, 1937.

(Signed) DOROTHY E. ROSE, *Editor.*

REPORT OF THE COMMITTEE ON COMPILATION OF  
ECOLOGICAL BIBLIOGRAPHY

Considerable material has been compiled for volume two of the Bibliography of the Ecology of Illinois. Additional helpers who have been working on the compilation of this material are Mr. Charles T. Black, Miss Alice L. Washburn, and Mr. Charles E. Janvrin.

(Signed) A. G. VESTAL, *Chairman.*

## REPORT OF THE LIBRARIAN

Since the last Annual Meeting the fourth number of Volume 28 and three numbers of Volume 29 have been distributed. The following surplus of these numbers remain in the State Museum:

Vol. 28, No. 4.....	480 copies	Vol. 29, No. 2.....	420 copies
Vol. 29, No. 1.....	401 copies	Vol. 29, No. 3.....	50 copies

Attached to this report is a complete record of the surplus volumes and quarterly numbers that are now on hand.

During the past year approximately one hundred and fifty volumes and numbers of the *Transactions* were sent in response to special requests. Most of these requests came from libraries or scientific academies that are on the exchange list. Consequently very little cash was received by the Librarian in payment for these copies.

Several complete sets of *Transactions*, so far as it was possible to make them complete, were sent in exchange for other sets of scientific publications. Among these should be mentioned the *American Midland Naturalist*, published at the University of Notre Dame, and the *Bulletin of the Geological Institution of the University of Upsala, Sweden*. In addition to these many other scientific publications were received from those on the exchange list.

In September, 1936, an arrangement was made with the Smithsonian Institution whereby foreign addressed *Transactions* may be sent at reduced rates through the United States International Exchange Service. Through this arrangement foreign addressed *Transactions* are shipped to the Smithsonian Institution in Washington after which the Institution transmits them to their destinations by mail free of further cost.

Recognition is herewith given of the splendid cooperation extended by the State Bureau of Multigraphing, which department has taken care of the addressing and stuffing of all issues of the *Transactions* without expense to the Academy or to the Museum.

Respectfully submitted,

(Signed) GILBERT WRIGHT, *Acting Librarian*.

Present supply of *Transactions* of Illinois State Academy of Science:

<i>Single Volumes</i>	<i>Quarterly Volumes</i>	<i>Quarterly Volumes</i>
Vol. 1..... 16	Vol. 23, No. 1..... 34	Vol. 27, No. 1.....474
Vol. 2.....492	No. 2..... 0	No. 2.....414
Vol. 3.....446	No. 3..... 0	No. 3..... 34
Vol. 4.....125	No. 4..... 36	No. 4..... 71
Vol. 5.....304	Vol. 24, No. 1..... 60	Vol. 28, No. 1..... 94
Vol. 6.....151	No. 2..... 93	No. 2.....124
Vol. 7.....428	No. 3..... 0	No. 3..... 0
Vol. 8.....472	No. 4..... 6	No. 4.....480
Vol. 9.....311	Vol. 25, No. 1..... 60	Vol. 29, No. 1.....401
Vol. 10.....418	No. 2.....241	No. 2.....420
Vol. 11..... 24	No. 3.....374	No. 3..... 50
Vol. 12-22 inc. .... 0	No. 4.....331	General Index
	Vol. 26, No. 1..... 50	(Vols. 1-25).....890
	No. 2.....348	Total number single
	No. 3..... 0	volumes and quar-
	No. 4.....666	terly numbers.....8,938

## REPORT OF THE COMMITTEE ON PUBLICATIONS

Because of our limited printing allowance of \$2,000 for the biennium ending June 30, 1937, it has been necessary to restrict the publication of manuscripts of papers presented before the sectional meetings to 1,000 word abstracts. It appears now that there is small likelihood that this allowance will be increased for the next biennium. Therefore the policy of allowing the printing of 1,000-word abstracts only, will have to be continued for the next two years. It is earnestly hoped that in the near future the biennial appropriation from the General Assembly may be increased, so that a more liberal publication program may be undertaken.

Respectfully submitted,

WILBUR M. LUCE,  
*For the Committee on Publications.*

## REPORT OF COMMITTEE ON LEGISLATION AND FINANCE

At various times the chairman of the committee conferred with officials at Springfield regarding the status of appropriations to the Academy from State funds. Arrangements have been made to secure an appropriation of \$2,000 for printing needs, and a tentative agreement has been made to allow the Academy to draw on any unexpended portion of the printing funds allotted to the State Museum. Inasmuch as funds from the latter source promise to amount to more than five hundred dollars, on the basis of total requisitions made during recent years, it is felt that the financial needs and requests of the Academy will be honored as they develop during the current biennium.

Respectfully submitted,

(Signed) DON L. CARROLL, *Chairman.*

## REPORT OF THE COMMITTEE ON MEMBERSHIP

An intensive campaign for new members was carried out by the committee during the past year. In addition to personal solicitations, the following work was done:

1. 400 invitations were sent to Illinois members of the A.A.A.S. who were not members of the State Academy
2. 100 invitations were sent to science teachers living in the north central part of the State
3. Many letters were addressed to present members of the Academy urging them to secure new members
4. 100 invitations were sent to individuals who participated in recent geological field trips sponsored by the Illinois State Geological Survey
5. Announcements were made at various meetings of science teachers

To date 115 new members were secured.

Respectfully submitted,

(Signed) JOHN VOSS, *Chairman.*

## REPORT OF THE JUNIOR ACADEMY

(Committee on High School Science and Clubs)

The Illinois Junior Academy of Science has had a very active year. The radio program has gone forward under the supervision of Mr. Tilbury, Dr. Parr, and Dr. Thomas. Mr. Astell has published three issues of the Science Club Service, copies of which were sent to all affiliated clubs as well as to several hundred schools for advance work. About 300 students registered for the Junior Academy

meetings and the program under the direction of Miss Rose Cassidy, and the exhibits directed by Mr. Harry Adams were well attended and very inspirational.

Two changes have been made in the policy to take effect for next year:

- (1) Officers will be chosen from a point system
- (2) Dues will be ten cents a member; special cases of membership in more than one club will be taken care of by special arrangements

Everyone showed a very helpful attitude and our business meetings have improved decidedly.

(Signed) MABLE SPENCER,  
ROSE CASSIDY,  
Co-chairmen.

REPORT ON *Science Club Service*, PUBLISHED BY THE ILLINOIS JUNIOR ACADEMY OF SCIENCE FOR JUNIOR ACADEMY OFFICIALS AND AFFILIATED CLUBS IN ALL STATES

The reception given *Science Club Service* during the past year has exceeded expectations. The three issues represent some 12,000 words, carefully selected for the benefit of sponsors and Junior Academy officials wherever located. Among the more significant aspects of the publication program for the academic year are the following: (1) Indiana Junior Academy of Science has voluntarily maintained its status of Sustaining Member, for the second year: (2) Iowa and Oklahoma Junior Academies of Science have maintained the status of Cooperating Members. The newly organized Junior Academy of the Academy of Science of St. Louis has begun its history as a Cooperating Member and is making cash provisions extending the service into the next academic year. St. Louis then represents the first of the large city organizations to enter the Junior Academy field. We should shortly expect something comparable to the New York City program growing under the auspices of the Junior Academy Movement in contrast with the latter which is under the auspices of the American Institute and the American Museum of Natural History.

The difference between the Sustaining and Cooperating Memberships as they have been set up is that the former involves a larger fee for a correspondingly larger number of copies from each issue and for a larger amount of space in *Science Club Service*. For the flat rates involved in these memberships, the following benefits are extended:

- (1) Privilege of having a Contributing Editor over whose signature the material of the given state is presented.
- (2) Fixed amount of space for copy in each issue, with provisions for accumulation of space credit.
- (3) Fixed number of copies to the State organization to be issued through the State or General Chairman, or other officials.
- (4) Exchange of the best ideas available for the benefit of all groups.

It is the intention of the Editor to keep this publication on as thoroughly a cooperative plan as is possible. The policy has resulted in a budget that shows, for the year, a total debit of \$61.33 and a total credit of \$62.50, of which \$28.75 is to be collected. Never before has the *Science Club Service* been self supporting. These figures do not include charges for the Illinois Junior Academy of Science.

*Recommendations:*

- (1) Designation of a Contributing Editor at hands of the Editor. The said Contributing Editor for the Illinois Junior Academy of Science should handle the copy for Illinois in the same way as the Contributing Editors of other states handle the copy. This will reduce the load of the person in charge of the final editing and make the load a less burdensome one.
- (2) A further broadening of the base to be indicated in the "Flag" of the publication.

- (3) Not less than three issues for the next academic year, with four the desirable goal if funds are available.
- (4) Club dues to be fixed at a minimum of Two Dollars (for twenty members) and 10 cents for each member above 20 in the club.
- (5) Concerted effort to increase the number of affiliated clubs at the earliest possible moment after the school year starts.
- (6) Early development of the WILL radio broadcast series in order to give it the widest publicity and greatest possible usage.

(Signed) LOUIS A. ASTELL.

May 6, 1937.

## JUNIOR SECTION MEETING

### WINNERS OF AWARDS

#### LOVING CUPS

- All-round Club: Botkemzo Club, Parker Senior H. S., Chicago.  
 Astronomy: Botkemzo Club, Parker Senior H. S., Chicago.  
 Biology: Biology Club, Joliet H. S., Joliet.  
 Chemistry: Chemistry Club, J. Sterling Morton H. S., Cicero.  
 Geology: Geology Club, Bloomington H. S., Bloomington.  
 Physics: Physics Club, J. Sterling Morton H. S., Cicero.  
 Junior High School: David Prince Junior H. S., Science Club, Jacksonville.

#### ASTRONOMY

##### *Group Poster*

- (1) Mendel Club, Visitation H. S., Chicago, "Saturn's rings."
- (2) Botkemzo Club, Parker Sr. H. S., Chicago, "The solar system."

##### *Group Model*

- (1) Botkemzo Club, Parker Sr. H. S., Chicago, "The solar system."

##### *Individual Project*

- (1) William Beck, J. Sterling Morton H. S., General Science Club, Cicero, "Reflecting telescope."

##### *Science Notebook*

- (1) Primrose Robinson, West Chicago Community H. S., Edisonian Club, "Astronomy notebook."

#### BIOLOGY

##### *Individual Poster*

- (1) John Slucki, Joliet H. S. Biology Club, "Chart of circulatory system."
- (2) Mathilda Horvath, Visitation H. S. Mendel Club, "Structure of a typical flower."
- (3) Richard Borden, Normal University H. S. Major Powell Science Club, "Reptiles."

Hon. mention: Carl Stoffel, J. Sterling Morton Field and Stream Club.  
 Laddie Podzeniek, Arlington Heights Science Club, "Wild life."

##### *Group Poster*

- (1) Joliet H. S. Biology Club, "Utility of birds."
- (2) Blue Island Community H. S. Biology Club.
- (3) J. Sterling Morton H. S. Field and Stream Club.

##### *Individual Project*

- (1) John Hill, Joliet H. S. Biology Club, "Tree wounds."
- (2) William L. Bruden, Rockford Sr. H. S. Natural Science Club, "Flora and fauna of Rockford Township."
- (3) Dorothy Watson, J. Sterling Morton Field and Stream Club, "Terrarium."

Hon. mention: Marian Schultz, Blue Island Community H. S. Biology Club.

##### *Group Project*

- (1) Rockford Sr. H. S. Natural Science Club, "Skeleton of a deer."
  - (2) J. Sterling Morton H. S. Field and Stream Club, "Display box."
  - (3) Edwardsville H. S. Science Club, "Bacteria cultures."
- Hon. mention: J. Sterling Morton H. S. Field and Stream Club, "Terrarium."

## BIOLOGY (Continued)

*Commercial Products (Individual)*

- (1) Luther Eggman, Joliet H. S. Biology Club, "Sprays."

*Commercial Products (Group)*

- (1) Joliet H. S. Biology Club, "Fish products."

*Individual Collections*

- (1) Robert Mitchell, J. Sterling Morton Field and Stream Club, "Fossils."  
 (2) J. L. Hufford, Joliet H. S. Biology Club, "Insects."  
 (3) Jean Fitzgerald, Visitation H. S. Mendel Club, "Hard and soft wood."

Hon. mention: Ralph Sullivan, Blue Island Community H. S. Biology Club, "Seeds."

*Group Collections*

- (1) Rockford Sr. H. S. Natural Science Club, "Coleoptera."  
 (2) Joliet H. S. Biology Club, "Insect life histories."

- (3) Lake View Biology Club, Lake View H. S., Chicago, "Winter twigs."

Hon. mention: J. Sterling Morton Field and Stream Club, "Shells."

*Individual Models*

- (1) Mary Forkel, Joliet H. S. Biology Club, "Capsella embryo."  
 (2) Mary Ann Knirsch, Blue Island Community H. S. Biology Club, "Bird eggs."

*Science Notebook*

- (1) Miriam Schooley, Botkemzo Club, Parker Sr. H. S., Chicago, "Botany notebook."  
 (2) Miriam Schooley, Botkemzo Club, Parker Sr. H. S., Chicago, "Zoology notebook."  
 (3) June Delich, Blue Island Biology Club, "Ancient History of Man."

Hon. mention: Cynthia Michael, Blue Island Biology Club, "Birds."

## CHEMISTRY

*Individual Poster*

- (1) Frank Slauf, J. Sterling Morton H. S. Chemistry Club, "Sulphur."  
 (2) Eleanor Morrison, Edwardsville H. S. Science Club, "Chlorine, bromine, iodine."  
 (3) Charles Rapp, Granite City H. S. Vocational Science Club, "Qualitative analysis."

*Group Poster*

- (1) Vocational Science Club, Granite City H. S., "Chemical trees."  
 (2) J. Sterling Morton H. S. Chemistry Club, "Nitric, hydrochloric, and sulphuric acid."

*Individual Project*

- (1) Arthur Ouska, J. Sterling Morton H. S. Chemistry Club, "Clay model."  
 (2) Sam Steinberg, Granite City H. S. Vocational Science Club, "Photography."  
 (3) Lawrence Thompson, Edwardsville H. S. Science Club, "Periodic chart."

*Group Project*

- (1) Normal Community H. S. Chem-Mystery Club, "Plastic wood."  
 (2) J. Sterling Morton H. S. Chemistry Club, "Making of sulphuric acid."  
 (3) Trinity H. S., River Forest Senior Scientist Club, "Blue prints."

*Commercial Products (Individual)*

- (1) Orilda Wilcox, Normal Community H. S. Chem-Mystery Club, "Vanishing cream."  
 (2) Joseph Relka, J. Sterling Morton H. S. Chemistry Club, "Lead chamber of sulphuric acid plant."

*Commercial Products (Group)*

- (1) Normal Community H. S. Chem-Mystery Club, "Making glass."  
 (2) Quincy H. S. Alchemy Club, "Cold cream."  
 (3) J. Sterling Morton H. S. Chemistry Club, "Producing sulphuric acid."

## CHEMISTRY (Continued)

*Individual Collections*

- (1) William Lukson, Edwardsville H. S. Science Club, "Collection of shells."
- (2) Albert Burnett, Granite City Vocational Science Club, "Metal."

*Group Collections*

- (2) J. Sterling Morton H. S. Chemistry Club, "Manufacture of rubber."
- (3) Edwardsville H. S. Science Club, "Photography booklet."

*Individual Models*

- (1) Harold Byland, Granite City Vocational Science Club, "Blast furnace."

*Science Notebook*

- (1) June Whitman, Normal Community H. S., Chem-Mystery Club, "Science notebook."
- (2) Dorothy Renschner, Normal Community H. S., Chem-Mystery Club, "Science notebook."

*Radio Notebook*

- (1) Beatrice Thrapp, West Chicago Community H. S., Edisonian Club, "Twenty radio talks."

## GEOLOGY

*Individual Poster*

Entries but no awards.

*Group Poster*

- (3) Bloomington H. S. Geology Club, "Geologic time clock."

*Individual Project*

- (1) Robert Bowen, Geology Club, Bloomington H. S., "Geology as a hobby."

*Group Project*

- (1) Geology Club, Bloomington H. S., "Pennsylvanian fossils and coal mine."

Hon. mention: Geology Club, Bloomington H. S., "Hand polishing of rocks."

*Individual Collections*

- (3) Robert Anderson, Botkemzo Club, Parker Sr. H. S., "Fossil collection."

Hon. mention: Donald Hopkins, Geology Club, Bloomington H. S., "Crystal collection."

*Group Collections*

- (2) Botkemzo Club, Parker Sr. H. S., Chicago, "Indian relics."

*Individual Model*

- (1) Roger Stauffer, Normal University H. S. Major Powel Science Club, "Lake Louise."

*Science Notebooks*

- (1) Edward Woods, Vocational Science Club, Granite City H. S., "Minerals and ores."
- (2) Floyd Brown, Geology Club, Bloomington H. S., "Volcanic notebook."

## PHYSICS

*Individual Poster*

- (1) Dan Howanitz, Botkemzo Club, Parker Sr. H. S., "Ether spectra."
- (2) Mary-jo Hall, Physics Club, J. Sterling Morton H. S., "Electrical appliance."

*Group Poster*

- (1) Physics Club, J. Sterling Morton H. S., "Invisible light."

*Group Project*

- (1) Physics Club, J. Sterling Morton H. S., "Telescope making."
- (2) Physics Club, J. Sterling Morton H. S., "Wind tunnel."
- (3) Edisonian Science Club, West Chicago Community H. S., "Short wave receiver."

*Commercial Products*

- (1) William L. Meag, Physics Club, J. Sterling Morton H. S., "Alternating current demonstration."

## PHYSICS (Continued)

*Individual Project*

- (1) George Best, Physics Club, J. Sterling Morton H. S., "Oscilloscope."
- (2) Jack ( ? ? ? ), Edisonian Science Club, West Chicago Community H. S., "Photoelectric relay."
- (3) Delvine Schneeberg, Major Powell Science Club, Normal University H. S., "Electron coupled radio receiver."

*Group Collections*

- (1) Physics Club, J. Sterling Morton H. S., "Methods of measuring the speed of light."

*Individual Models*

- (1) Lea Grace Beaudro, J. Sterling Morton H. S. Physics Club, "Measurement of light speed."
- (2) Howard Bittner, Arlington Heights H. S. Science Club, "Model aeroplane."

## NEWSLETTER

*Ditto*

- (1) Edwardsville Sr. H. S.

*Handicraft*

- (1) Edwardsville H. S.
- (2) Joliet H. S.

*Mimeograph*

- (1) J. Sterling Morton H. S. Chemistry Club.
- (2) East Moline H. S.
- (3) J. Sterling Morton H. S. Biology Club.

## JUNIOR HIGH SCHOOL

*Individual Poster*

- (1) Edwin White, David Prince Jr. H. S., Jacksonville, "The clock of the sky."

*Group Poster*

- (1) David Prince Jr. H. S. Science Club, "Travels of sun, earth, and moon."

*Individual Project*

- (1) Wallace Schildman, David Prince Jr. H. S. Science Club, "The polar constellations."

*Group Projects*

- (1) Abraham Lincoln Jr. H. S. Bit-o-Science Club, Rockford, "Quarterly paper."
- (2) Abraham Lincoln Jr. H. S. Astronomy Club, Rockford, "Large Scrap-book."
- (3) Abraham Lincoln Jr. H. S. Science Club, Rockford, "Terrarium."

*Commercial Products (Individual)*

- (1) Wayne Herrin, David Prince Jr. H. S. Science Club, "Six stereoptican slides,"

*Commercial Products (Group)*

- (1) J. Sterling Morton Jr. H. S. General Science Club, Cicero.
- (2) David Prince Jr. H. S. Science Club, "Constellation slides."

*Individual Collection*

- (1) Wayne Herrin, David Prince Jr. H. S. Science Club, "Leaves of Jacksonville trees."

*Group Collection*

- (1) David Prince Jr. H. S. Science Club, "Wild flowers."

*Individual Model*

- (1) George Carroos, David Prince Jr. H. S., "Planetarium."

*Science Notebook*

- (1) Wayne Herrin, David Prince Jr. H. S. Science Club, "Astronomy."
- (2) Edwin White, David Prince Jr. H. S. Science Club, "Astronomy."

*Radio Notebook*

- (1) Wayne Herrin, David Prince Jr. H. S. Science Club.
- (2) Edwin White, David Prince Jr. H. S. Science Club,

REPORT OF THE DELEGATE TO THE ACADEMY CONFERENCE  
OF THE A.A.A.S.

Atlantic City, December 28, 1936

The delegates to the Academy Conference met at 4:15 p. m. at Haddon Hall Hotel, in Atlantic City, William Alexander of the Ohio Academy presiding, with S. W. Bilsing of the Texas Academy as Secretary. At the close of the Conference the delegates were the guests of the A.A.A.S. at a complimentary dinner.

Dr. H. A. Enders presented a report of the committee appointed to consider what disposition had been made of the A.A.A.S. grants for research. It included a detailed statement of grants made by 18 academies which showed a wide diversity in the fields of research in which the funds were granted. Various problems of biology were most frequently favored, but the range extended to astronomy, surgery, anthropology, chemistry, and geology.

Various delegates made suggestions as to the proper routine to follow in receiving applications for the grants and in selecting the proper fields of research, but no recommendations were made by the Conference.

Dr. Otis Caldwell communicated the following: "At the recent meeting of the Executive Committee of the American Association for the Advancement of Science the following vote was passed (1) that the sum of each research grant for 1936-37 is to be based upon the number of members in good standing in both the Academy and in the A.A.A.S.; (2) the Academy is asked to report to the A.A.A.S. the number of members common to both organizations. These changes have been asked by some academies and are approved by the Executive Committee. Furthermore, another vote passed at the Executive Committee Meeting provides that when the amount of the research grant has been determined as based upon the academy organizations, the research grant shall then be forwarded to the proper officer in each academy and disbursed directly by the academy. Reports of the research assignments made by the academy are to be sent in accordance with the vote quoted herewith. We sincerely hope that this arrangement will be an improvement and that it will be welcomed by the academies. In case some one else in your academy has been designated to attend to such matters, will you please send this letter to the proper person."

There followed a series of brief reports from the delegates regarding the activities and problems of their particular academies. Many spoke of the increasing interest in high school science clubs and in the development of Junior Academies.

Your delegate reported the increasing importance of "Science Club Service" published by our Junior Academy and edited by Louis A. Astell. Dr. Enders of the Indiana Academy also emphasized the importance of this publication in directing and correlating the activities of the science club in the various states. The desirability of financial support for this publication was discussed without reaching any other conclusion than that the various academies should be urged to subscribe.

It was suggested that reports from those who had received grants might be called for at a future conference.

(Signed) GEO. D. FULLER, *Delegate.*

## REPORT OF THE DELEGATE TO THE CONSERVATION COUNCIL

Among the notable growths and activities of the past year should be included the development of the General Wildlife Federation with units in the process of formation in Illinois and other states. Mr. Darling resigned from the U. S. Biological Survey and following this, gave his time to bring about the Conference

and Federation activity. Many states are now developing Federations through various conservation agencies and in many cases under the sponsorship of the Junior Chamber of Commerce. It is hoped that a great unity of purpose and action will develop throughout the country bringing conservation development to a place more nearly in line with the needs of our National development.

For years the State Academy of Sciences has insisted that stream pollution must be stopped. The control of stream pollution seems definitely assured through laws requiring state approval, through license, of definite types of sewage disposal plants whenever a new plant is installed or an old plant must be rehabilitated. Fish are again finding the Illinois river habitable and bass are again abundant. The constant application of this law will eventually insure reasonably clean streams.

Development of erosion control, the removal of lands unsuitable for agriculture from cultivation, and forest extension are contributing definitely to wild life preservation through plant cover.

The Board of Advisers appointed by the governor in 1931 laid out a State Park policy containing four major divisions: (1) Historical; (2) scenic; (3) wooded areas; and (4) parkways connecting the areas. Since then not one area has been acquired that is not in accord with this policy. An important addition of land on which Nature may make reclamation is furnished by strip mining. By law the land must be leveled but it may well be a matter of agreement that such land be made the property of the state free from the leveling obligation.

Starved Rock state park should be much larger in order to accommodate the crowds. The old hotel has been converted into a historical museum, a hotel of logs is being built which may induce Illinois people to come and enjoy this beautiful spot.

Some progress has been made toward the solution of forest problems. Of the original 14,000,000 acres of forest in Illinois only 2,300,000 acres remain and this area is in poor condition. To aid these problems two National Forest units were approved in 1933, the Shawnee Unit of 469,272 acres and the Illini Unit of 317,560 acres. Of this twenty-three per cent has been approved for purchase and will shortly be completed. Federal allotments for 1937-38 have been greatly reduced so that the acquisition of the remainder may be much delayed. In view of the fact that New York has 2,250,000 acres and Pennsylvania has 1,500,000 acres of state forests it seems Illinois could well carry the rest.

Illinois is centrally located with a population within three hundred miles of the National Forest units of 19,000,000 of which 7,826,000 are residents of Illinois. The recreation resources of the Forest includes cliffs, rocks and caves, hilly wooded ridges, fine views, and two large river valleys. During 1936 70,000 people visited these areas.

Slowly but surely local, state, and national conservation is becoming more and more sane. The right or wrong of every conservation measure proposed may well be considered from the standpoint of our grandchildren in order that we may train ourselves to a long-time viewpoint.

(Signed) V. O. GRAHAM, *Delegate*.

## REPORT OF THE COMMITTEE ON RESOLUTIONS

We the Committee on Resolutions of the Illinois State Academy of Science, report the following:

RESOLVED, That it is the sense of the Academy that it is indebted to the trustees and President Gordon Chalmers of Rockford College for the very adequate accommodations and arrangements for this meeting. We wish especially to express our thanks to the following for their efforts in making this meeting a success: The president and members of the Rockford Chamber of Commerce; the citizens who have so generously opened their homes to our members; W. W. Aukenbranch, Superintendent of Rockford Schools; Mr. J. E. Blue of the Senior High School; Mr. Welch of the Roosevelt Junior High School; the principals of the other schools; Mr. H. C. Muth of the Lincoln Junior High School; Mrs. Paul Conklin for assisting with the Junior Academy; Professor Evelyn Fernald for her untiring work as chairman of the committee on local arrangements; Swan Peterson and Company for the flowers supplied at luncheon and banquet; the Rockford Garden Club and the Nature Society.

RESOLVED, That the long service of Dr. George D. Fuller, who is retiring at his own request from the office of Treasurer, is appreciated on account of his faithfulness and business management of the office.

RESOLVED, That we wish to express our appreciation of the management and accomplishments of the Junior Academy in the work that it is doing.

RESOLVED, That it is the sense of the Academy that we continue our interest in all enterprises tending to conserve the natural resources of our State, both public and private.

Death has removed from us the following members whose influence and good works are remembered with pleasure and the loss of whom is felt keenly by the Academy:

- Dr. Joseph B. Bacon, Macomb, Ill.
- Miss Anna M. Blake, 409 W. Williams Street, Normal, Ill.
- Dr. H. H. Heflin, Kewanee, Ill.
- Mr. Fred R. Jelliff, Galesburg, Ill. (Life member)
- Dr. Edwin Oakes Jordan, University of Chicago, Chicago (Life member)
- Dr. C. S. Oglevee, 1006 N. Union Street, Lincoln, Ill.
- Frederick W. Platt, 4140 N. Keller Avenue, Chicago
- Miss E. Muriel Poggi, University of Illinois, Urbana
- Albert B. Reagan, 177 E. 4th Street, Provo, Utah
- Dr. K. K. Smith, Northwestern University, Evanston
- Dr. Julius Stieglitz, University of Chicago, Chicago
- Dr. S. L. Weber, 5113 Kimbark Avenue, Chicago

(Signed) CLARENCE BONNELL, *Chairman.*

JOHN R. BALL.

## AFFILIATED HIGH SCHOOL SCIENCE CLUBS

- Arlington Heights*: Arlington Heights Science Club, High School.
- Bloomington*: Amateur Burroughs Club, High School.  
Bloomington Geology Club, High School.
- Blue Island*: Blue Island Biology Club, Community High School.
- Charleston*: Teachers College High School Science Club, High School.
- Chicago*: Botkemzo Club, Parker Senior High School.  
Crane Tech. Zoa-Phyta Club, Crane Tech. High School.  
Fenger Science Club, Fenger High School.  
Lake View Science Club, Lake View High School.  
Major Powell Science Club, Chicago Normal.  
Mendel Science Club, Visitation High School.  
University Science Club, University of Chicago High School.
- Cicero*: Morton Biology Club, J. Sterling Morton High School.  
Morton Chemistry Club, J. Sterling Morton High School.  
Morton Physics Club, J. Sterling Morton High School.
- Clinton*: Bugology Club, Community High School.
- Danville*: Danville Science Club, High School.
- DesPlaines*: Maine Chemistry Club, Maine Township High School.
- East St. Louis*: Lansdowne Science Club, Lansdowne Junior High School.  
Natural Science Club, Rock Senior High School.
- Edwardsville*: Edwards Science Club, High School.  
High School Science Club, Edwardsville High School.
- Granite City*: Vocational Science Club, High School.
- Jacksonville*: David Prince Junior High School Science Club.
- Joliet*: Joliet High School Biology Club, High School.  
Joliet Junior Mineralogists, Township High School.
- McLeansboro*: McLeansboro Science Club, High School.
- Normal*: Chem-Mystery Club, Community High School.
- Pontiac*: Bi-Fi-Ki Society, High School.
- Quincy*: Quincy Alchemists Club, High School.
- Rockford*: Astronomy Club, Abraham Lincoln Junior High School.  
Botany Club, Senior High School.  
Natural Science Club, Senior High School.  
Zoology Club, Senior High School.
- Rockton*: Mote Scientifique, Hononegah Community High School.
- Urbana*: Thornburn Junior Science Club, Thornburn Junior High School.
- West Chicago*: Edisonian Science Club, Community High School.

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. Pepon. (1927.)
- Illinois 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 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.

---

Index to Vol. 29 will be included in Vol. 30, No. 1.



TRANSACTIONS OF THE  
ILLINOIS STATE ACADEMY OF SCIENCE  
GENERAL INDEX TO VOLUME 29  
1936-1937

---

NOTE.—Articles are classified by author, by subject, and further by the following groups of subjects: Academy business, anthropology, botany, chemistry, education, geography, geology, medicine and public health, physics, psychology, and zoology. Since 1930 the *Transactions* have been issued quarterly. The number of the quarterly issue is given in parentheses. Page numbers for each article are inclusive.

A

Academy business

- Affiliated high school science clubs and scientific societies affiliated with Academy (4): 302-303
- American Association for the Advancement of Science, report of delegate to the Academy Conference of the (4): 299
- Annual meeting, minutes of 30th (4): 288-289
- Auditing committee, report of (4): 291
- Conservation Council of Chicago, report of delegate to (4): 299
- Council meetings, minutes of (4): 285-287
- Ecological Bibliography, report of committee on compilation of (4): 291
- Editor, report of (4): 291
- Junior Academy, report of (4): 293
- Junior Section meeting (4): 295  
Winners of awards (4): 295-298
- Legislation and finance, report of committee (4): 293
- Librarian, report of (4): 292
- Membership committee, report of (4): 293
- Memoirs
  - Bain, Walter Gavin, M. D., (1): 17-18
  - Hankinson, Thomas Leroy (1): 19-20
- Officers and committees for 1936-1937, reports of (4): 288-303
- Publications, report of committee on (4): 293

Academy business—*continued*

- Resolutions, report of the committee on (4): 301
- Science Club Service, report on (4): 294
- Treasurer's report (4): 290
- Administration and supervision of special schools and classes, problems connected with (Beals), (2): 231-233
- Agriculture in Egypt, problems of, as related to (Blanchard), (2): 136-138
- Acid catalysis in liquid ammonia (Slobutsky and Audrieth), (2): 104-105
- Aird, C. Clifton, Alaska-Yukon: Unique adjustments, yet unsung (2): 139-141
- Algae and certain fungi, preservation of color in (Stover), (2): 76
- Adolescence, contributions of physical education to (Kranz), (2): 239-240
- Adolescent mind, preparing it for living (Condron), (2): 234-236
- Anderson, Everett S., Putting thrills into laboratory experiments (2): 110
- Animal life, remains from the Kingston kitchen midden site near Peoria, Illinois (Baker), (2): 243-245
- Antiquity of man in America, an interesting anthropological find from the Lake Michigan region (Van Male), (2): 52-53

## Anthropology

- Archaeological survey of Peoria County (Simpson), (2): 50-51  
 Archaeology of western Kentucky (King), (2): 35-38  
 Banner-stones, evolution of (Knoblock), (2): 44-46  
 Indian camp sites along the Mackinaw River near State Route 51 (Hudelson), (2): 41-43  
 Lake Michigan region, an interesting anthropological find from (Van Male), (2): 52-53  
 Mouth, the evolution of the (Wolfe), (2): 54-56  
 Teeth and bones of the mound builders, as related to their diet (Ruyle), (2): 47-49  
 Woodland culture, evidences of at Mossville (Barloga), (2): 33-34  
 Archaeology of western Kentucky (King), (2): 35-38  
 Atlas of the Geography of Illinois (Voskuil), (2): 132

## B

- Bacterial wilt of corn, was there an outbreak of it in central Illinois in 1891 and 1892? (Stevens), (2): 73-75  
 Baker, Frank Collins, Remains of animal life from the Kingston kitchen midden site near Peoria, Illinois (2): 243-245  
 Banner-stones, evolution of (Knoblock) (2): 44-46  
 Barloga, F. L., Evidences of woodland culture at Mossville (2): 33-34  
 Banana port of Santa Marta, South America, the (Zeller), (2): 145-146  
 Barrens vegetation in Illinois (Vestal), (2): 79-80  
 Beals, Frank L., Problems connected with administration and supervision of special schools and classes (2): 231-233  
 Beaver, Paul, Notes on *Stephanoprora Polycastus* (Dietz) from the American crow (2): 247-250  
 Bennett, C. W., Some interesting methods of balancing oxidation-reduction equations (2): 85-86  
 Bigwood Township, Ontario, new nepheline syenites from (Quirke), (2): 179-185  
 Bismuth, non-existence of crystal structure of, in the molten bismuth (Schroeder), (2): 220-222  
 Blanchard, W. O., Some problems of Egyptian agriculture (2): 136-138

- Bog, a Pleistocene deposit and its fossil fauna (Riggs), (2): 186-189  
 Bogs, a comparative study of on Cary and Tazewell drift (Voss), (2): 81  
 Boley, C. C., and McCabe, L. C., The separation and concentration of vitrain, clarain, and fusain in Illinois coal (2): 153-155

## Botany

- Bacterial wilt of corn, was there an outbreak of it in central Illinois in 1891 and 1892? (Stevens), (2): 73-75  
 Barrens vegetation in Illinois (Vestal), (2): 79-80  
 Bogs, a comparative study of, on Cary and Tazewell drift (Voss), (2): 81  
*Brachymeria* (Hymenoptera, Chalcididae), the Illinois species (Burks), (2): 251-254  
 Color in algae and certain fungi, preservation of (Stover), (2): 76  
 Floral zones in mountains of southern Mexico (Noé), (2): 72  
 Growth behavior of excised root tips, influence of certain organic substances upon (Galligar), (2): 59-68  
 Maturing pine forest by reduction in the number of trees (Turner), (2): 77-78  
 Sample-plot statistics in University woods (Marberry, Mees, and Vestal), (2): 69-71  
 Brown, H. A., and Paine, E. B., Electrical discharge phenomena in insulation under high continuous potentials (2): 207-208  
 Burks, B. D., The Illinois species of *Brachymeria* (Hymenoptera, Chalcididae) (2): 251-254  
 Burlington limestone in the Quincy Region, its economic utilization (Lamar), (2): 170-171

## C

- Cady, G. H., The classification of Illinois coals under the operation of the Guffey Bill (2): 149-152  
 The occurrence of coal balls in No. 6 coal bed at Nashville, Illinois (2): 157-158  
 Canada, Bigwood Township, Ontario, New nepheline syenites collected from (Quirke), (2): 179-185

- California, southwestern, dams and reservoirs as related to water supply of (2): 133-135
- Cary and Tazewell drift, a comparative study of bogs on (Voss), (2): 81
- Catalysis, acid, in liquid ammonia (Slobutsky and Audrieth), (2): 104-105
- Cathode ray discharge tubes having hollow cathodes, origin of positive rays in (demonstration) (Knipp and Holcomb), (2): 211-213
- Chemistry**
- Acid catalysis in liquid ammonia (Slobutsky and Audrieth), (2): 104-105
- Chemical resources natural to southern Illinois (Neckers), (2): 95-96
- Coal testing laboratory, as related to the modern coal industry, some remarks on (Rees), (2): 101-103
- Cold light, demonstration of (Sveda and Audrieth), (2): 106
- Energy sources, present and future (Phipps), (2): 98-100
- Highway construction, chemistry in (Dykins), (2): 87-88
- Laboratory experiments, putting thrills into (Anderson), (2): 110
- Laboratory work, its presentation, correlation and demonstration (Shilz), (2): 115-116
- Organic chemistry, its position in a general chemistry course (Gouza), (2): 111-112
- Organic flourine compounds, some anomalous properties of (Finger and Reed), (2): 89-91
- Oxidation-reduction equations, some interesting methods of balancing (Bennett), (2): 85-86
- Photography, as a high school and college course (Sammis), (2): 113-114
- Projects, their place in high school chemistry (Woodworth), (2): 117-119
- $\text{SiO}_2\text{-Al}_2\text{O}_3\text{-CaO-MgO}$  Glasses, corrosion characteristics of (Fryling and Tooley), (2): 92-94
- Starches, pretreating, the effects on corn and wheat starch gels produced by pretreating (Woodruff and MacMasters), (2): 107-109
- Titanium-Hydrogen Peroxide compounds, a study of (Nicholson), (2): 97
- Chemistry, organic, its position in a general chemistry course (Gouza), (2): 111-112
- China, Foochow Basin, some aspects of geography of the (Kwan-te), (2): 142-144
- Clarain, vitrain and fusain of Illinois coal, separation and concentration of (McCabe and Boley), (2): 153-155
- Coal balls, their occurrence in No. 6 coal bed at Nashville, Illinois (Cady), (2): 157-158
- Coal, Illinois, separation and concentration of vitrain, clarain, and fusain of (Boley and McCabe), (2): 153-155
- Coal testing laboratory as related to the modern coal industry, remarks (Rees), (2): 101-103
- Coals, Illinois, the classification of under the operation of the Guffey Bill (Cady), (2): 149-152
- Cohee, G. V., Petrology of the marine sediments off the Mid-Atlantic Coast (2): 161-163
- Cold light, demonstration of (Sveda and Audrieth), (2): 106
- College, merits of a national radio fraternity in a non-technical (Young), (2): 228
- Color, in algae and certain fungi, preservation of (Stover), (2): 76
- Condron, David, Preparing the adolescent mind for living (2): 234-236
- Corn, bacterial wilt of, was there an outbreak of it in central Illinois in 1891 and 1892? (Stevens), (2): 73-75
- Corn and wheat starch gels, the effects produced by pretreating (Woodruff and MacMasters), (2): 107-109
- Corrosion characteristics of  $\text{SiO}_2\text{-Al}_2\text{O}_3\text{-CaO-MgO}$  Glasses (Fryling and Tooley), (2): 92-94
- Crawford, W. W., Descriptions of two larval Nematodes of family Camallanidae found in damselfly naiads (*Enallagma* sp.) (2): 255
- Crystal structure of bismuth, non-existence of in the molten bismuth (Schroeder), (2): 220-221

**D**

- Dams and reservoirs of southwestern California as related to water supply (Jahns), (2): 133-135
- Damselfly naiads, descriptions of two larval Nematodes of family Camallanidae found in, (*Enallagma* sp.) (Crawford), (2): 255

- Diet, teeth and bones of the mound builders as related to their (Ruyle), (2): 47-49
- Discharge phenomena, electrical, in insulation under high continuous potentials (Brown and Paine), (2): 207-208
- Discharge tubes, cathode ray, having hollow cathodes, origin of positive rays in (demonstration) (Knipp and Holcomb), (2): 211-213
- Dykins, Fred A., Chemistry in highway construction (2): 87-88
- Floral zones in mountains of Southern Mexico (Noé), (2): 72
- Fluorine compounds, organic, some anomalous properties of (Finger and Reed), (2): 89-91
- Foochow Basin, some aspects of geography of the (Kwan-te), (2): 142-144
- Forest, maturing pine, by reduction in the number of trees (Turner), (2): 77-78
- Fossil fauna, a Pleistocene bog deposit and its (Riggs), (2): 186-189
- Fraternity, radio, merits of in a non-technical college (Young) (2): 228
- Fruit industry of Illinois as regards its geographic aspects (Harris), (2): 125-128
- Fryling, Charles F., and Tooley, Fay V., Corrosion characteristics of  $\text{SiO}_2\text{-Al}_2\text{O}_3\text{-CaO-MgO}$  Glasses (2): 92-94
- Fungi, preservation of color in algae and certain (Stover), (2): 76
- Fusain, vitrain, and clarain in Illinois coal, the separation and concentration of (Boley and McCabe), (2): 153-155

## E

## Education

- Administration and supervision, problems connected with special schools and classes (Beals), (2): 231-233
- Adolescent mind, preparing the, for living (Condron), (2): 234-236
- Physical education, its contribution to adolescence (Kranz), (2): 239-240
- Reading, motivated remedial reading in the high school (Kopel), (2): 237-238
- Egypt, problems related to agriculture in (Blanchard), (2): 136-138
- Elder, Stanley G., The contact between Glenville and Platteville formations (2): 164-166
- Electrical discharge phenomena in insulation under high continuous potentials (Brown and Paine), (2): 207-208
- Electrical transient visualizers (Reich), (2): 217-219
- Endocrine glands (Ivy), (1): 9-14
- Energy sources present and future (Phipps), (2): 98-100
- Equations, balancing oxidation-reduction, some interesting methods (Bennett), (2): 85-86

## F

- Fauna, a Pleistocene bog deposit and its fossil (Riggs), (2): 186-189
- Finger, G. C., and Reed, Frank H., Some anomalous properties of organic fluorine compounds (2): 89-91
- Flexural vibrations of piezoelectric quartz bars (Tykociner and Woodruff), (2): 225-227
- Flint, W. P., The effect of winter temperatures of 1935-1936 on some of the common Illinois insects (2): 256-258

## G

- Galligar, Gladys C., Influence of certain organic substances upon the growth behavior of excised root tips (2): 59-68
- Gels, starch, the effects produced by pretreating corn and wheat starch upon the (Woodruff and MacMasters), (2): 107-109

## Geography

- Agriculture, some problems of Egyptian (Blanchard), (2): 136-138
- Alaska-Yukon, adjustments unique yet unsung (Aird), (2): 139-141
- Atlas of the geography of Illinois (Voskuil), (2): 132
- Banana port of South America, Santa Marta, the (Zeller), (2): 145-146
- California, southwestern, dams and reservoirs as related to water supply of (Jahns), (2): 133-135
- China, some aspects of geography of the Foochow Basin (Kwan-te), (2): 142-144
- Foochow Basin, some aspects of geography of the (Kwan-te), (2): 142-144

Geography—*continued*

Fruit industry in Illinois, its geographic aspects (Harris), (2): 125-128

Meat production in Illinois, its geographic aspects (Huck), (2): 129-131

Weather, exceptional, of recent years (Ward), (2): 123-124

## Geology

Coal, Illinois, and the separation and concentration of its vitrain, clarain, and fusain (Boley and McCabe), (2): 153-155

Coal balls, occurrence of in No. 6 Coal Bed at Nashville, Illinois (Cady), (2): 157-158

Coal balls, preservation of plant material in, Nashville, Illinois (Schopf), (2): 159-160

Coals, Illinois, and their classification under the operation of the Guffey Bill (Cady), (2): 149-151

Geologic mapping of Illinois, 1839-1936, progress made in (Weller), (2): 192-193

Glacial history of Quincy, Illinois region (Leighton), (2): 172-176

Jurassic of southern Mexico, a collecting trip in 1935 (Noé), (2): 156

Limestone, Burlington, in the Quincy region; its economic utilization (Lamar), (2): 170-171

Nepheline syenites, new, from Bigwood Township, Ontario (Quirke), (2): 179-185

Optic figures, a new means of demonstrating (Quirke), (2): 177-178

Pleistocene bog deposit and its fossil fauna (Riggs), (2): 186-189

Volcanic phenomena, Craters of the Moon, Idaho (Shepherd), (2): 190-191

Glaciers, glacial history of Quincy, Illinois region (Leighton), (2): 172-176

Glands, endocrine (Ivy), (1): 9-14

Glasses,  $\text{SiO}_2\text{-Al}_2\text{O}_3\text{-CaO-MgO}$ , their corrosion characteristics (Fryling and Tooley), (2): 92-94

Glenwood and Plattville formations, the contact between (Elder), (2): 164-166

Goodfellow, Louis D., Recent research in vibro-tactile sensitivity (2): 197-204

Gouza, Julius J., The position of organic chemistry in a general chemistry course (2): 111-112

Growth behavior of excised root tips, influence of certain organic substances upon the (Galligar), (2): 59-68

Guffey Bill, Illinois coals and their classification under the operation of the (Cady), (2): 149-151

Gyroscope, a convenient method for measuring the speed of a (Larson), (2): 214

## H

Harris, Ralph S., Geographic aspects of the fruit industry of Illinois (2): 125-128

Heat insulation (McClenahan), (2): 215-216

High school, Chemistry projects and their place in (Woodworth), (2): 117-119

Photography as a high school and college course (Sammis), (2): 113-114

Reading, motivated remedial, in the (Kopel), (2): 237-238

Highway construction, chemistry in (Dykins), (2): 87-88

Hoff, C. Clayton, Studies on the lymnaeid snail, *Fossaria parva* (Lea), Part I: Winter habits (2): 259-262

Holcomb, James E., and Knipp, Chas. T., Origin of positive rays in cathode ray discharge tubes having hollow cathodes (demonstration) (2): 211-213

Huck, Emilie, Geographic aspects of meat production in Illinois (2): 129-131

Hudelson, C. W., Indian camp sites along the Mackinaw River near State Route 51 (2): 41-43

## I

Idaho, volcanic phenomena in Craters of the Moon (Shepherd), (2): 190-191

## Illinois

Atlas of Illinois geography (Voskuil), (2): 132

Bacterial wilt of corn, was there an outbreak of it in central Illinois in 1891 and 1892? (Stevens), (2): 73-75

Barrens vegetation in Illinois (Vestal), (2): 79-80

Brachmyeria (Hymenoptera, Chalcididae), the Illinois species (Burks), (2): 251-254

## Illinois—continued

## K

- Burlington limestone in the Quincy region, its economic utilization (Lamar), (2): 170-171
- Chemical resources natural to southern Illinois (Neckers), (2): 95-96
- Coal, Illinois, the separation and concentration of vitrain, clarain, and fusain (Boley and McCabe), (2): 153-155
- Coal balls, their occurrence in No. 6 coal bed at Nashville, Illinois (Cady), (2): 157-158
- Coal balls, from Nashville, Illinois, plant material as preserved in (Schopf), (2): 159-160
- Coals, Illinois, their classification under the operation of the Guffey Bill (2): 149-152
- Fruit industry of, and its geographic aspects (Harris), (2): 125-128
- Geography of Illinois, an Atlas (Voskuil), (2): 132
- Geographic aspects of meat production in (Huck), (2): 129-131
- Geologic mapping of Illinois, 1839-1936, progress made in (Weller), (2): 192-193
- Geography of Illinois, an Atlas (Voskuil), (2): 132
- Geographic aspects of meat production in (Huck), (2): 129-131
- Geologic mapping of Illinois, 1839-1936, progress made (Weller), (2): 192-193
- Indian camp sites along the Mackinaw River near State Route 51 (Hudelson), (2): 41-43
- Insects, common Illinois, effect of winter temperatures of 1935-36 on some (Flint), (2): 256-258
- Insulation, heat (McClenahan), (2): 215-216
- Ivy, A. C., Endocrine glands (1): 9-14
- J
- Jahns, Richard H., The relation of dams and reservoirs to the water supply of southwestern California (2): 133-135
- James, A. J., A study of a remarkable meteor (2): 167-169
- Jurassic of southern Mexico, a collecting trip in 1935 (Noé), (2): 156
- Javelins, an interesting anthropological find from the Lake Michigan region (Van Male) (2): 52-53
- Kentucky, archaeology of western (King), (2): 35-38
- King, Fain W., Archaeology of western Kentucky (2): 35-38
- Kingston kitchen midden site near Peoria, Illinois, remains from (Baker), (2): 243-245
- Knight, Kenneth L., Preliminary factors in the use of tree rings to date mounds of the Mississippi Valley (2): 39-40
- Knipp, Charles T., A cold cathode rectifier (demonstration) (2): 209-210
- Knipp, Chas. T., and Holcomb, James E., Origin of positive rays in cathode ray discharge tubes having hollow cathodes (demonstration) (2): 211-213
- Kopel, David, Motivated remedial reading in the high school (2): 237-238
- Knoblock, Byron W., Evolution of banner-stones (2): 44-46
- Kranz, L. G., Contributions of physical education to adolescence (2): 239-240
- Kwan-te, Lin, Some aspects of geography of the Foochow Basin (2): 142-144
- L
- Laboratory experiments, four suggestions for putting thrills into (Anderson), (2): 110
- Laboratory switchboard, one of low cost (Smith), (2): 222-224
- Laboratory work, its presentation, correlation and demonstration (Schilz), (2): 115-116
- Lake Michigan region, an interesting anthropological find from (Van Male), (2): 52-53
- Lamar, J. E., The economic utilization of the Burlington limestone in the Quincy region (2): 170-171
- Larson, K. G., A convenient method for measuring the speed of a gyroscope (2): 214
- Larval nematodes of family Camallanidae in damselfly naiads, descriptions of two (Crawford), (2): 255
- Leighton, M. M., The glacial history of the Quincy, Illinois, region (2): 172-176
- Limestone, Burlington, in the Quincy region, its economic utilization (Lamar), (2): 170-171

## M

- MacMasters, Majel M., and Woodruff, Sybil, The effects on corn and wheat starch gels of pretreating (2): 107-109
- Marberry, W. M., Mees, J. D., and Vestal, A. G., Sample-plot statistics in University woods (2): 69-71
- Marine sediments, petrology of, off the Mid-Atlantic coast (Cohee), (2): 161-163
- Maturing pine forest by reduction in the number of trees (Turner), (2): 77-78
- McCabe, L. C., and Boley, C. C., The separation and concentration of vitrain, clarain, and fusain in Illinois coal (2): 153-155
- McClenahan, F. M., Heat insulation (2): 215-216
- Meat production in Illinois, its geographic aspects (Huck), (2): 129-131
- Medicine and public health
- Glands, mucous membrane of the nose (Sneller), (1): 5-8
- Milk, preliminary studies in (Walker and Dunk), (2): 29-30
- Vibro-tactile sensitivity, recent research in (Goodfellow), (2): 197-204
- Mees, J. D., Marberry, W. M., and Vestal, A. G., Sample-plot statistics in University woods (2): 69-71
- Meteor, a study of a remarkable one (James), (2): 167-169
- Mexico, southern, the Jurassic of, a collecting trip in 1935 (Noé), (2): 156
- Mid-Atlantic coast, petrology of the marine sediments off the (Cohee), (2): 161-163
- Mississippi Valley, preliminary factors in the use of tree rings to date mounds of the (Knight), (2): 39-40
- Mossville, evidences of woodland culture at (Barloga), (2): 33-34
- Mound builders, teeth and bones as related to diet (Ruyle), (2): 47-49
- Mounds, of the Mississippi Valley, preliminary factors in the use of tree rings to date mounds (Knight), (2): 39-40
- Mouth, the evolution of the (Wolfe), (2): 54-56

## N

- Nashville, Illinois,  
Coal balls in No. 6 coal bed at Nashville, Illinois, occurrence of (Cady), (2): 157-158

- Coal balls, plant material as preserved in, from Nashville, Illinois (Schopf), (2): 159-160
- Neckers, J. W., The natural chemical resources of southern Illinois (2): 95-96
- Nematodes, larval, of family Camallanidae in damselfly naiads, descriptions of two (Crawford), (2): 255
- Nicholson, D. G., Titanium-Hydrogen Peroxide compounds (2): 97
- Noé, A. C., A collecting trip into the Jurassic of southern Mexico in 1935 (2): 156
- Floral zones in the mountains of Southern Mexico (2): 72
- Nose, mucous membrane of the (Sneller), (1): 5-8

## O

- Ontario, new nepheline syenites from Bigwood Township (Quirke), (2): 179-185
- Optic figures, a new means of demonstrating them (Quirke), (2): 177-178
- Organic fluorine compounds, some anomalous properties of (Finger and Reed), (2): 89-91
- Oxidation-reduction equations, some interesting methods of balancing (Bennett), (2): 85-86

## P

- Paine, E. B., and Brown, H. A., Electrical discharge phenomena in insulation under high continuous potentials (2): 207-208
- Peoria County, archaeological survey of (Simpson), (2): 50-51
- Peoria, Illinois, a study of a remarkable meteor in the winter of 1875-1876 (James), (2): 167-169
- Remains of animal life from the Kingston kitchen midden site near (Baker), (2): 243-245
- Petrology of the marine sediments off the Mid-Atlantic coast (Cohee), (2): 161-163
- Phipps, H. E., Present and future energy sources (2): 98-100
- Photography as a high school and college course (Sammis), (2): 113-114
- Physical education, contributions of to adolescence (Kranz), (2): 239-240

## Physics

- Bismuth, does the crystal structure of solid single crystal bismuth exist after the bismuth crystal is melted? (Schroeder), (2): 220-221
- Cold cathode rectifier, (demonstration) (Knipp), (2): 209-210
- Electrical discharge phenomena, in insulation under high continuous potentials (Brown and Paine), (2): 207-208
- Electric transient visualizers (Reich), (2): 217-219
- Flexural vibrations, of piezoelectric quartz bars (Tykociner and Woodruff), (2): 225-227
- Gyroscope, a convenient method for measuring speed of a (Larson), (2): 214
- Heat insulation (McClenahan), (2): 215-216
- Positive rays, origin of, in cathode ray discharge tubes having hollow cathodes, (demonstration), (Knipp and Holcomb), (2): 211-213
- Radio fraternity, national, merits of in a non-technical college (Young), (2): 228
- Switchboard, a low-cost laboratory (Smith), (2): 222-224
- Pine forest, maturing by reduction in the number of trees (Turner), (2): 77-78
- Plattville and Glenwood formations, contact between (Elder), (2): 164-166
- Pleistocene bog deposit and its fossil fauna (Riggs), (2): 186-189
- Polaroid, a new means of demonstrating optic figures (Quirke), (2): 177-178
- Projects in chemistry, their place in high school (Woodworth), (2): 117-119

## Psychology

- Adolescent mind, preparing it for living (Condon), (2): 234-236
- Physical education, its contribution to adolescence (Kranz), (2): 239-240
- Reading in the high school, motivated remedial (Kopel), (2): 237-238

## Public health and medicine

- Glands, endocrine (Ivy), (1): 9-14
- Milk, preliminary studies in (Walker and Dunk), (2): 29-30

## Public health and medicine—continued

- Nose, mucous membrane of the (Sneller), (1): 5-8
- Vibro-tactile sensitivity, recent research in (Goodfellow), (2): 197-204

## Q

- Quartz bars, piezoelectric, flexural vibrations of (Tykociner and Woodruff), (2): 225-227
- Quincy, Illinois region, Glacial history of (Leighton), (2): 172-176
- Economic utilization of the Burlington limestone in the (Lamar), (2): 170-171
- Quirke, T. T., A new means of demonstrating optic figures (2): 177-178
- New Nepheline Syenites from Bigwood Township, Ontario (2): 179-185

## R

- Radio fraternity, national, merits of in a non-technical college (Young), (2): 228
- Reading, motivated remedial, in the high school (Kopel), (2): 237-238
- Rectifier, a cold cathode rectifier (demonstration) (Knipp), (2): 209-210
- Reduction-oxidation equations, some interesting methods of balancing (Bennett), (2): 85-86
- Reed, Frank H., and Finger, G. C., Some anomalous properties of organic flourine compounds (2): 89-91
- Rees, O. W., Some remarks on the coal testing laboratory as related to the modern coal industry (2): 101-103
- Reich, Herbert J., Electronic transient visualizers (2): 217-219
- Reservoirs and dams of southwestern California, as related to water supply (Jahns), (2): 133-135
- Resources, natural chemical, of southern Illinois (Neckers), (2): 95-96
- Riggs, Elmer S., A Pleistocene bog deposit and its fossil fauna (2): 186-189
- Ross, Herbert H., The nearctic sawflies of the genus *Fenusia* (Hymenoptera, Tenthredinidae) (2): 263-266
- Ruyle, J. B., The teeth and bones of the mound builders as related to their diet (2): 47-49

## S

- Sample-plot statistics in University woods (Marberry, Mees, and Vestal), (2): 69-71
- Santa Marta, the South American banana port (Zeller), (2): 145-146
- Sawflies, nearctic, of the genus *Fenusa* (Hymenoptera, Tenthredinidae) (2): 263-266
- Schilz, Carl E., Presentation, correlation and demonstration in laboratory work (2): 115-116
- Schools, special, and classes, problems connected with administration and supervision of (Beals), (2): 231-233
- Schopf, James M., Preservation of plant material in coal balls from Nashville, Illinois (2): 159-160
- Schroeder, J. Henry, Does the crystal structure of solid single crystal bismuth exist after the bismuth crystal is melted? (2): 220-221
- Sensitivity, vibro-tactile, recent research in (Goodfellow), (2): 197-204
- Shepherd, G. Frederick, Volcanic phenomena in the Craters of the Moon, Idaho (2): 190-191
- Silicate melts glasses, corrosive characteristics of  $\text{SiO}_2\text{-Al}_2\text{O}_3\text{-CaO-MgO}$  glasses (Fryling and Tooley), (2): 92-94
- Simpson, A. M., Archaeological survey of Peoria County (2): 50-51
- Slobutsky, Charles, and Audrieth, L. F., Acid catalysis in liquid ammonia (2): 104-105
- Smith, Clarence R., A laboratory switchboard of low cost (2): 222-224
- Snail, Lymnaeid, *Fossaria parva* (Lea), Studies. Part I: Winter habits (Clayton), (2): 259-262
- Sneller, Charles D., Mucous membrane of the nose (1), 5-8
- Sommer, Joseph B., Notes on the European Starling in Illinois, (2): 267
- South America, Santa Marta, the banana port of, (Zeller), (2): 145-146
- Spears, an interesting anthropological find in the Lake Michigan region, (Van Male) (2): 52-53
- Speed, of a gyroscope, a convenient method of measuring (Larson), (2): 214
- Starches, the effects on corn and wheat starch gels produced by pretreating (Woodruff and MacMasters), (2): 107-109
- Starling, European in Illinois (Sommer), (2): 267
- Stephanoprora polycestus* (Dietz), from the American crow (Beaver), (2): 247-250
- Stevens, Neil E., Was there an outbreak of bacterial wilt of corn in central Illinois in 1891 and 1892? (2): 73-75
- Stover, E. L., An interesting preservation of color in the algae and certain fungi (2): 76
- Supervision and administration, problems connected with special schools and classes (Beals), (2): 231-233
- Sveda, Michael, and Audrieth, L. F., Demonstration of cold light (2): 106
- Switchboard, laboratory, a low-cost (Smith), (2): 222-224
- Syenites, new nepheline, from Bigwood Township, Ontario (Quirke), (2): 179-185

## T

- Tazewell and Cary drift, a comparative study of bogs on (Voss), (2): 81
- Teeth and bones of the mound builders, as related to their diet (Ruyle), (2): 47-49
- Temperatures, winter of 1935-1936, the effect on some of the common Illinois insects (2): 256-258
- Testing laboratory, coal, some remarks on as related to the modern coal industry (Rees), (2): 101-103
- Titanium-Hydrogen Peroxide compounds (Nicholson), (2): 97
- Tooley, Fay V., and Fryling, Charles F., Corrosion characteristics of  $\text{SiO}_2\text{-Al}_2\text{O}_3\text{-CaO-MgO}$  Glasses (2): 92-94
- Transient visualizers, electric (Reich), (2): 217-219
- Tree rings, preliminary factors in the use of, to date mounds of the Mississippi Valley (Knight), (2): 39-40
- Turner, Lewis M., Reduction in the number of trees in maturing pine forest (2): 77-78
- Tykociner, J. T., and Woodruff, M. N., Flexural vibrations of piezoelectric quartz bars (2): 225-227

## U

- University woods, sample-plot statistics of (Marberry, Mees, and Vestal), (2): 69-71

## V

- Van Male, W. C., An interesting anthropological find from the Lake Michigan region (2): 52-53
- Vestal, A. G., Marberry, W. M., and Mees, J. D., Sample-plot statistics in University woods (2): 69-71
- Vibrations, flexural, of piezoelectric quartz bars (Tykociner and Woodruff), (2): 225-227
- Vibro-tactile sensitivity, recent research in (Goodfellow), (2): 197-204
- Visualizers, electric transient (Reich), (2): 217-219
- Vitrain, clarain, and fusain in Illinois coal, the separation and concentration of (Boley and McCabe), (2): 153-155
- Volcanic phenomena in the Craters of the Moon, Idaho (Shepherd), (2): 190-191
- Voskuil, W. H., An atlas of the geography of Illinois (2): 132
- Voss, John, A comparative study of bogs on Cary and Tazewell drift (2): 81

## W

- Walker, Robert J., and Dunk, Milton R., Preliminary studies in milk (2): 29-30
- Ward, Harold B., Exceptional weather of recent years (2): 123-124
- Water supply, the relation of dams and reservoirs to that of southwestern California (2): 133-135
- Weather, exceptional, of recent years (Ward), (2): 123-124
- Weller, J. Marvin, Progress in geologic mapping of Illinois, 1839-1936 (2): 192-193
- Wheat and corn starch gels, the effects produced by pretreating (2): 107-109
- Winter temperatures of 1935-1936, the effect on some of the common Illinois insects (Flint), (2): 256-258
- Wolfe, L. H., The evolution of the mouth (2); 54-56
- Woodland culture, evidence of at Mossville (Barloga), (2): 33-34

- Woods, University, sample-plot statistics in (Marberry, Mees, and Vestal), (2): 69-71
- Woodworth, M. E., The place of projects in high school chemistry (2): 117-119
- Woodruff, M. N., and Tykociner, J. T., Flexural vibrations of piezoelectric quartz bars (2): 225-227
- Woodruff, Sybil, and MacMasters, Majel M., The effects on corn and wheat starch gels produced by pretreating the starches with freezing or with chemical reagents (2): 107-109

## Y

- Young, O. B., Merits of a national radio fraternity in a non-technical college (2): 228
- Yukon, Alaska-, adjustments in, unique yet unsung (Aird), (2): 139-141

## Z

- Zeller, Rose, Santa Marta the banana port of South America (2): 145-146

## Zoology

- Animal life, remains from the Kingston kitchen midden site near Peoria, Illinois (Baker), (2): 243-245
- Brachymeria* (Hymenoptera, Chalcididae), the Illinois species (Burks), (2): 251-254
- Illinois insects, the effect of winter temperatures of 1935-1936 on some of the common, (Flint), (2): 256-258
- Larval nematodes of family Camallanidae, descriptions of two found in damselfly naiads, (*Enallagma* sp.) (Crawford), (2): 255
- Nearctic sawflies of the genus *Fenusa* (Hymenoptera, Tenthredinidae) (Ross), (2): 263-266
- Snail, Lymnaeid, *Fossari parva* (Lea), studies. Part I: Winter habits (Clayton), (2): 259-262
- Starling, European in Illinois (Sommer), (2): 267
- Stephanoprora polycestus* (Dietz), from the American crow (Beaver), (2): 247-250

5  
e  
APR 2 1938

UNIVERSITY OF ILLINOIS

TRANSACTIONS  
OF THE  
ILLINOIS STATE  
ACADEMY OF SCIENCE

---

VOLUME 29

JUNE, 1937

NUMBER 4

---

Minutes of Council Meetings  
Minutes of Thirtieth Annual Meeting  
Reports of Officers and Committees



EDITED BY DOROTHY E. ROSE

PRINTED BY THE ILLINOIS STATE ACADEMY OF SCIENCE

Affiliated with the

STATE MUSEUM DIVISION, CENTENNIAL BUILDING

SPRINGFIELD, ILLINOIS

TRANSACTIONS OF THE ILLINOIS STATE ACADEMY OF SCIENCE

	PRICE
Vol. I, 1908, published by the Academy.....	\$1.50
Vol. II, 1909, published by the Academy.....	1.50
Vol. III, 1910, published by the Academy.....	1.50
Vol. IV, 1911, published by the State.....	Gratis
Vol. V, 1912, published by the State.....	Gratis
Vol. VI, 1913, published by the Academy.....	1.50
Vol. VII, 1914, published by the Academy.....	1.50
Vol. VIII, 1915, published by the Academy.....	1.50
Vol. IX, 1916, published by the Academy.....	1.50
Vol. X, 1917, published by the Academy.....	1.50
Vol. XI, 1918, published by the State.....	Gratis
Vol. XII, 1919, published by the State (exhausted)	
Vol. XIII, 1920, published by the State (exhausted)	
Vol. XIV, 1921, published by the State (exhausted)	
Vol. XV, 1922, published by the State (exhausted)	
Vol. XVI, 1923, published by the State (exhausted)	
Vol. XVII, 1924, published by the State (exhausted)	
Vol. XVIII, 1925, published by the State (exhausted)	
Vol. XIX, 1926, published by the State (exhausted)	
Vol. XX, 1927, published by the State (exhausted)	
Vol. XXI, 1928, published by the State (exhausted)	
Vol. XXII, 1929, published by the State (exhausted)	
Vol. XXIII, 1930, published by the State. Quarterly issues (Nos. 2 and 3 exhausted)	
Vol. XXIV, 1931, published by the State. Quarterly issues (No. 3 exhausted)	
Vol. XXV, 1932. Quarterly issues	
Vol. XXVI, 1933. Quarterly issues (No. 3 exhausted)	
Vol. XXVII, 1934. Quarterly issues	
Vol. XXVIII, 1935. Quarterly issues (No. 3 exhausted)	
Vol. XXIX, 1936. Quarterly issues	

Volumes 23 and following are free to members. Price to non-members is \$1.50 for complete volume.

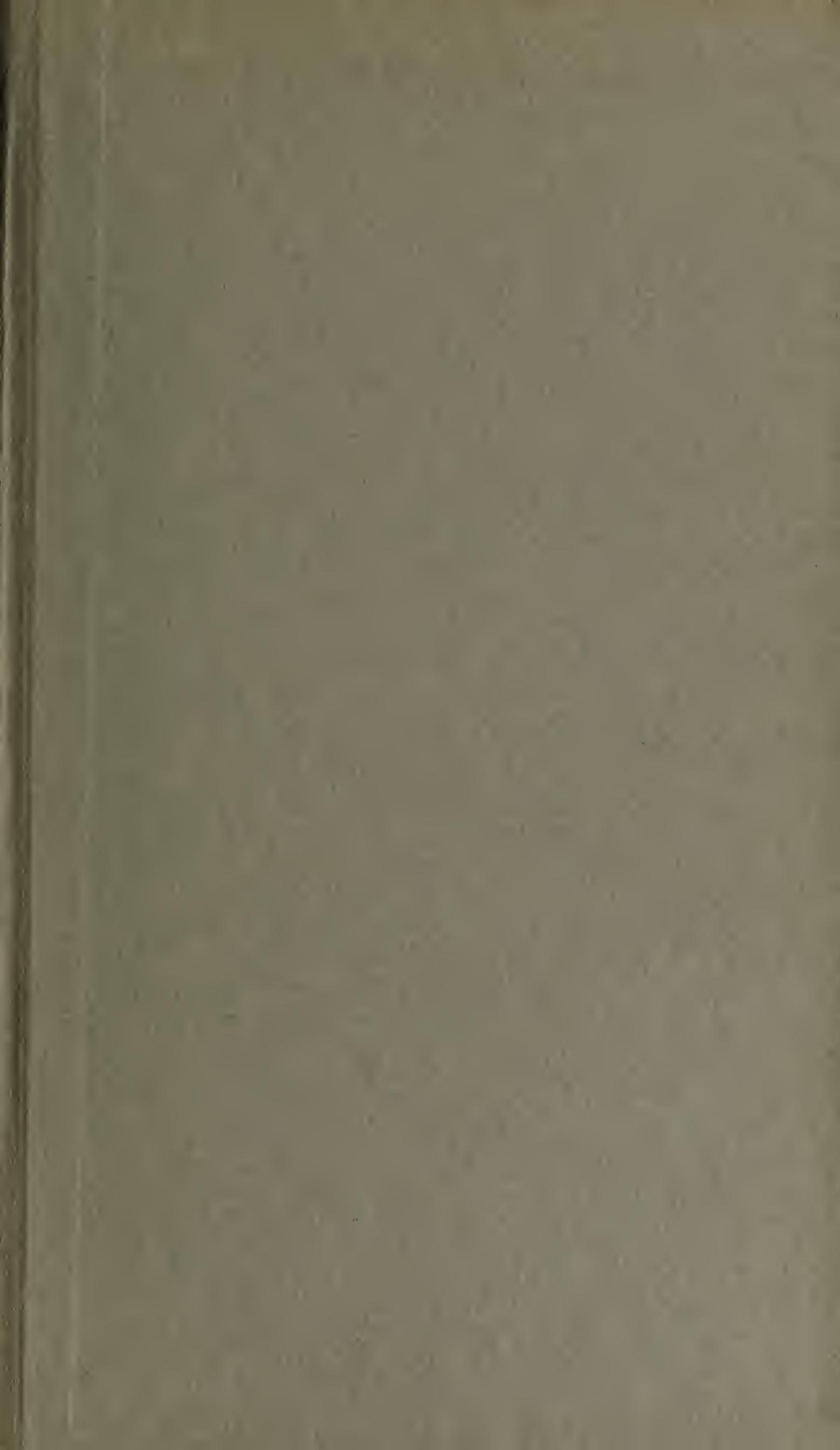
Address orders to The Librarian, State Museum, Springfield, Illinois.











UNIVERSITY OF ILLINOIS-URBANA  
506IL C004  
TRANSACTIONS. SPRINGFIELD  
28-29 1935-37



3 0112 026533494